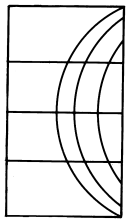

Jerald Hage

Adaptive Costs: A New Institutional Paradigm of Rules for the Competitive Game

In a relatively short time period, the rules of competition in the marketplace have changed dramatically.[1] In the past, although many factors impacted on the competitive advantage of the firm (Porter, 1990), lower costs typically provided the major advantage. To gain this price advantage, firms had to be concerned with reducing wages, mechanizing the production system and in general seeking a variety of methods for improving productivity. Today, the nature of competition is shifting in a number of industrial sectors as more and more firms find themselves forced to emphasize product and technological innovation. Rather than simply developing a new product that meets a consumer need, innovation today frequently involves a whole set of complex problems, ranging from ensuring the quality of the product (namely durability, low operating costs) to the addition of special attributes via a microchip (control features) and new materials (e.g. plastics) to the reduction of various negative externalities such as pollution, the use of scarce resources, illness and mortality, and so forth (Hage and Powers, 1992). To make matters even more complicated, increasingly the speed with which these new product innovations are developed confers advantages to the firm in its ability to capture a larger share of the market, namely strong first mover effects become determining. All of these new demands occur in a context where product lives are becoming shorter and shorter.

Given the new imperatives of rapidly creating complex innovations where a variety of expertises are involved and first mover effects are powerful, firms are increasingly trying to become more flexible or adaptive to technological and market changes. Not only are firms downsizing by eliminating many layers of management, creating profit centers and spinning off parts of their businesses as separate corporations, but most strikingly they are moving away from vertical integration across the supply chain.[2]

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Furthermore, while many of these changes started first in the USA they have spread to Europe and to Japan, and most recently South Korea where the *chaebol* are being broken up.

Perhaps the single best indicator of change in competitive rules is the choice of a new organizational form that transaction cost analysis (Williamson, 1985) would not have predicted: joint ventures, interorganizational networks, and strategic alliances of one kind or another (Hage and Alter, 1997; Häkansson, 1990; Noria and Eccles, 1992; Powell, 1990, 1998). What is perhaps most surprising about this development is its ubiquitousness; it is found not only in the private sector (Doz and Hamel, 1998) but in the public one (Hage and Alter, 1997; Morrissey et al., 1984), and between them (Powell, 1998; Valentin, 1995), not just in the USA (Lynne et al., 1990), but in Europe and Japan as well as between these continents (Hagedorn, 1993; Harbison and Pekar, 1998; Mockler, 1999).

New concepts and arguments – organizational learning (Lundvall, 1993), codifying tacit knowledge (Choi and Lee, 1997) and trust – have gradually been developed to help explain the prevalence of joint ventures and interorganizational alliances. But none of these concepts builds a new institutional paradigm about the new rules of competition although together they provide many insights. In particular, these ideas do not stress the central importance of complex innovative products in the competitive marketplace, an imperative brought about by the rapid growth in knowledge and the resulting short product lives. Nor do these ideas necessarily point to why joint ventures and research consortia have so rapidly replaced vertical integration and networks, and strategic alliances have replaced the giant firm.

The objective of this article is to provide a new institutional paradigm based upon the concept of adaptive costs and benefits. Adaptive costs reflect: (1) the costs of monitoring the scientific, technological and competitive environments; (2) the costs of developing complex innovative products with low externalities; and (3) the costs of mistakes from launching a product either too quickly or too slowly. Given this concern about these kinds of adaptive costs, the firm is likely to form joint ventures, strategic alliances and interorganizational networks to reduce these costs, hence the existence of a new logic of competition. Furthermore, these kinds of collaborative interorganizational relationships confer additional benefits: they increase the value of the tacit knowledge stock of the firm, allow economies in research, and help the firm position itself more effectively in the marketplace.

The first section of this article explores the impact of knowledge on both supply and demand on the marketplace, explicating the paradox of knowledge growth as well as providing a qualification. Then the second section indicates why productivity measures are not necessarily effective for evaluating the firm, especially within a relative short time period of five years, and outlines the adaptive cost-benefit framework. The concept of adaptive costs

is compared to a number of similar ideas that have been suggested in recent years and the nuances of their meanings are compared and contrasted. The third section contrasts the logic of competition via productivity and the logic of competition via innovation. Some evidence for the argument that joint ventures, strategic alliances and interorganizational networks reduce adaptive costs is presented.

The Growth in Knowledge and the Marketplace

The major force that is upsetting the nature of competition is not so much globalization, although that clearly has expanded the number of competitors, but instead how knowledge is shaping both the demand and supply side of the market.[3] If we were to roll back the clock and examined the kinds of products that were available in the 1950s and 1960s and then assumed that there had not been many product innovations or changes in consumer utilities since then, then globalization would not have changed very dramatically the general ranking of the major corporations. A majority of the top companies in the American Fortune 500 of the two decades immediately following the Second World War would still probably be with us and in approximately the same order. Clearly, the present is quite different not only in the USA but also in Europe. Consider some of the new names such as Nokia, Microsoft, Liquid Air and Sony. Not only have many of the old dominant firms disappeared or merged but there has been a number of shifts in the rank order of the surviving firms; the old companies that have survived at the top such as Ford, Mercedes, Siemens and Dupont have stressed innovation. Outside the automobile and electrical industries (and of course petroleum), it is mainly new companies like Intel, Toshiba, American On Line and Samsung, that have become global giants. Why is this so?

The Impact of Knowledge on Product Demand

On the demand side, increased knowledge leads to longer and longer periods of education because of the inability of the human mind to absorb all the new knowledge. As individuals move from a college diploma on to graduate school, they specialize more and more in particular areas of expertise. The impact of knowledge on the educated consumer's utility functions has been described in some detail in Hage and Powers (1992) and therefore is only briefly summarized here. One major impact is that consumers have become more concerned about the quality of the product (that is its durability and operating costs). This emphasis on quality explains the long-term dominance of the Japanese companies and also of many Germany and Italian firms (Piore

and Sabel, 1984; Porter, 1990; Prais et al., 1989; Steedman and Wagner, 1989). Equally important, consumers are learning that *all* products have a series of potentially undesirable impacts on their health, their safety, the quality of their environment and so on. Japanese cars made inroads initially because they both cut gas consumption and were of high quality (Womack et al., 1990). Then they lost some market share because they were not perceived to be as safe. Michelin Tire has become dominant because it produced a safety tire that was also of higher quality. Miller Lite beer captured a significant part of its market where health consciousness would not seem to matter. Thus, the educated consumer not only has demanded quality but increasingly a reduction in various externalities, creating demands for innovations even in old consumer markets such as cars, tires, beer and so on.

But perhaps the most critical impact of increased education and specialization is that it leads away from the mass markets of the 1950s and 1960s to highly specialized markets as consumers build individualized lifestyles. At the extreme, individuals want customized products of one kind or another. Even after the product is sold, the customer wants individualized service. The importance of service has allowed a firm like General Electric to make enormous gains in profitability by selling service contracts attached to all of their main products.

The causes of this shift in demand originated not only in occupation specialization associated with college diplomas and graduate degrees but arose from a number of other societal changes including the availability of leisure time and its use in international travel, transnational migration and the steadily lengthening age of the population. All of these changes have generated highly specialized market niches.

Finally, an educated consumer also wants the latest technological advance encapsulated in a beautiful design. The need to marry high technology with esthetics has perhaps not been emphasized enough in the literature. Again, this has been a particular strength of both German and Italian firms. Novelty effects are thus strong, and consumers quickly move onto the latest advance in technology. How else does one explain the dizzying speed with which consumers buy into new PCs, mobile telephones and DVD television technologies?

The Impact of Knowledge on Product Supply

On the supply side, knowledge has spawned a variety of ways in which the marketplace has been altered. The most common observation is that applied research and product development have led to a proliferation of products and technologies each with a relative narrow market niche to meet the variety of consumer demands described in the preceding section. So many of the

products that we take for granted were not invented 20 years ago, including utility vehicles, compact disks, high speed trains, mobile telephones, fax machines, color photo copying machines, video players, camcorders, and so on.

Furthermore, no sooner were these products invented, than in many cases, attempts were made to improve their quality, convenience of use and flexibility, requiring that we replace the 'old machines' with new ones. Improvements in these various aspects also represent product innovation because they require the redesign and frequently at minimum product research if not basic research. In some areas such as health care products and drugs slight improvements in quality or effectiveness have conferred considerable gains in market share.

A radical product innovation also occurs when there is a substantial improvement in a particular performance criterion. High speed trains in Europe and Japan have kept their rail road transportation systems largely competitive. The speed of the PCs has been continuously improved *every few months*. And for some time, although not recently, the gas consumption of the automobile was steadily reduced. One performance criterion that dominates these days is convenience; improvements in this capture market share. This is one of the reasons why many stores and even businesses in the USA now stay open all night, and one observes similar pressures in European countries such as Germany that has traditionally kept quite restricted hours.

More critically, product innovation has also consisted of adding new attributes to products that previously were absent. The addition of color to television and stereo-sound to hi-fi equipment and then later color and stereo-sound to the PC are only a few common examples, but they are representative of what has been happening to many products.

Besides the variety of new kinds of products and technologies, however, the most dramatic impact of knowledge on the marketplace has been the increase in the complexity of the product. This complexity is an effect of either the addition of a new attribute, or the substitution of new kinds of materials that have superior performance qualities, or the subtraction of various kinds of undesirable externalities. If you will there is a new consumer 'mathematics' in the manufacturing of products and the provision of services as well.

The addition of new attributes is most easily observed in the incorporation of various kinds of micro-chips in many products, which can create cybernetic control in the operation of the product. Another common addition is the creation of voice responses or warnings as part of this cybernetic control. Still another frequent illustration of the addition of new attributes is when several products are combined into one, for instance the telephone and fax machine with the answering machine, the television and the video recorder, the scanner and the printer, and increasingly the mobile phone with all of these!

Another way in which products are being made more complex is the attempt to substitute or change various kinds of raw materials that are used in the production of a product to provide it with additional or better performance characteristics. An example is the use of plastics as a substitute for cement in construction where materials research is not only trying to provide the necessary strength but also provide plastics that have various kinds of colors and do not fade with exposure to sunlight. And of course, plastics have found their way into a whole host of products from the racing automobile to the racing bicycle. But while plastic is the most easily observed it is hardly the only new kind of material. Micro-chips as they have passed from one generation of speed to the next have been constructed of new kinds of materials. And this is repeated in one product after another. This has led to a whole new branch of engineering called materials sciences.

Still a third way has been the attempt to reduce various kinds of negative externalities, such as pollution in the manufacturing of the product, to make the product more energy efficient, or to increase the safety and health features of the product, and so on. To reduce pollution usually requires a fuel that is 'clean' or expensive additions (such as scrubbers to chimneys). Yet to be solved is the problem of the greenhouse effect because of the concentration of CO_2. Electric motors now only consume one-third of the energy that they used to and most electrical appliances have been similarly improved in their energy conservation. The food industry has been struggling to make all sorts of common foods less dangerous to the human body by subtracting fats, sugars, salts, to say nothing about undesirable chemicals that previously had been used as preservatives. Organic foods are now a major niche in the marketplace. All of these changes – and frequently the same product innovation involves many of them – make the manufacturing of products much more complicated than it used to be.

None of these problems were necessarily insurmountable for a large corporation with slack resources if it had a great deal of time in which to do the research – basic and applied – in order to develop the product or more likely a family of products to satisfy different market niches and have the right combinations of performance qualities and few negative externalities. But the second and equally dramatic impacts of knowledge are the short product lives and the continual technological change that upsets established markets, suddenly making products from other sectors viable. Given a narrow market niche to begin with, this new fundamental of competition makes many companies highly vulnerable regardless of how deep their resources – intellectual and financial – are. Suffice it to think about General Motors, which went from over 50 percent of the American automobile market to around 30 percent. Or about IBM, which has had to cut its number of employees worldwide almost by one-third. More recently Apple, which had gone into decline, seems to be recovering with new and innovative

products. The sudden rise and fall of many small high tech companies is well documented. In other words, instability and high risk have become part of competition in ways that previously never existed.

The Basic Paradox of Knowledge Growth

The irony of knowledge growth is that it leads to both more complex products with multiple attributes and at the same time shorter product lives (Stalk and Hout, 1990). One must do more and more quickly. Furthermore, competition can center around not only innovative products such as digital television or a new technique for treating AIDS but the adoption of new technologies such as optic fibers or flexible manufacturing. Together these are placing enormous pressures on the size of research and development budgets and thus a concern about adaptive costs. One has an indirect measure of the pressure to innovate quickly by examining the amount of R&D expenditures, both public and private in specific market segments.

So, our first assumption in the development of a theory about the new economy is:

The greater the growth rate of knowledge (as measured by research expenditures) within an industrial sector or market segment, the more the firm must compete over the speed of innovation rather than productivity.

The main thrust of this assumption is that the strategy of cost cutting as the major competitive move is no longer a feasible one in specific markets (Smith et al., 1992). The strategy literature (Porter, 1990) has emphasized the variety of ways in which firms can seek competitive advantage but much less the circumstances that force organizations to be innovative. Our argument is that in certain sectors, whether private or public, firms have no choice or else severely constrained choices if they want to remain within the marketplace. When investments in research and development are quite high in some of the firms in specific market segment, then the firms in the same segment have to respond in a similar way, and match R&D budgets. Examples of such research-intensive market segments or industrial sectors are the chemical, computer, home camera and film, photocopy, bio-tech, electrical products and so forth. In the public sector, the dominant areas in which large amounts of research are invested are the military and health care (Hollingsworth, 1991).

One reason why the growth in knowledge requires innovation is that it tends to divide markets into smaller and smaller niches. Consistent with our argument that mass markets have been replaced with multiple smaller markets, firms are more vulnerable to changes in these smaller markets. Thus, product and process innovation becomes a strategy for maintaining their competitive edge.

Thus, the central paradox is that the more money is spent on research the more needs to be spent. The more that is known in one sense, the more that is unknown. Thus a competitive race starts over finding an innovative product, which produces a spiral in costs that companies cannot afford. As an example, the development of a new drug costs about half a billion if it goes into clinical trials, a new car costs about 1 billion, and an airplane such as the proposed 550-passenger Airbus aeroplane 15 billion. The building of a new computer chip plant typically costs about a billion or more. In these industries one sees either a radical reduction in the number of competitive firms and/or the development of a number of interorganizational networks.

Exceptions and Qualifications

These processes of knowledge creation and its consequences for market competition are not relevant in all industrial sectors or market segments. Some products are still valued on a few simple criteria such as price and convenience. If they were not, we would not see the spread of what some have called 'McDonaldization' (Ritzer, 1993) to many kinds of simple services. The McDonald's process of fast food production is just another form of high volume production over long time periods, although even McDonald's has tried to create new products and has become concerned about the impact on the environment of its wrappings and cardboard. And if productivity were not more important than innovation in some product sectors, we would not see the large-scale movement of some industries from the advanced industrialized countries to the developing countries. Shoes, textiles, toys and a number of other standard products are increasingly produced in Asia. We still have the need for basic products produced in long production runs and in these the cost of production becomes the dominant criterion for the consumer.

Another and more interesting exception is those high tech industries that have market segments involving highly standardized products for global markets and yet where there is continual change. Good illustrations are the generic softwares such as Microsoft's Word and of course the ubiquitous PC. In these instances the changes only involve one or two parts or components; the change process is effectively routinized in these instances. For example, one can substitute a more advanced microprocessor chip in the PC easily because most of the other components remain the same. The same is true for many features of generic software. 'Componentization' allows for the change process to be routinized and thus the maintainence of long production runs across time. What makes these market segments interesting is that they reflect the logics of both the old and the new competition.

The Adaptive Cost-Benefit Framework

If innovation and especially complex products that are brought to market quickly are the major performance criteria for firms in knowledge-intensive sectors, then we need a new way of thinking about the costs associated with this performance. But besides the problem of costs, there are also various kinds of benefits that can accrue from collaboration. Finally, once the adaptive cost-benefit framework is presented, then one can more easily understand why productivity measures do not include these new kinds of costs.

The Definition of Adaptive Costs

We can define the concept in the following way.

Adaptive costs are the costs of effective and complex responses to technological, scientific and competitive changes in the environment to include:

1. the costs of monitoring the environment;
2. the costs of developing complex products;
3. the costs of being either too slow or too fast.

The critical issue for a firm is not to be content with monitoring what the competitor does but to continue to seize upon opportunities that are presented to the firm by scientific and technological breakthroughs, many of which may occur far removed from the expertise of the firm itself. This problem has been adeptly demonstrated across time by Utterback (1994), who has observed that those firms that have the dominant design or technology in an industry almost always fail to observe the new dominant design, which typically originates in another sector of the economy. To avoid this problem, companies need to continually observe technical and scientific advances in a variety of research specialties, and because of the growing complexity of products, this variety is increasing across time.

One way in which globalization is impacting on the world is that low tech competitors may be located in many different countries, including such developing countries as Brazil, India and Indonesia. Even high tech competitors are to be found in countries like Taiwan (Matthews, 1997) and South Korea (Kim, 1997). Given this, the firm must keep a wide flung network of observation to anticipate competitive moves on the part of its competitors. For example, when Kiri introduced a dry ice beer in California, Anhauser-Busch was ready to respond within two weeks since it had been studying the Japanese marketplace for some time.

Our concept of adaptive costs may appear to be quite similar to North's (1990) idea of adaptive efficiency. But his frame of reference is institutional

rules or laws and how they impact on organizations. For example, if a society has anti-trust laws then it can prevent the development of monopolies, which may make the economy as a whole more adaptive. In other words, North's concept of adaptive efficiency refers more to national economic growth.

Neither is our concept of adaptive costs the same as the first mover effect. The latter concept and kindred ones do not include the costs of monitoring the scientific, technological and competitive environment or the costs of developing responses given changes in any of these arenas. Instead, they emphasize the benefits, a point to which we return later.

Nor is our concept of adaptive costs the same as the idea of time to market (Smith et al., 1992) because this idea does not include the problem of costly mistakes, particularly from responding too quickly before adequate quality controls have been developed. Time to market does not consider the costs of monitoring and developing a competitive response although it does have the advantage of offering a methodology for studying one dimension of the problem of adaptive costs.

The Definition of Adaptive Benefits

Reducing the costs of monitoring the scientific, technological and market environments and of developing complex product innovations in a short period of time is not the only benefit that is part of the adaptive cost-benefit framework. In the next section, the logic of competition that makes collaboration a way of reducing adaptive costs and gaining benefits is described. Here our emphasis is on what are these benefits from collaboration. Although various authors have stressed such ideas as sharing risk and the costs of product development (Alter and Hage, 1993) – that is reducing adaptive costs – they have missed what are some of the most critical advantages of collaboration.

Adaptive benefits are the survival of the firm and improvement in the various intangible resources of the firm including:

1. increases in the tacit knowledge of the firm;
2. increases in the flexibility of the firm;
3. better positioning of the firm in the global marketplace.

Not unexpectedly, and partly in response to these changes in the quantity and kinds of interorganizational arrangements (Hage and Alter, 1997; Hagedorn, 1993; Harbison and Pekar, 1998; Mockler, 1999), new management literatures have emerged that emphasize the importance of organizational learning (Cohen and Sproull, 1996; Conner and Prahalad, 1996) and the acquisition of tacit knowledge (Nonaka and Takeuchi, 1995). But again, these literatures are only partially complete. The literature on tacit knowledge has primarily

emphasized its importance *within* the firm rather than *between* firms. Likewise, organizational learning literature has not indicated the possibility of increases in tacit knowledge from interorganizational relationships.

A gain in a competitive position does not necessarily mean increased profits but instead the potential to be on the groundfloor for a series of product developments, or in a good position to take advantage of changes in consumer utilities. In other words, it relates to the long view of where a firm needs to be for future growth and development rather than for current profits.

In summary, one of the advantages of the adaptive cost-benefit framework is that it synthesizes a number of new ideas across quite a wide range of literatures. The reduction of costs and the acquisition of benefits encourage firms that face rapid technological and scientific change with mounting R&D expenditures to seek out partners, and this, for a variety of reasons, as we have seen.

The Inadequacy of Productivity as a Measure of Organizational Performance

The inadequacy of productivity as a measure of organizational performance stems primarily from not obtaining good measures of the benefits that accrue with collaboration. Adaptive costs, for example R&D, add to the costs of the firm immediately, whereas the benefits to be achieved do not appear on the 'bottom line' for many years. The costs of monitoring the environment and particularly the costs of product development are continual in those industrial sectors in which there is competition over product innovation though these do not necessarily result in new products immediately or even in five years' time. Then, too, the benefits of collaboration are not captured at all by productivity measures, except over a very long time period.

Productivity measures primarily tap into the quantity of products produced at a particular cost but do not capture *improvements* in the quality of the product. We have already mentioned the improvement in gasoline consumption; parallel with it was an improvement in the cost of operating and repairing automobiles. None of these improvements has been incorporated into measures of productivity for this industry and what is true here is applicable elsewhere. Instead, the increases in prices for automobiles have usually been treated as inflation. Even if one were to average productivity over a five-year period, it would not necessarily capture these gains in quality.

When product research and development add new product qualities then again productivity measures do not capture this value added. Clearly, the addition of color to television represents an increase in the cost of manufacturing black and white television but certainly this provides the consumer

with considerable improvement in their satisfaction. Many of these new qualities are difficult to evaluate in economic terms and therefore can make productivity measures at the organizational level quite misleading. How does one evaluate the value gained in keeping stores open all night for the convenience of the consumer? Again, this makes American retailing appear less efficient than its German competitors but is it really?

In summary, the adaptive cost-benefit framework is necessary to provide firms with a clear perception of what are the kinds of costs and benefits that they should be concerned with. Productivity is no longer an adequate measure in many industrial sectors. This means a new logic of competition, our next topic.

Knowledge and the Logic of Competition

Collaboration represents a new kind of logic of competition, one quite different from the micro-economic model of perfect competition and certainly far removed from the logic of transaction costs (Williamson, 1985). In both models of reasoning, the problem of distrust and productivity maximization form essential ingredients. In the new logic of competition, trust and innovation become essential elements of strategy. To indicate the differences between the old and new logics, we briefly review the old or traditional model of competition and then contrast it quickly with the logic of the new model. This is then followed by a discussion of the many different kinds of collaboration that now are quite visible.

The Old Logic of Competition

Traditionally, managerial strategy was to gain a competitive edge by reducing the costs of manufacturing. Typically, this involved a number of managerial strategies, which are listed in Figure 1.

The most critical was to achieve economies of scale, especially within the American context: then the company could reduce its prices and gradually eliminate its competition by gaining a greater share of the marketplace and thus an even larger economy of scale. Clearly, this was the effective strategy of such companies as Standard Oil of New Jersey, AT&T, Siemens, Imperial Chemical, General Motors and so on. Obviously the 'elimination' of competitors could be achieved in other ways, most typically with mergers in the USA or cartels in Europe.

The simplest way of achieving economies of scale was to standardize the product, ensure that it had only a relatively few parts, and then produce this in long production runs. The Ford Model T was the best example of this

- Reduce the number of employees or their skill levels and therefore the wage bill, i.e. downsizing and deskilling;
- Rely upon assembly-line production and faster throughput amortizing the capital investment, i.e. Fordism;
- Simplify coordination via the formalization of rules and procedures and thus reduce management costs, i.e. bureaucracy (Weber, 1946; Chandler, 1977);
- Constantly search for ways of reducing costs which are attempts to gain a larger share of the market;
- Produce large quantities of the same goods and services to achieve economies of scale (and scope) over long time periods, i.e. mass production (Chandler, 1977);
- Integrate forwards and backwards to reduce uncertainties and to be able to control the costs of suppliers and distributors, i.e. reduce transaction costs (Williamson, 1975, 1985);
- Invest heavily in new equipment that provides greater economies of scale;
- Attempt to obtain a monopoly control over either national or global markets.

Figure 1 The Organizational Logic of Productivity

logic. Most of the heavy American industry (Chandler, 1977) during the 1880s through the 1950s was built on this logic. Examples in manufacturing were steel, rubber tires, cigarettes, food processing, automobiles, elevators, cement and so forth. Counterparts in services included railroad transportation, insurance companies, banks, department stores and telephone services.

Since productivity and therefore price in the marketplace was the major criterion, then managers would ignore various kinds of externalities and pass these costs onto society and the individual. Cheap fuel pollutes more than 'clean fuel'; it was chosen. The ignoring of hazards to the health of the workers and consumers has been well documented, necessitating legislation to force companies to provide safer work environments. Toxic wastes were dumped into rivers and streams. Manufacturers also produced products that they knew were dangerous for the consumer, including asbestos insulation, cigarettes and unsafe cars or trucks.

It goes without saying that mass products produced in long production runs required not only a standardized product with a few simple parts but more critically a technology that allowed the product to be produced in this way. A key element in this technology was what has been called Fordism, that is the assembly-line mode of production. With this, eventually came the use of cheap, unskilled labor. In those industries where this logic still dominates, for example in shoes, toys, many electronic components and textiles, one observes that more and more companies are moving their manufacturing plants to third world countries to achieve even lower wages and thus greater productivity advantages in the global marketplace.

This single-minded emphasis on productivity was not the only model of competition within industrialized economies (see Mintzberg, 1979; Hage, 1980, 1988). A variation on this theme were the craft and artisan industries and services where mass tastes and production techniques did not apply.

Another exception were those industries based on economies of scope, that is producing several products on the same production line. In these sectors, productivity was not the only criterion because new products were occasionally developed in the research laboratories of the large firms. Examples included the chemical and electrical industries, although even here many of the products were mass produced on long production lines (for example, dyes, paints, aeroplane engines, light bulbs).

Some of the new high tech industries, as we have already observed, have market segments involving standardized products that are sold globally. Both generic softwares and PCs fit this description. Here we find many of the old rules of competition still apply. Microsoft has certainly attempted to create a monopoly. And the PC manufacturers worry about market share. But at the same time in many instances we also find a reliance on joint ventures and alliances under specific conditions as we discuss below in the subsection on forms of collaboration.

The New Logic of Competition

The logic of competition for complex product innovation with short product lives is the exact opposite of the logic of competition built upon economies of scale. The contrast with the old logic of competition can be seen in Figure 2.

The new imperative is to first increase the diversity of skills, and in particular to have competent researchers, rather than constantly reducing either the number of employees or their skill levels. A good verification of this assertion is the emergence of human resource management programs in business schools, which are quite different from the old personnel programs. Instead of emphasizing assembly-line production, the emphasis is now on

- Increase the diversity set of skilled technicians, professionals and scientific researchers, i.e. a complex division of labor (Hage, 1965);
- Create teams or employ flexible manufacturing technologies so as to be adaptive to changes in the marketplace;
- Rely upon mechanisms of integration that emphasize communication across diverse specialties (Lawrence and Lorsch, 1967) and shifting patterns of leadership, i.e. the organic structure (Burns and Stalker, 1961);
- Adopt an aggressive strategy of producing radically new products or services (Zammuto and O'Connor, 1992);
- Eliminate vertical and horizontal integration both forwards and backwards to gain more flexibility;
- Produce services and products in small batches and even customize them so as to gain a niche in the marketplace;
- Invest heavily in research to develop new products or services to survive;
- Create joint ventures and strategic alliances to facilitate adaptiveness and innovation (Alter and Hage, 1993; Badaracco, 1991; Gomes-Casseres, 1996; Jarillo, 1993).

Figure 2 The Organizational Logic of Innovation

teams of production workers that are capable of producing almost customized products upon command and of adjusting their production runs continually. One observes this trend particularly in certain German and Italian companies (Prais et al., 1989; Piore and Sabel, 1984; Steedman and Wagner, 1987, 1989).

Since the new competition requires quick responses, coordination cannot rely upon bureaucratic rules and highly formalized procedures because these are too slow and inflexible; instead, verbal communication in extended networks coupled with shifting patterns of leadership depending upon who has the necessary expertise. In other words, this mode of competition favors the organic structure (Burns and Stalker, 1961).

Given this emphasis on quick responses in an environment where there

are constant changes in both technologies, consumer demands and competitive moves, the firm emphasizes short production runs with frequent changes so that the products remain novel and competitive rather than long production runs. Given this requirement, there is a tendency to avoid investing a large amount of capital. Again, this encourages firms to collaborate and share the costs of capital investment.

Although we have stressed the strategy of innovation rather than cost reduction, we have perhaps not placed enough accent on the idea of high risk taking. The only way of staying ahead of the competition is to constantly take large risks relative to product innovation. This, of course, is one of the reasons why adaptive costs are rising. And as the innovation becomes more and more radical, the costs of failure also become greater.

Contrary to the logic of transaction cost analysis, where the emphasis is on acquiring suppliers and customers to avoid opportunism and thus the movement towards vertical integration both forwards and backwards, the new logic of competition encourages suppliers and customers since they have specialized expertise to work together in the development of new and especially radical innovative products. But under these conditions, there can be little opportunism. All gain or all lose and thus each of the partners is highly motivated to contribute.

Rather than investing in high cost machinery, the investment strategy with the new logic of competition, and consistent with the preceding arguments about the need for a diversity of skills and expertise, investments are made in research of various kinds and continual education to valorize the human capital in the firm. This makes the constant upgrading of the tacit knowledge of the firm a key benefit.

Finally, and consistent with the preceding, rather than seeking monopoly control or a cartel within a single market, we find firms seeking to create joint ventures and interorganizational relationships. And this leads to our topic of collaboration as the solution for reducing adaptive costs and for gaining adaptive benefits.

Collaboration as the Solution for Reducing Adaptive Costs

If the problem is not only how to have rapid product development of complex products given some new scientific, technological or competitive change, then what does the firm do to solve this difficulty? The answer lies in our second assumption in the development of a theory for the new economy, namely the complexity law, which is:

The more diverse the human capital and tacit knowledge available to the firm, the more likely the firm will develop effective, timely and innovative responses to competitive moves in the marketplace.

In other words, to use new materials, to add micro-chips, to reduce a variety of externalities, to improve performances and so forth, the firm is frequently obliged to reach out and find other firms that share in the development of complex products *so as to increase its diversity of human capital and tacit knowledge* (Badaracco, 1991). A good example is IBM, which despite having 400,000 employees worldwide and a number of excellent research centers still failed to have the right expertise to develop enough new products. Since 1990, it has moved aggressively from only a few joint ventures to a large number. If IBM with all of its intellectual and financial resources found it difficult to span the full range of expertise needed to develop radically new products, then one can begin to imagine the problems of smaller companies.

This assumption calls attention to the diversity of human capital, that is the degree of complexity involved in the innovation process. The evidence for complexity leading to product innovation is based on a long line of research that has been recently reviewed (see Damenpour, 1991; Hage, 1999; Zammuto and O'Connor, 1992). Although the indicators of complexity vary across countries because of the variations in educational systems and the way in which knowledge is organized, the greater the complexity, the greater the rates of product and process innovations, both incremental and radical. Unfortunately, there has been little research on the complexity of joint ventures and interorganizational networks. But what evidence there is (Meeus et al., 1999; Oerlemans et al., 1998) indicates that networks have higher rates of innovation than do single firms.

Still another reason why firms are encouraged to seek out diverse partners for either applied research or product development and even sometimes basic research, is that frequently one successful experiment in basic research can lead to a variety of products, many of them beyond the tacit knowledge and expertise of the firm. Collaboration thus becomes a mechanism for gaining multiple advantages from investments in research by the firm (Häkansson, 1990).

In other words, by engaging in joint ventures, strategic alliances, and interorganizational networks, firms are gaining access to a diverse set of skills. This allows for more complex product innovations to be developed, which once created, are more likely to be successful on the market because of a more diverse set of perspectives involved in the decision-making.

Although several authors have provided attempts to explain the movement towards joint ventures, hybrids and interorganizational networks, generally they have not emphasized the importance of reducing adaptive costs. Powell (1990) in particular has postulated the network as a hybrid but this misses completely the evolutionary trend occurring in one industrial sector after another as the costs of search, the costs of research costs and the costs of mistakes mount. And while a variety of reasons have been provided

in the literature (see review in Alter and Hage, 1993), none of these have stressed the importance of complexity in developing radically new products.

The Variety of Forms of Collaboration

Unlike vertical integration, there are a variety of different kinds of collaboration. One strategy is to work closely with the customer with the objective of providing customized products for a considerable variety of consumer tastes or needs. A good example of this is the Japanese *kieretsu* (Alter and Hage, 1993; Womack et al., 1990). This form of collaboration is common in those former mass production industries that are moving in the direction of customization such as automobiles, kitchen furniture, ceramics and so forth and where quality is critical.

A quite different form of collaboration is for a diverse group of firms that work together to develop a radically new product that would impose a world standard. These have been labeled strategic alliances by Gomes-Casseres (1996). Again, this is common in certain kinds of mass production industries such as consumer electronics (VCRs, digital television, RISC chips and so on). These alliances are quite complex and in the instance of consumer electronics usually of short duration. Once the product is developed and accepted, then various joint ventures of manufacturing produce the product.

Still another form of collaboration among competitors in those industries where the costs of product development are extraordinarily high is the creation of joint ventures (Harbison and Pekar, 1998). Illustrations include the automobile, commercial aircraft and semi-conductor industries. At times, this strategy is also combined with the traditional one of merging of firms to generate a global giant and thus the traditional strategy of monopoly as well.

Quite different is the strategy of competitors joining together in research consortia (Aldrich and Sasaki, 1995). This is common when basic research is the most important aspect of the problem of radical product innovation and where basic research is performed by the industry itself. SEMATECH and Airbus stand out as quite successful radical product research collaborations (Browning et al., 1995).

But the most common forms of collaboration are among firms in adjacent sectors where the concern is to introduce new kinds of materials or to reduce externalities or to gain more efficiencies from investments in research and development. With the developing of small batches of products designed to meet specific market niches, this means multiple supply chains and thus the tendency to have close working relationships with various suppliers. Typically this takes the form of a joint venture.

Conclusions

Knowledge, meaning the heavy investments in R&D, has profoundly altered the nature of the competitive marketplace from the standard thinking used in the first two industrial revolutions. By altering the tastes of individuals and at the same time the scientific and technological opportunities for firms, innovation and especially radical innovation has become the major criterion upon which firms in research-intensive industrial sectors or market segments compete. The recent frenzy in the stock market where the stocks of new small high tech companies rapidly escalate upwards indicates in another way how important innovation has become and also how difficult it is to predict which firms will win in these struggles.

For our purposes, the most interesting implication is that firms in the process of having to specialize in quite narrow niches must also seek out expertise in many different areas. Thus rather than the giant firm standing alone we see many medium and even giant firms working together with quite a range of other firms to find the new generation of radical innovative products. The world is being knitted together in quite complex networks of interorganizational joint ventures, research consortia and global alliances. Some of these are quite temporary but others are of lasting duration.

This expansion in knowledge as the new order of things is much more important than globalization. The latter social force has altered the boundaries of competition but not the nature of competition. It is the growth in knowledge that has fundamentally changed the rules of competition.

Notes

Some of the ideas in this article are also found in another paper written with Zhongren Jing. That paper is titled 'Adaptive Costs: A New Paradigm for the Choice of Organizational Form' and is concerned primarily with the differences between an adaptive cost framework and transaction costs. This article is primarily concerned with how knowledge has changed the rules of competition. I am indebted to both Zhongren Jing and Zhengful Shi for their helpful comments in the development of this framework.

1 Although the thesis of postindustrial society has been discussed now for two decades, little has been said in the various expositions about the impact of knowledge on the nature of competition (see Bell, 1973; Toeffler, 1981; Piore and Sabel, 1984; and for an exception see Hage and Powers, 1992).
2 Many consider that downsizing is primarily for the purposes of increased productivity but its more important utility is greater flexibility in the marketplace.
3 Given the variety of definitions of globalization, the meaning used here is simply the quite rapid increase in the volume of international trade relative to the global

world product as a consequence of the reduction in tariff barriers and the lowering of the costs of transportation. To it could be added the idea of the transnational migrations of many different populations.

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