Note de recherche

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An Empirical Analysis

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Networks and Proximity: An Empirical Analysis

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A growing body of theoretical and empirical literature examines inter-firm agreements and the role they play in the development of firms' strategies (Hagerdoorn and Schakenraad, 1990, Chesnais, 1988). According to this literature, geographical proximity plays a dual role in network formation. On the one hand, it contributes to the formation of networks through the establishment of personal contacts and the built-up of social capital in local business districts. On the other hand, geographical proximity plays a dissuasive role in the formation of networks by erecting barriers to entry and inhibiting innovation. This may happen when networks are densely located in some closely related business communities. Firms located in distant geographical areas are, apparently, more prone to establish network relations.

Some researchers (Teece, 1982, Antonelli, 1988) relate the formation of networks to the process of innovation and technological change. *Externalities* and spillover effects are important in some industries (high-tech for example) and highly dependent on distance. High levels of communication affect the transmission of externalities. Geographical proximity is thus a strong necessary condition to take advantage of externalities generated by other firms. Networks emerge as a result of efforts to internalize selectively the variety of factors necessary to master the process of innovation. Regional clustering in industrial districts enhances complementary advantages and provides the skills and specialization necessary to achieve higher levels of productivity and competitiveness. Intra-regional exchange relations are thus seen as a way of strengthening a firm's market base increasing, thereby, the industry's competitive position internationally. The problem with the externalities approach is that it fails to take into account the dynamic nature of networks and does not provide any analytical framework explaining the durability of the agreements.

Another strand of research emphasizes the presence of *transaction costs* as a factor contributing to the formation of networks. According to this theory, networks are seen as long-term agreements located between market transactions and internal organization and are set in order to internalize the transaction costs incurred by firms in the market place (Williamson, 1985). Transaction costs are minimized especially when asset specificity and uncertainty are located at an intermediate level. The problem with the transaction costs approach is that it considers trade-offs between institutional arrangements in a static way. It also fails to explain why networks are established even when transaction costs are minimal or even not existent. There is a growing theoretical and empirical literature (Ciborra, 1990, Zanfei, 1990) arguing that networks are becoming an important strategy for acquiring and managing *knowledge assets*. Networks are increasingly seen as primary mechanisms by which firms formalize their links to external sources of innovation and the creation of new knowledge assets. An increase in knowledge contributes to a firm's competitive advantage. To the extent that competition, technological changes and other environmental factors increase R&D costs and risks and shorten products' life cycles, sharing resources among different organizations reduces costs and favors the formation of networks. Networks are thus considered to be the outcome of two simultaneous failures; of markets in transferring knowledge and of internal organization in accumulating it.

Firms use networks as a temporary solution to the problem of acquiring knowledge assets. Networks as a "wait-and-see" strategy are very valuable especially in uncertain and dynamic information environments. In that way, networks can be considered as "options" with real underlying value. In this paper we use the *option value theory* (Arrow and Fisher, 1974) to specify the value of the flexibility of the network. We analyze it as an option in an uncertain and dynamic information environment. Networks are unstable strategies and as such they do not minimize transaction costs. Their value lay therefore in *dynamic* aspects such as *flexibility and interactive learning*, which further generate a new specific asset. As this new asset is gradually appropriated by the partners and it is progressively embedded into their routine processes, the collaboration of partners increases and the network becomes more integrated and therefore more stable.

There are benefits and costs of interactive learning, which depend on the "knowledge" distance between the two entities (Lundvall, 1991). I argue that *distance does not necessarily have a geographical dimension but it is mostly associated with culture and distance in knowledge*. The more distant (different) firms' knowledge base is, the greater their learning potential. Once the network is set up, interactive learning becomes possible through the establishment of procedures, which allow information channels to be shared, and codes of information to be exchanged. The process of mutual understanding is costly when the knowledge distances are far apart (Llerena and Wolff, 1991).

My approach, by using the concept of *knowledge proximity* rather than of geographical distance, explains the formation of networks better (both vertical and horizontal).

Networks are situated some distance apart on the knowledge continuum by complementary technologies (i.e., vertical networks) or closer to that continuum with similar streams of production process but with different knowledge bases (horizontal networks). Case studies from the car and the telecommunications industries serve as examples in testing my approach.

The next section examines, in more detail, the arguments for network formation and reviews the literature. I then present the analytical framework and the testable hypothesis of my model. To validate the thesis, I examine the reasons for establishing networks in the car and telecommunications industries. It appears that the networks are the preferred strategy when the degree of sunkness of costs (risk) is high. The net benefits are maximized when firms "buy" the option of "wait-and-see" strategy.

Networks, Agreements and Transaction Costs

Flexibility is a market characteristic, the cornerstone of any market mechanism. Economists argue that flexibility, through price and quantity adjustments, inherent in unfettered (not regulated) market structures ensures an optimal allocation of resources (Pareto optimality). Networks, as opposed to integration are more flexible organizational structures than hierarchies (integration).

If integration and other centralized strategies reduce flexibility why do firms decide to go ahead with this strategy? Williamson (1975, 1989) argued that firms use hierarchies instead of markets because of the existence of transaction costs. The latter are loosely defined to include any costs associated with the use of markets instead of hierarchies. Transaction costs are exacerbated because economic agents act opportunistically, especially in environments characterized by asymmetric information and uncertainties. If we add to this bounded rationality, i.e., the natural limitations in the cognitive abilities of economic agents to resolve complex situations, and asset specificity, economic agents would incur substantial costs to make contracts between parties that try to take into account every possible outcome. This *ex ante* limitation in writing perfect contracts and the costs associated with *ex post* complying, monitoring and enforcing the contract's contingent clauses provides firms with sound incentives to use hierarchies instead of market transactions.

Asset specificity and uncertainty play a significant role in explaining a firm's decision to use hierarchies. Asset specificity arises from the specialization of a valuable resource. The higher the specificity of an asset, the lower its ability to find alternative uses without sacrificing valuable productive capacity. Investments in specific assets with limited alternative uses are considered to have high sunk costs, which give rise to a small number environment with possibilities of strategic bargaining and opportunistic behavior. Asset specificity can take various forms such as geographic specificity, physical asset specificity, and human resources specificity.

Uncertainty arises from changing market and technology conditions. The recent radical technological changes greatly transformed many markets. The institutional changes (deregulation, globalization, internationalization and atomization of production) that have followed the technological innovations increased transaction costs and with them the specificity (the sunkness) of assets used in the production process. In these cases, transaction costs would make the use of hierarchies more cost efficient than market transactions.

In the past decade or so the use of hierarchies did not preclude the use of other strategies like networks. Firms use multiple strategies at the same time. For example, the telecommunications, computers and computer programming, biotechnology, pharmaceutical and the car industries, to name a few, have been dramatically transformed lately through consolidations and outright purchases of rival firms (Niosi, 2001). At the same time these industries have created many networks. Transaction costs theory has difficulties in explaining the simultaneous adoption of these strategies. According to the transaction costs theory, hierarchies (integration) should be the outcome whenever changes in asset specificity result in an increase in the transaction costs. It can then be argued that the transaction costs approach does not fully capture the dynamic features of technology and the formation of networks. I demonstrate, later in the chapter, that option theory gives a more reasonable explanation for the formation of networks.

To substantiate the main argument of transaction costs theory, Llerena et al. (1991) used a diagram (Figure 3.1) to show the links among asset specificity, transaction costs and the various forms of organizational structure. Networks are situated between markets and hierarchies and correspond to an intermediate level of asset specificity. The governance structure that emerges is the one that minimizes transactions costs. But when asset specificity is too high (such as in the telecommunications and the car industries), transaction costs theory is inadequate to explain the formation of networks.

It is my proposition that transaction costs are important but they are not the only factors considered by firms in their integration or network decisions. Other factors such as flexibility and the benefits arising out of it can be predominant factors. It can be the case that firms decide to use both strategies at the same time. If, for example, uncertainty is low, the benefits from using the market are much higher than for other strategies. At intermediary levels of uncertainty, integration is the more advantageous strategy, while when uncertainty is at a high level, networks provide a better choice. There is then a relationship between uncertainty (as measured by the amount of sunk costs) and net benefits of each alternative strategy. The benefits from networks are valuable because they offer flexibility and interactive learning and contribute to the creation of knowledge (vertical and/or horizontal). Networks can thus be analyzed as a means of increasing flexibility. The nature of flexibility considered is a key to our analysis. Flexibility refers to the adaptation capability of the firm and its learning ability. Its adaptation capability protects itself from external shocks while its learning ability enables the network to create resources through a collective learning process (Favereau, 1989, Aoki, 1988).

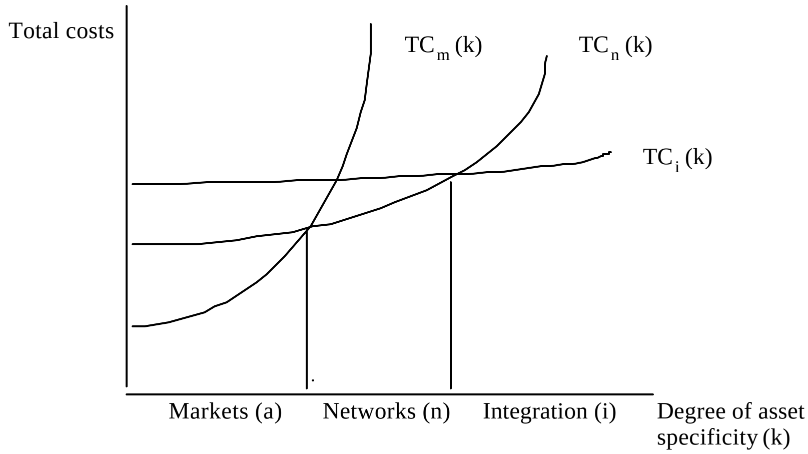

Figure 3.1 Asset Specificity and Choice of Organizational Forms

Networks and Adaptability

Clusters and networks are becoming essential in the present context of globalization. Networks are not simply geographic concentrations of companies. It is a cooperation and interaction of learning through combinations of different kind of knowledge emanating from suppliers, customers, manufacturers of complementary products, government and other institutions such as universities, standards agencies and vocational training providers. Networks' growth is a self-reinforcing cycle. As a single firm's success brings other suppliers or inspires cooperation with other companies or institutions, other companies that can benefit from those resources are drawn closer to the network. Clustering and networking offer companies a favorable business environment that enables firms to get a competitive advantage they could not acquire in isolation (Porter, 1998, p. 78).

The value of networks lies on their ability to create new specific assets. They are conducive to resource creation and innovation through information efficiency generated by cooperation among member firms. The creation of new specific resources increases the core competencies of member firms, their competitiveness and their profitability. Greater knowledge means a greater degree of adaptability and greater capacity to deal with changing economic and business environments. The degree of appropriation of the new knowledge determines the viability and the duration of the network. If spillover effects are low and the appropriation high then agreements tend to be more stable. Learning through interaction and confrontation increases the possibilities for combining diverse experiences and different kinds of knowledge. Such a way of learning brings more innovative approaches to resolve problems related to the management and innovation (R&D) within and among firms.

This interactive learning and the creation of new resources are not without costs. At the beginning of the formation of networks costs are particularly high. But as member firms learn from each other and share their newly created information, establish a common language of communication and reduce their cultural differences, the costs become less important. Once the initial stages of collaboration are set out and cooperation is smoothed out, the interactive learning process begins to bring about the benefits of collaboration. Complementarities in knowledge among member firms are more important in the interactive learning process rather than common knowledge already shared by firms. Accordingly, the benefits of interactive learning increase with greater knowledge distances of member firms. Lundvall (1991) examined the interactive learning in networks and illustrated graphically (Figure 3.2) the potential benefits and costs derived from knowledge distances among member firms. Obviously, the net benefits are maximized when these distances are at an intermediate (d*) level.

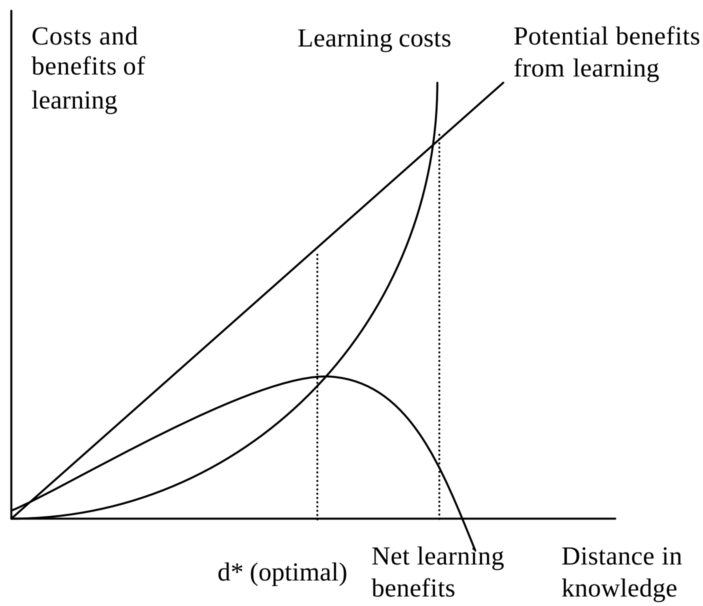

Figure 3.2 Benefits and Costs of Learning

The creation of new specific assets which are gradually incorporated into the networks become routine operations which contribute, in their turn, to the stability of the agreements. Networks become more stable as their capability to appropriate the creation of new specific assets is greater. The new information and communication technologies (ICT) play a pivotal role in shaping the appropriation of new specific assets. Broadband (high-speed data) and other ICT services have the ability to erase distances that have often been considered obstacles to the appropriation of spillovers and the establishment of networks. With ICT's help, many smaller communities and non-urban localities can now become part of a network and enjoy the benefits that used to be the sole province of concentrated activities around certain urban poles. New ICT infrastructure is within the reach of many far distant localities, giving distant firms the same digital opportunities as their urban counterparts. The building of wireless networks, the installation of coaxial cables, or the deployment of copper-based DSL lines and the decision of many high-tech companies to upgrade their own infrastructure and the expansion of the portfolio of services brings greater possibilities of network formation regardless of geographical distances[1].

Uncertainties arising from technological diversification, market segmentation, changing economic and business environment and information asymmetries are increasing. Network-building strategies are flexible business decisions. They allow firms to wait until they accumulate more experience and information before choosing a definite organizational form. Networks are temporary strategies that give firms more time to cope with uncertainty and complexity of information (an intermediate solution between markets and hierarchies). In that sense networks is an "option" with a great underlying value. Viewed as such, the option theory can be used to analyze the formation of networks. The next section presents the option model.

Theoretical Elements of the Formation of Networks: The Option Theory Model

Option theory is concerned with the optimal timing of a strategic decision or when to exercise a strategic decision. The option of optimally acting in the future should be of value today. By undertaking a risky project (j) that is costly and difficult to reverse (sunk investment), the firm incurs costs and "kills" the option of investing if and when conditions are more favorable in the future. If the firm invests today, it would want the present value of expected benefits to equal or exceed the present value of expected costs plus the value of the option to wait. I argue that networks provide member firms the option to wait and see and act later when the firm has more information and knowledge especially in a complex and ever-changing dynamic environment where complexities and opportunistic behavior are more prevalent.

I begin with a simple two-period model to get a feel for these two important aspects of network building capacity. Consider a firm with the following project. Develop a new technology either internally (i.e., an integrated solution (i)) or through building a network (i.e., an agreement (a)). The outcome of this strategy is uncertain. The project (j) has (π) probability of success and ($1-\pi$) of failure.

Using the network entails more transaction costs than using the integrated approach. On static terms, the integrated approach will be favored instead of the establishment of networks. Nevertheless, the strategy to establish networks would be preferred over alternative strategies should we consider that the latter increases a firm's specter of choices in the future and allows it to get more timely information and elaborate more sound strategies. Because of the existence of an *"option value"* in the networks strategy, the latter would be preferred over alternative strategies. The network building process is more like a "buying time" strategy that allows firms to wait and see how the situation evolves before taking a more definite approach.

The value attached to this option strategy can be high enough to compensate for the higher transaction costs of network building ($c_a > c_i$), especially in a world characterized by ever-increasing information complexities. Flexibility is, however, synonymous to instability and the network building strategy is inherently unstable. Networks could become more stable when adaptation and learning are explicitly included into this framework. Suppose a firm decides to use the integrated approach and that the technology development provides T_0 revenues today and D_1 in the future. The present value of the firm choosing the integrated approach is

$D = T_0 + \rho D_1$ where $\rho = 1/(1+\delta)$ is the discount factor. (3.1)

If the firm decides to use the "decisional flexibility" approach i.e., the strategy of building a network, its current value would be A_0. In the future, both this decision (A) and the revenues of the firm are uncertain. Suppose that there are two possibilities

- a positive state of nature (s=1) during which the network building is a success and the new technology is introduced
- a less positive state of nature (s=2) during which the network building is a failure and the technology is not introduced

In the first case, the net revenue $T_{1,1}$ is greater than the firm's current value $A_{1,1}$. In the second case (s=2) the net revenue $T_{1,2}$ is less than the value of the firm $A_{1,2}$. Thus, in the future state 1 $T_{1,1} > A_{1,1}$, and in future state 2, $A_{1,2} > T_{1,2}$.

Suppose we attach probabilities to these two strategies, π with state 1 (s=1) and $(1-\pi)$ with state 2 (s=2), assuming that $T_0 > A_0 > 0$. If the integrated approach is not consummated today, it is optimal to use the integration strategy if state 1 occurs. By contrast, the network building strategy is more optimal if state 2 occurs. With this optimal, state-contingent decision rule, the expected present value of building a network is given by

$P = A_0 + \rho[\pi T_{1,1} + (1-\pi) A_{1,2}]$ (3.2)

It is obvious from this equation that integration is a preferred strategy if D>P, while the network-building approach becomes more attractive if D<P because it gives the option to wait and see and adopt the most advantageous strategy depending on the prevailing state of nature in the time.

The point of indifference, where D = P, implies that

$$T_0 + \rho D_1 - A_0 = \rho[\pi\, T_{1,1} + (1-\pi)A_{1,2}] \qquad (3.3)$$

The left hand side of the equation represents the net value of adopting the integrated approach today while the option value in t = 0 has been deducted from $T_0 + \rho D_1$. On the right hand side the term $\rho[\pi T_{1,1} + (1-\pi)A_{1,2}]$ is the option value of not adopting the integrated approach today (t = 0). If the firm adopts the networking–building approach today instead of the integrated approach, it preserves the option of behaving optimally in the future (integrate in state 1 and use the network-building strategy in state 2). Option value in this case is the discounted expected net value of behaving optimally in the future. Option value is unambiguously positive with positive values for $T_{1,1}$ and $A_{1,2}$ and $1 > \rho > 0$, $1 > \pi > 0$. The above results are presented in Table 3.1.

It is interesting making a comparative static analysis by examining the impact of changing certain values on the incentives to preserve the option of acting more freely in the future. First, an increase in $T_{1,1}$ or $A_{1,2}$ will increase option value and it will tend to increase the incentive to build a network instead of favoring the integration approach. In contrast, an increase in T_0, D_1 or a decrease in A_0 will increase the net value of integration (left hand side) and tend to increase the likelihood of the integrated approach. Finally, an increase in the discount rate δ, will reduce the option value of network formation (right hand side) more than it reduces the left hand side, thus integration becomes a more preferable solution than building a network today. Table 3.2 summarizes the comparative static results of alternative business strategies.

Table 3.1 Comparing Costs and Benefits of Various Business Strategies

Strategies	Transaction costs	Option value	Firm's present value	Decision rule
Network	High	high	$P = A_0 + \rho[\pi\, T_{1,1} + (1-\pi)\, A_{1,2}]$	If D<P Adopt the network strategy
Integration	Low	low	P = positive	If D>P Adopt the integration strategy

It is interesting enough to examine a relationship not so obvious *a priori* concerning the sign of $d\pi/d\delta$ and the optimal option offered to the firm of being indifferent between the integrated approach and the network building strategy. Multiplying both sides of the last equation by $(1+\delta)$ we get the following equation

$(T_0 - A_0)\, d\delta = (T_{1,1} - A_{1,2})\, d\pi$, or (3.4)

$d\pi/d\delta = (T_0 - A_0)/(T_{1,1} - A_{1,2})$ (3.5)

The latter takes into account the changes in π which must counter an increase in δ in order to preserve the indifference. I have assumed that $T_0 > A_0$. If $T_{1,1} > A_{1,2}$, it will be the case that $d\pi/d\delta > 0$, On the contrary, if $A_{1,2} > T_{1,1}$, then $d\pi/d\delta < 0$. Such an outcome is perfectly justified since an increase in the discount rate reduces option value and we would need to increase the probability of the higher-valued future state in order to maintain indifference. If $T_{1,1} > A_{1,2}$, then π must go up, whereas if $A_{1,2} > T_{1,1}$, π must go down in order for $(1-\pi)$ to go up.

Table 3.2 Comparative Statics of Various Business Strategies

Factors	Value of the strategy	Decision rule
If $T_{1,1}\uparrow$ or if $A_{1,2}\uparrow$	$\uparrow$ the network option value	$\uparrow$ network formation
If $T_{0,}$ $D_1\uparrow$ or $A_0\downarrow$	$\uparrow$net value of integration today	$\uparrow$integration adoption strategy
If $\delta\uparrow$	$\downarrow$option value of network formation	Integration today (killing the option)

Although the value of both strategies is quite high today, it is the network strategy that brings more value in the future because of the option it provides to the firm to act later when it possesses more information. This is illustrated graphically (Figure 3.3).

Firms value the short and long term costs and benefits before they adopt a specific strategy. The present value of both integration and network building strategies is quite high but unequal. The integration strategy has a higher value today than the network strategy but its option value is quite low. In contrast, the network strategy has a lower value today but combined with its much higher option value, it has a total present value much higher than the integration strategy because of the flexibility it provides[2]. Firms will use the network strategy whenever uncertainty and other business factors are unstable. The analysis of the establishment of networks in the telecommunications and the car industries provides a heuristic proof of our arguments. Next section deals with this.

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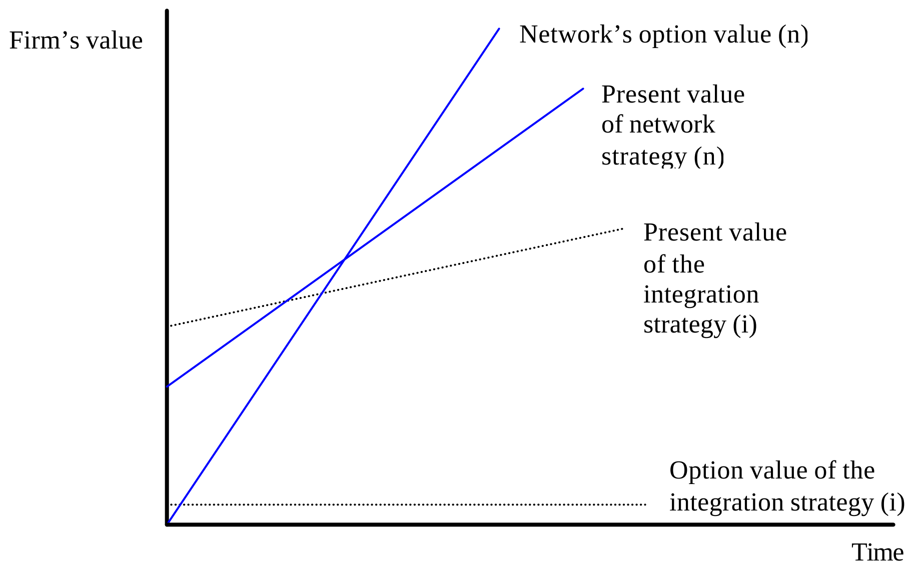

Figure 3.3 Comparing the Value of Network-building and Integration Strategies

Networks and Risk in the Car and Telecommunications Industries

To illustrate our argument we take as an example the car and telecommunications industries. The first one is a more traditional industry although knowledge-intensive one, especially now with the integration of many new technologies in building and running the cars. Although cars seem to be standardized products their components are not. They are completely different from what they were in the past and they depend on a great number of new technologies and knowledge inputs. As Loasby (1998) has argued, firms are becoming increasingly multi-technology in their production processes. They are increasingly relying on a growing range of networks to get access to external capabilities.

The telecommunications industry has always been viewed as highly dynamic, especially after it has been deregulated and converged with information and media industries. It has a high-tech component and it is knowledge-intensive. Both car and telecommunication industries face major technological breakthroughs and a change in their competitive environment. Both have become more global and face market segmentation (micro-market phenomenon). Their degree of asset specificity and uncertainty is quite high, leading one to argue that transaction costs are potentially important to explain their integration strategies. It is true that both industries have used integration in the past few years, but the number of alliances and knowledge networks they have created has increased dramatically as well. The option theory can better explain this strategy.

In the past decade or so, car and telecommunications industries began forming alliances and networks beyond their national boundaries with the goals of rationalizing production through joint research, development, design, production, and engineering, component sharing and enhancing competitive positions in the markets. Ballard Power Systems, a Canadian firm with its new fuel-cell technology, has entered into agreements with all major car producers in Canada, the United States, Europe and Asia. The networks were established because of the knowledge proximity rather than the geographical distance of the partners. Geographical distance among partners was not an important factor in the creation of these networks. Rather the goal to increase their competitive edge through tapping into localized sources of specialized expertise (gaining a location advantage), complementary technologies and the knowledge proximity were the main incentives to form the networks.

Indeed, the car industry is a truly global one. It uses geographical spread in order to achieve technological diversification by using agreements and/or outright purchases of rival firms. This strategy gives firms a competitive edge and allows them to get into markets and territories entirely out of reach only few years ago. These strategies reduce uncertainties and risks and provide incentives to increase investment and innovations. There are a number of factors that make the car industry business environment more complex and risky. For example, there are tougher environmental regulations[3] worldwide, chiefly in California[4] that obliges car manufacturers to reduce the gases from emissions. Pollution cannot be reduced to predetermined levels without the use of new, more efficient technologies.

Ballard Power Systems is the inventor of the Ballard fuel cell, a proprietary zero-emission engine that combines hydrogen (which can be obtained from natural gas, methanol, petroleum or renewable sources) and oxygen (from air) to generate electricity without combustion. It is a promising technology that could revolutionize the world if it becomes economically viable. It could supplant existing technologies but as yet it is simply an interesting and promising technology. There are a multitude of similar technologies (e.g., Fuelcell Energy Inc., Global Thermoeletric Inc., Plug Power, Active power, Capstone Turbine Corporation), but at the moment, none of them has managed to establish itself as the standard of the industry. Car manufacturers could use this technology to make their cars cleaner and environmentally friendly. But there are many unknown factors. First of all, the new rules of the game are not clear yet. Environmental regulation differs from country to country and the introduction of clean cars is at the far bottom of the agenda of many countries especially the less developed ones. Carmakers have worried that investments made before these more stringent environmental regulations might become "stranded assets" and they are reluctant to go ahead with more investments if regulations are not clear.

The uncertainty arising from cleaner technologies and government regulations is compounded by a new market trend, which also affects the telecommunications industry. Carmakers have to face a micro-market phenomenon. They must provide a range of "quasi-customized" goods and services. Acquiring knowledge of market and demand changes is costly as market research is done for ever-thinner segments of the market. As a result, relative R&D costs increase and car manufacturers have to acquire a deep knowledge of their clients' future needs in order to integrate them early in the innovation process.

It is clear that, in the car industry, the degree of environmental uncertainty and the risks associated with the internal dynamics of technical progress are quite high[5]. According to my argument, the car industry can mitigate some of these uncertainties, especially the ones arising from market segmentation and changing customer preferences by acquiring competitors. Horizontal consolidation allows the industry to get the knowledge and know-how it needs in order to reduce marketing and production costs arising from market uncertainties. The desire to acquire *horizontal knowledge* favors consolidation as the recent examples from the car industry demonstrate (Daimler Benz buying Chrysler, Renault buying Nissan, etc.). Thus the acquisition of core competencies and strategic assets has many justifications, but transaction costs are an important motive. The formation of networks is a more appropriate strategy, however, should companies desire to acquire *vertical (upstream/downstream) knowledge*. Given that environmentally friendly technologies are quite new and not standardized yet, the wait-and-see strategy, as it was explained above, is the least expensive one and the most valuable. Thus, General Motors, Ford Motors, DaimlerChrysler, Honda, Nissan, Volkswagen, ALSTHOM and other major carmakers have created networks with the main provider of the clean environment technology, the Canadian firm, Ballard Power Systems.

By choosing major players in every continent, Ballard tries to get extensive expertise in engineering, management solutions and design of its fuel cell engine. Since it is a late R&D company there are many roadblocks to successful implementation of proton exchange membrane (PEM) fuel cells. There are costs challenges, competition and the uncertainty of the technology. Fuel cells are expensive to manufacture and economies of scale have not yet been mastered. The problem of competing technologies amplifies the uncertainties in this area. The primary rivals to fuel cells are hybrid engines – internal combustion plus an electric motor – and battery-powered cars. Next there is the problem of building a whole network of fueling stations. Putting into place an infrastructure for the entire country is a daunting task. But given that Ballard has a superior fuel cell why would car companies do their own? It is more advantageous to them to establish networks with Ballard and develop together this new technology. It is the least expensive and more profitable strategy for the car industry.

The same story can be said for the telecommunications industry. In the past decade or so, Bell Canada and other major telecommunication firms have made a number of agreements and established networks with other telephone firms and equipment manufacturers worldwide. When uncertainty is at an intermediate level, *upstream* and *downstream knowledge* is acquired by mergers and acquisitions. When uncertainty (as measured by the degree of sunkness of costs) is high, a networks strategy is used to acquire vertical knowledge.

After a decade of drastic regulatory and technological changes the telecommunications industry is still under the shock of convergence. New technologies and new services are continuously introduced while prices are dropping drastically making these servic es accessible to a great number of users. Like the car industry, the telecommunications industry faces a customization of its demand. New services or packages of services are offered in a variety of forms in order to satisfy the particular needs of almost every group of customers. Acquiring the necessary knowledge for evaluating the needs of its customers increases market research costs and relative R&D costs. Information, communications and the media (print and electronic) industries converge as new broadband, IP and DSL technologies expand the capacity of the network and transmission costs are reduced.

Regulatory risk is less important to the telecommunications industry than to the car industry. Telecommunications have been deregulated and the new regulatory rules are clear and well known to the parties concerned[6]. The uncertainties arise from technological changes and the absence of technological standards in the mobile and cellular telephony. Furthermore, it is not clear yet whether the new technologies will really allow various industries with such diverse line of services like basic telephony, data, multimedia (image, sound, etc.), Internet, television, PCS, print and electronic news, 3G technology, etc., to converge.

As may be expected, the telecommunications industry uses both integration and networks strategies at the same time. When uncertainties are at an intermediate level downstream or upstream knowledge is acquired by outright acquisition of suppliers and/or customers. At low uncertainty levels the benefits of using the market are much higher than the benefits of other strategies. Lastly, when the uncertainty is quite high, the network formation strategy is much more beneficial than the other strategies as illustrated in the graph below (Figure 3.4). The higher the uncertainty the higher the option value attached to the network formation strategy.

To illustrate my argument, (i.e., when risk is high network formation is the appropriate strategy), I report some historical statistical evidence from the telecommunications industry. When modern digital switches were introduced with storage-controlled programs, switch development changed from a hardware- to a software–based project. The development of a modern switch is a very lengthy process with high fixed (sunk) costs, switch software accounts for about 75% of its total cost (which in 1990 figures was about $1.5 billion). The next generation switches (optical switches designed to respond to the increased use of fiber optics or digital switches designed to handle broadband transmissions) are even more expensive to develop ($2 billion per switch). The risks arising from the introduction of these new technologies are quite high especially when markets are competitive and the costs are rising. To reduce risk, major telecommunication carriers forged network agreements. Their goal was to reduce the number of models from twelve to three or five switches. Table 3.3 lists some of the networks for this technology.

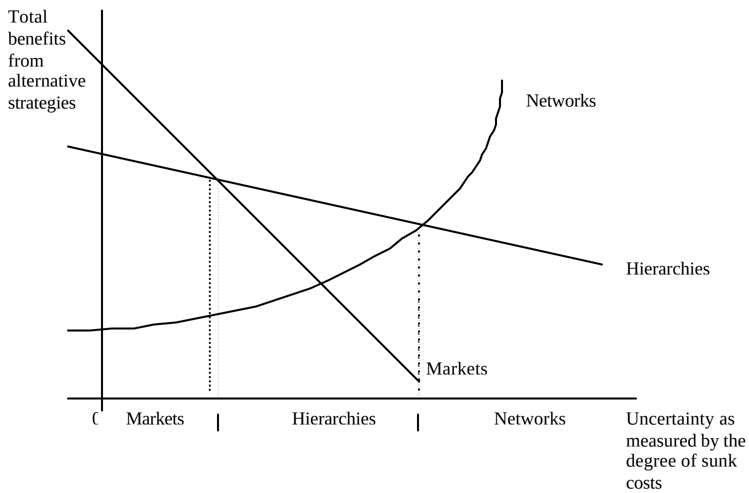

Figure 3.4 Benefits and Cost of Alternative Strategies

The same argument holds with the personal communications networks (PCN). In the 1990s the exact form of PCN technology was not clear. The cost of developing each of the three networks was estimated to be in the range of $1 billion to $2 billion each. Table 3.5 lists the three groups of companies that have established networks for developing these new technologies.

The striking characteristic of these networks is that they are international in nature. They are set regardless of geographical distances. What matters is the knowledge distances among the partners and the interaction of learning and the capacity of the new entity to create new resources.

Table 3.3 Networks in Central Office Switches

Companies	Country	Year
CGE (Alcatel) and ITT	France	1987
Ericsson and CGT	France	1987
AT&T and Philips	Netherlands	1986
AT&T and Italatel	Italy	1989
AT&T and GTE	United States	1989
Siemens and EC-Plessy (GTP)	United Kingdom	1989

Source: Hausman, (1991)

Conclusions

Networks and clusters have traditionally been thought of as being agreements among firms in specific localized geographic areas (e.g., biotechnology and pharmaceuticals in Montreal, or biotechnology and computer technologies in Texas, Massachusetts, California). Transaction costs theory has been advanced as one of the most prominent candidates in explaining their formation. In an ever-changing environment with great uncertainties arising from globalization, deregulation and above all technological changes and innovations, the use of markets entails substantial transaction costs. The latter are compounded by limited rationality, asset specificity and asymmetric information (the free-riding problem). Contracts are necessarily incomplete and their enforcement and monitoring is quite costly. The use of in-house approaches, such as integration, is a strategy, which allows firms to reduce transaction costs.

The transactions costs theory being static in nature fails to account for the ever-increasing use of agreements (networks, clusters, etc.,) among firms. It is argued in this paper that networks can be viewed as a wait-and-see strategy, which allow firms to get more information and knowledge and act accordingly in the future. Networks have an intrinsic value, which lies in the option offered to firms to have the choice to decide in the future. As an option, networks can be evaluated using the traditional finance and environmental option theory.

Table 3.4 Networks in Personal Communications Technologies in the UK

Group 1	Group 2	Group 3
BAE (UK)	Gable & Wireless (UK)	STC (UK)
Pacific Telesis(USA)	Motorola (US)	Thorn-EMI (UK)
Matra (France)	Telefonica (Spain)	US WEST (USA)
Millecom (UK & US)		Deutsche Bundesposts (Germany)
Sony (Japan)		

Source: Hausman, (1991)

It is undeniable that integration may fetch certain advantages that cannot be realized by the use of networks. There may be *first-mover advantages* and integration may be the most appropriate strategy to get them. I argue that hierarchies are used in order to get core competencies and strategic assets immediately. This may be dictated by the degree of openness of the market, the change in policies of a country or a major technological breakthrough. Firms may proceed to horizontal (competitors markets) or vertical (highly complementary products or services) relations in order to reduce risk and uncertainties resulted from major changes (institutional, regulatory, competitive, political, etc.,), which dramatically affected the business environment.

There may be *second-mover advantages*, especially when the uncertainties arise from the introduction of new and expensive technologies and there is no standard in the industry. The risks are high and the business environment very uncertain. Integration can be a costly strategy. In such circumstances network formation and clusters have a value because they allow firms to elaborate clearer strategies in the future. This may be the case when products, services, or technologies of some firms are potentially related but at the current stage of knowledge and technological advances the outcomes are unclear. It is therefore more advantageous to adopt the wait-and-see approach. Option theory is a more robust one, capable of explaining networks and clusters in a dynamic environment.

The car and telecommunications industries have been used as a case study to illustrate these arguments. In effect, both industries work in a business environment, which is characterized by rapid technological changes and micro-segmentation of their market demand. Costs in developing new products or new techniques of production are quite onerous. Yet, there is no agreement as far as the technological standards are concerned. There are many competing technologies to be used for cleaner cars and there are many technologies (none of them quite well established) in the telecommunications (including cellular, PCS, 3G, etc.). Given that the business environment is quite uncertain and risky, networks provide a sound alternative to integration[7].

Notes

1 Obviously, not all firms use the latest ICT services. In countries of digital “haves and have nots” the traditional reasons for network creation are still valid. The digital divide is a reality and the currently available technologies are not well suited to serving small numbers of customers spread over a wide area. Even in the USA, broadband reaches only 20% of zip codes in less urban areas (it is 57% in urban areas).

2 As with any other option, the network strategy will get a zero value in the future if the firm waits to long before acting (exercising it). But such an outcome is consistent with the option theory. It is not because your house did not pass on fire that your insurance is worthless.

3 The Kyoto accord specifies that 37 industrialized countries must reduce, by year 2012, their pollution emissions (greenhouse gases) by 6 per cent from 1990 levels (Gentzoglanis, A., 2000).

4 By 2003 some 6% of all new vehicles sold in California have to be so-called “partial emission” cars, while 4% must be zero-emission standards. California has the strictest environmental regulations because it has the worst air pollution problems.

5 Although Ballard has not turned a profit – after 17 years of developing its fuel cell – and it is not expected to reach profitability until the middle of the decade, the company’s future could potentially be huge.

6 There are still uncertainties concerning competition at the local level and in the new services (Internet, cellular, etc).

7 This is not to say that firms could use exclusively the network strategy. Integration may be used simultaneously especially when the firm wants to acquire rapidly core competencies or strategic assets, as we mentioned above.

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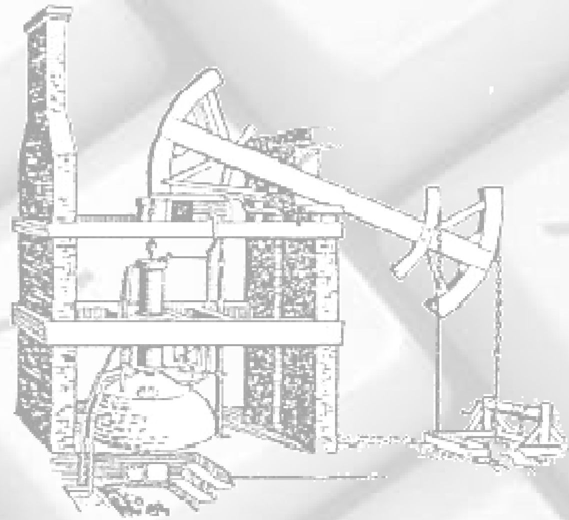

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