PROTECTING TECHNOLOGICAL CORE COMPETENCES IN A GLOBAL ECONOMY

Esteban Fernández/José M. Montes/Guillermo O. Pérez-Bustamante/Camilo J. Vázquez

University of Oviedo

Department of Business Administration and Accountancy

Faculty of Economics, Avenida del Cristo S/N, 33006, Oviedo

Phone: 00-34-985104974 Fax 00-34-985236670

Gperez@econo.uniovi.es

1. Introduction

The purpose of this paper is to identify and analyse the isolating mechanisms that preserve the technological competitiveness of a firm from its competitors. After stating some basic concepts concerning technological imitation, we study the barriers which the imitator must overcome (Section 2), the conditions in which these barriers are lowered (Section 3) and finally the strategies followed by the innovator to raise them (Section 4). A correct understanding of these factors enables the innovator to raise barriers to protect its advantage and appropriate the entrepreneurial rents arising from its technological core competences.

Innovation provides important competitive advantages for the company which commercialises it and, in general, tends to produce a certain upheaval among rival companies which, so as not to lose market positions, will attempt to imitate the innovation in a short period of time. Imitating an innovation is usually a rather slow process although its rate varies according to each case. For example, in a study on different industrial sectors, Mansfield (1961) estimates that the time-lag for half the companies to imitate an innovation varies between 0.9 and 15 years, the average being 7.8 years. However, the imitation process begins relatively quickly. Hence, a rival knows the decision of another company to implement a R&D project between 12 to 18 months after this decision has been made, when the typical R&D process lasts on average between 2 to 3 years (Mansfield, 1985).

The time necessary to complete the imitation process is a very important variable as it conditions the balance between static efficiency (derived from the effects of an innovation on the industry market structure) and dynamic efficiency (derived from the technological progress arising from the

innovation). The more time taken to imitate, the less competition in the market place and the greater the advantages of the monopoly benefits for the innovator. In these circumstances there is a strong incentive to invest in the technological development. On the other hand, if a rapid imitation is foreseen the incentives are substantially lowered. For companies it would be more profitable to copy the innovations developed by others, given that competition will make it unfeasible to pass on to the prices the expenditure incurred to develop them. In general terms, this free rider behaviour will finally result in a suboptimal investment in innovation activities. Nor can we forget that imitating innovation provides advantages which are no less important. Imitation is an act of "creative copying" - a "copy" because it tries to reproduce the innovator's technology and "creative" as it entails introducing modifications and gradual improvements which perfect the correct functioning of the technology and contribute to adapting it to the differentiated demands of the diverse market segments. On the other hand, imitation avoids over-investment in R&D and could increase the customers' benefits gained as rivalry between the companies intensifies. Evidence in this sense shows, however, that there are few competitors capable of imitating an innovation - between 3 and 5, in the case of radical innovations and between 6 and 10 in the case of incremental ones (Levin *et al.*, 1987). Consequently, the low number of imitators creates favourable conditions to reach collusive agreements which can reduce the loss of monopoly benefits arising from the innovation.

2. Barriers to imitation

There are a series of barriers to imitation that, in order to be overcome require high spending dissipating thus a large part of the imitator's profits. These barriers are linked to the two basic problems which are raised in any imitation. The first, is a problem of information concerning the technology which they attempt to imitate; what it consists of, what advantages it provides and its nature and complexity. The varying ease with which these questions can be answered depends on the transparency of the technology itself and the degree of causal ambiguity experienced by the imitator. The second problem refers to the acquisition and economic exploitation of the technology. In this sense, the barriers to imitation are created due to factors which substantially increase the cost of replicating the technology and overcoming the first mover advantages of the innovator.

2.1. Transparency and causal ambiguity

To imitate a technology it is necessary to have information on its characteristics and the advantages

it provides. Obtaining this information can be very expensive and difficult. Along these lines, Davis and North (1971) underline that cost-lowering in the acquisition of necessary information on the new technologies seems to have been a crucial determinant in the increase of the imitation rate of the innovations.

Language barriers and the opacity of the competitive advantage also make the technology less transparent. Although English is the international scientific language, many documents and journals are published in other languages and so are inaccessible to the majority of organisations; this is the case, for example, of more than ten thousand Japanese technical publications (Badaracco, 1991). An efficient way of reducing the visibility of the technology advantages is to hide the profits arising from technology by consolidating the balance sheets of the company's different businesses to prevent rivals distinguishing the profitable technologies from those which are not so.

Causal ambiguity refers to "the basic ambiguity concerning the nature of the causal connections between actions and results" (Lippman and Rumelt, 1982), which prevents -in our case- identifying the factors which make up the technological system to be imitated. The causal ambiguity experienced by the imitator is determined by the complexity of the system and the nature of the constituent technologies. A complex technological system with a high component of tacit knowledge (Polanyi, 1967) sets up barriers to its understanding and learning and so it is difficult to replicate and transfer even within the company itself. In this sense, causal ambiguity does not only prevent external imitation but also explains why some companies find great difficulties in replicating their most competitive technologies (Teece, 1985), which might mean a restriction of business growth (Kogut and Zander, 1995).

Complexity is related to the number of technologies involved in the technological system and the knowledge required to combine them. To replicate a complex system the imitator must master all the technologies forming it and be aware of the causal connections which link them. The more numerous, intricate and tacit, the more difficult it will be to work out their uncovering. On the other hand, complexity is associated with high costs and risks, which contribute to putting off potential imitators. The tacit nature of the knowledge bases that supports part of the system technologies also negatively influences their imitation.

2.2. Uncertain and costly imitability

The imitation of new technology can be impeded by the uncertain expected outcome of the imitation process. This uncertainty arises from the stochastic nature of the accumulation process of technological knowledge. Given the difficulty involved in identifying and controlling the relevant variables, the results of the process are uncertain, random and nothing assures that the imitator will achieve the same success as the innovator.

The very knowledge that there exists a new attractive product and the mere examination of its specifications are often an unsuitable base for a successful imitation. The knowledge acquired in the research effort or by implementing the technology may be necessary to imitate many products (especially if they have a high degree of complexity); and lack of this knowledge is an important barrier to imitation. Sometimes the company should gain the knowledge by itself through learning by doing, which involves establishing at least a pilot plant where the operation process simulates the conditions of full-scale production, making irreversible investments which markedly increase the exit costs in case of failure. In this way, the knowledge related to learning by doing cause technology obtaining to be slow and costly for the imitator.

An additional barrier to be overcome by the imitator takes the form of the costs associated with the adjustments which must be introduced to replicate an innovation. The introduction of a new technology, maintaining its organisational design and its previous resource base can destroy the relations existing between these elements, generating the suboptimizing of the system as a whole. To take full advantage of the new technology's potential it is necessary to introduce adjustments in other related elements of the system such as the business organisation or culture. These adjustments generate various costs, which range from redundancies to sunk costs due to investments in current technology -specific assets which must be avoided. To the above costs we must also add those caused by the tensions and conflicts arising from the changes required in the power structure of the organisation (Leonard-Barton, 1992).

2.3. First mover advantages

The longer the rivals take to imitate a new technology, the greater the opportunity for the innovating company to introduce incremental improvements, thus remaining the technological leader. It will also have more time to establish a strong market position which enables it to impose its technological standard, acquire a significant market share and spread its exclusive co-operation network of technological partners, suppliers, distributors and customers.

The innovator gains time to consolidate its market leadership when patenting the innovation. By means of patent control it can limit and restrict the use of a certain technology. For example, when the DuPont scientists invented nylon they did not limit themselves to patenting the basic composition of superpolymers and their production process but they researched the complete series of molecular variations with potentially similar properties to nylon, thus covering their discoveries with hundreds of patents preventing other companies from developing an effective substitute. Furthermore, when a company dominates a field by a massive accumulation of patents, not only does it prevent rival companies from operating, unless by their acquiescence, but it also becomes the logical buyer of the new related concepts patented by independent researchers. Patents can be used to strengthen the monopoly benefits by carrying out related sales, conditioning the sale of the patented product to the purchase of another product or service - generally complementary - which could be acquired in a competitive market (Levin *et al.*, 1987). These and other advantages can encourage the companies to compete in a kind of patents race which substantially increases the costs of technology generation (Fudenberg *et al.*, 1983).

The duration and scope of patents are questions which directly affect the incentives for innovation. The longer the patent lasts, the greater the monopoly benefit received by the inventor and the greater the incentive to invent. There is substantial evidence to indicate, however, that the technological obsolescence of the patents is important. Studying the renewal applications of patents, Schankerman and Pakes (1986) found that the average economic life of patents was four years, with a confidence interval of 2.8 to 5.6 years. Hence, although there are differences between sectors or technologies, a longer protection period may not have significant effects on the benefits gained by the innovator.

The patent holder is interested in the patent scope being as broad as possible, so that it embraces not only the invention itself but also other related ones, enabling him to control the future evolution of a technology. A broad scope generates a market power that is converted into efficiency losses for competitors, at the same time as it discourages their efforts in incremental innovation.

The innovator also benefits of other first mover advantages (Lieberman and Montgomery, 1988, Kerin *et al.*, 1992). The innovating firm may have an influence on the technological standard that will be set for the industry, which will enable the innovator to profit from the "bandwagon" and "network" effects associated with defining this standard. On the supply side, the bandwagon effect brings it about that, by the initial sales and technology licences, interest for the new product will

increase, due to considering that it is going to become the norm or standard in the sector. From the demand point of view, the network effects produce externalities among users by providing them with a benefit which increases directly in proportion to the number of customers who have already acquired the technology (Katz and Shapiro, 1986). The cost of changing from one standard to another strengthens their loyalty to the first set standard. The costs entailed in this change are derived from the loss of investments in specialised assets (or co-specialised) and from the know-how specific to this standard (Wernerfelt, 1985).

In the case of product innovations, the innovator can influence the customers' concept of the ideal attributes of the product (Carpenter and Nakamoto, 1989). The innovating firm can also choose the most profitable market segments and place itself in an optimal position. In the same way, anticipating the creation of a quality reputation and image, backed up by a brand or commercial name, the innovator only has to direct its marketing effort towards maintaining the clientele. The follower must allocate more resources in order to create more surprising and creative publicity to increase its renown and snatch clients away from the leading firm. Consequently, the cost the innovating company must incur to keep one of its customers is lower than the cost the imitator has to run up to snatch a customer away (Comanor and Wilson, 1979). Buzzell and Farris (1977) estimate that, on average, the percentage of sales devoted to sales promotion and publicity costs is 1.45% greater for early imitators compared to innovators. They also note that these costs are 2.12% higher for the latecomers compared to those of the early imitators. In fact, when the quality of the new product is not easily established by inspection or immediate experience the customers tend to be loyal to the first brand. Likewise, the innovator may take advantage of the most important users' opinions who are the leaders in market tendencies.

Market entry order is related to market share in such a way that the innovators gain larger market share than the latecomers (Kerin *et al.*, 1992). Hence, the innovator can attain important scale economies and exploit the experience associated to its use. The cost advantage is especially important as a barrier to entry when there is no market room for more than a few companies which are efficient in size and if the first company entering the market has already assured itself a high market share. Additionally, these advantages are strengthened when combined with an important commitment in the shape of substantial investments in assets and specific capabilities, which are irrecoverable should this market position be lost (Ghemawat, 1991). The experience effect works efficiently at the beginning of the product life cycle: the leader's advantage is obvious, as leadership

in experience is obtained more easily in the early stages when production quickly doubles (experience increases tenfold when going from unit 2 to 2000, but only doubles when moving from 2000 to 4000). The company wishing to attain cost advantages will have to move along the experience curve and so its aim is to grow faster than the competitors (Abell and Hammond, 1979). To maintain the advantage of the experience effect, the know-how generated should be kept secret (Ghemawat and Spence, 1985).

The imitator can incur higher costs in the acquisition of certain factors and in product distribution. The first in the market obtains a privileged position which allows it to negotiate exclusively with the suppliers of materials or production equipment.

The innovator can also benefit from privileged access to certain scarce resources by means of exclusive long-term supply contracts. When the distribution channels have a limited capacity for transport, storing or sales, the distributors devote more resources and the best sites in the commercial establishment and shelf-position to the well-known brands as they have greater probability of being bought, precisely because the customers are loyal to these brands. In order to gain access to the distribution channels the imitator has to accept the disadvantageous conditions set up by the distributors, thus incurring greater distribution costs than those of the innovator. The innovator also puts pressure on Government bodies at all levels, to become the sole agent supplying the new technology. Finally, the innovator can construct a wide network of co-operation involving technological partners, suppliers, distributors and customers which creates a barrier to imitation as it will exclude those competitors who do not form part of the network. This exclusion prevents them from gaining access to the technological knowledge and the complementary assets necessary to exploit it (Lieberman and Montgomery, 1988).

To limit the innovator's first mover advantages, the imitator will try to shorten the imitation process. The problem therefore lies in that the innovator has to face up to the diseconomies of time compression. In the case of R&D investments, the appearance of diminishing returns due to time compression supposes that maintaining a certain investment ratio in R&D over time increases the stock of technological knowledge to a greater extent than the doubling of this ratio in half the time. That is to say, the accumulation of technological knowledge is more efficient when carried out gradually over time than when done instantaneously (Dierickx and Cool, 1989). These diseconomies of time compression apply to the accumulation of the complementary assets required to exploit the innovation in the market.

2.4. Some empirical results

The results of the studies by Levin *et al.* (1987) on the relative importance of the different factors conditioning the innovator's benefit show that patents are less effective than other appropriation mechanisms. In the case of process innovations, the following are considered more important –and in this order- first mover advantages, experience effect, trade secret and commercial capability of the innovator. Product patents are more effective than process patents but they are also considered less effective than first mover advantages, experience effect and commercial capability.

Analysis by sectors suggests that patents seem to be effective as a means of appropriating the benefits from innovation only in a small number of industries. Process patents are effective in the case of the pharmaceutical and chemical industries. Product patents are considered especially valuable for pharmaceutical products, pesticides, organic chemistry and bulk chemistry. Only in the case of pharmaceutical products it is considered that the patents constitute an appropriation method which is more effective than the rest. This is probably the effect of the administrative requirements indispensable to put a new medicine onto the market forcing the companies to divulge too much information about the product, thus making the protection by patent more valuable. Cockburn and Grilichies (1988) confirm that it is also in these sectors where patents and the announcements of new investments in R&D are more valued by the capital markets.

Another interesting result of the study by Levin *et al.* (1987) indicates that the average time necessary to effectively replicate a non-patented innovation oscillates between 6 and 12 months whereas the time needed to effectively duplicate a patented innovation varies from 1 to 3 years. As to the imitation costs, the results of the study by Mansfield *et al.* (1981) on 48 cases of product innovations in the pharmaceutical, chemical and electronics sectors show that the patented inventions have greater imitation costs than the non-patented ones (measured by the duplication costs/innovation costs ratio). This happens especially in those sectors where patents are more effective (pharmaceutical and chemical industry). In their study, Levin *et al*. (1987) find that these three sectors follow a similar pattern. A reason for the longer times and greater costs required to imitate patented inventions lies in the fact that the non-patented ones may be less important innovations and more easily reproducible; and the patented ones require the imitator to make changes or additional improvements to be able to exploit them without violating the patent right.

3. Eliminating barriers

The barriers for imitation are lowered when the technological knowledge supporting the innovation is presented in three forms: codified, in people's minds or incorporated in machines. This knowledge is termed "migratory" (Badaracco, 1991) as it can migrate easily towards competitors who have the complementary assets necessary to exploit it, wearing down the imitator's competitive advantage.

The causal ambiguity experienced is lower when the invention has been patented. The patent application requires a full, clear description of the invention in such a way that an expert in the matter is able to reproduce it. This information forms the basis of the patent documents to which access can be gained at a low cost. Once the patent has been granted and thus published, the patent documents form part of a database. With the patents system, inventions are revealed several years before their first use; whereas, if there were no patents, these inventions could only be known when the products were commercialised. Empirical evidence shows that 70% of the information written down in patent documents does not appear published in other types of information sources until five years later, if it is actually ever published. For example, the discoveries made by Karl Ziegler on opheline polymerisation, which won him the Nobel Prize for Chemistry in 1963 were published in the form of patents from 1953 to 1960 and only from this year onwards did they begin to appear in the form of research articles. Patents provide imitators useful information about the state of the art, the technological evolution in the sector or the technologies developed by the innovator. By accessing to this information the imitators can assimilate more easily and quickly the knowledge sustaining the patented innovation. This information combined with the knowledge the companies possess can give rise to an innovation even superior to the one they are trying to imitate.

The imitation potential of a technology is at its greatest when knowledge is: a) codified, as in this case it can easily be transferred (in blue prints or computer diskette), b) easily interpreted (it can be converted into equations or symbols which are universally understood) or c) easily assimilated (technology is independent of any cultural context) (Hamel *et al.*, 1989). Codified knowledge is translated into a set of interpretable rules and norms which facilitates its transmission and reproduction by third parties. Despite having a similar level of codification, a product technology is more easily imitated than a process technology especially if the latter requires specialised human resources (Von Hippel, 1988) since it is more difficult to gain access to this technology. In accordance with Mansfield (1985), the information on product innovation is diffused in less than a year in 70% of the cases, whereas 60% of the cases of process innovations take more than a year

and a half to be spread in the market.

The knowledge incorporated in the products and machinery is exposed to diverse types of industrial espionage. One of the most characteristic is reverse engineering: breaking down the product (or machine) into its basic components to understand the mechanics of its working and later imitate it improving its internal configuration.

Migratory knowledge is difficult to retain within the company. On the other hand, tacit knowledge is knowledge incorporated in the very reality of the company possessing it and does not migrate. It is context-specific and very difficult to transmit if not by demonstrating, observing, implementation and learning by practice (Polanyi, 1967).

Likewise, the availability of complementary resources necessary to exploit an innovation is a critical factor when the technological knowledge created by the innovator can easily migrate. Just as explained by Chandler (1990), in the capital-intensive industries the first companies to develop an appropriate organisational structure of supply, production and distribution to exploit the scope and scale economies associated with the new technologies appearing at the end of the nineteenth century, gained a competitive advantage which enabled them to remain leaders for decades. The key factor to success was not in many cases either the invention of new technologies or the commercialisation of a new product but rather making the necessary investments in complementary assets of supply and distribution to guarantee a continuous production flow and provide specialised after-sales services required for the diffusion of the new products. Furthermore, arising from the lack of complementary assets, the innovator undergoes a series of disadvantages which benefit the imitators. The imitator learns from the innovator, avoiding committing the same technological and commercial mistakes. Proof of this is that the imitation costs are lower than the innovation costs in most industries. Hence, Mansfield *et al.* (1981) point out that in the case of the innovations of electronic, chemical and pharmaceutical products the average cost of imitation was 65% of the innovation cost. The imitator faces less uncertainty as the market demand is better known and predictable. Furthermore, he finds less market resistance for the improved copied product, the innovator having convinced the potential users of the advantages of the innovation. On the other hand, the potential customers can delay the purchase and wait for the technical difficulties inherent in the launching of a new technology on the market to be lessened or rather wait for a second competitor to appear, so that they can benefit from greater price competition. The imitation process also involves the introduction of improvements perfecting the functioning of the innovation. By

means of these improvements the weakest flank of the innovator's market strategy can be attacked (Yip, 1983).

The innovator's vulnerability is also related to its inertia, for different reasons, preventing it from benefiting from the first mover advantages. The innovator may delay the introduction of the innovation so as not to cannibalise its current products or else to avoid the loss of investments specific to its previous technological capabilities. It can be affected by organisational flexibility problems: the application of a new technology requires considerable changes in the organisational patterns, in the business culture or in the company power structure which generate rejections and conflicts that delay or prevent the introduction of the innovation. The innovator may also be unwilling to improve the original design by introducing incremental improvements or the most recent technological advances in other related technologies (Lieberman and Montgomery, 1988, Yip, 1983). In fact, the innovator runs the risks of entering the market with a product which is not the best possible one or of manufacturing it with a technology which is not completely developed.

4. Defence of the imitation barriers

To reinforce technology protection, the company can send its potential imitators an explicit sign that it will take full legal action or retaliate violently should its rights be violated, all the more so if for the manufacture of its products it had to make investments in irreversible assets. The threat of a hostile response to any attempt at imitation gains greater credibility the longer the useful life of the new technology and of the complementary assets required to exploit it (Eaton and Lipsey, 1980).

The innovator should take measures to avoid the diffusion of the technological knowledge to the competitors. Exploiting the causal ambiguity it may prefer to keep the innovation secret, as the patent reveals too much information, which enables competitors to develop variants of the basic technology. This strategy also has a disadvantage; if a competitor develops the same process or product he can use it without obtaining permission or paying royalties to the innovating company. Very important technical improvements which are not open to being patented are also kept secret. Hence, Hollander (1965) found that in the case of the DuPont rayon plants many of the small technical improvements which followed the introduction of the new technology had not been patented and that taken together they constituted a greater contribution to production than other major changes.

Some companies do not only develop new products internally but also increasingly tend to manufacture their own machinery; in this way they do not divulge the machine characteristics to the machinery suppliers. The latter by leaking details about the new product and even providing clues about its characteristics and components inform competitors. On the other hand, when the companies manufacture machines and equipment for their own use and have a large production capacity, they inhibit technological standardisation, thus creating obstacles for imitation.

It is also important to avoid knowledge leaving the company along with the workers, to control the knowledge transferred to partners in a technological alliance and to control the spread of knowledge transferred or generated in an alliance towards other competitors. The loss of human resources can be very costly when an individual leaves the company taking knowledge which is non separable from him or should it be separable becomes highly valuable for a competitor. A key aspect in human resource management is attempting to prevent workers leaving, trying to retain them and using different methods to expropriate the benefits they generate. Labour Law allows the inclusion in contracts of certain clauses limiting the freedom of movement of personnel, at least for a certain period of time. But it is difficult and expensive to make these clauses stand up in court; furthermore, different courts interpret them differently and so it is not an efficient means of protecting technology (Badaracco, 1991).

Different mechanisms which produce incentives for remaining in the company can also be incorporated into the job contract. Hence, the distribution over time of appropriate salary packages can be structured in such a way that current remuneration is decreased at the expenses of increases in the future remuneration in the form of compensations for long service or high pensions which the worker loses should he leave the company. The future perception of these deferred payments takes the form of recovering an investment the worker had been building up over time as a guarantee of his remaining in the company, and so termed "golden handcuffs".

The business culture also contributes to retaining human resources by including among its key values the workers' loyalty to the company. Long term employment strengthens this value just as the expectations created by a clear promotion system which works according to some implicit rules (long service, for example). These are not formally written down anywhere in the company but constantly respected over time and integrated in its business culture. Finally, the culture and norms of a country can encourage the retention of workers; for example, in Japan it is socially frowned upon for a worker to leave his company to work in another, and the period of time an employee

remains in a company considerably affects his wage and especially his retirement pension.

As for strategic alliances it is necessary to avoid breaking the agreement and so maintain long-term stability. A stable alliance prevents the partners from co-operating with companies which do not form part of the agreement and thus limits technology imitation. The breaking of an alliance enables the companies to seek new partners with which they can interchange the technologies developed in the framework of the finalised agreement, dissipating the advantages created, and at the same time developing other new more efficient ones.

The stability of the alliance is conditioned by the degree of its acceptance by the other members or parties of the co-operating organisations and by its own organisational complexity. It is also conditioned by the status, mobility and competence of the management of the associated companies involved in the agreement. Management mobility and their pursuit of short-term objectives can cause the breakdown of alliances. Managers know that they will soon be in another company or another post and that it is unlikely that they will be held responsible for the consequences of their past decisions (Axelrod, 1984). Hence, they will break the alliance if this benefits their personal expectations.

The stability of the alliance is obtained by promoting trust between the parties, more than emphasising the formal and legal aspects of the contracts. In this respect, Macaulay (1963) reaches the conclusion that businessmen prefer to trust in somebody's word expressed in the form of a short letter, a handshake or even simply in their honesty even if the transaction is exposed to serious risks. Even when two companies make use of a contract to formally seal an agreement, Macaulay (1963) discovered that they would rarely have recourse to judicial sanction if they had to make adjustments due to later circumstances. Trust encourages a fluent communication which can include personal or social matters and so increases the interdependence between partners, strengthening trust and reinforcing long term relations. To gain this trust, in the alliance creation process, attention must be focused not on contractual or capital investment-related questions but rather on the quality of the people who will directly develop the contracts within their respective organisations. Besides, success requires frequent ice-breaking meetings at least at three organisational levels: top management, consultant staff and executive management (Ohmae, 1989).

Trust must have a mutual basis, which takes the form of distributive justice (Axelrod, 1984). As soon as one of the partners begins to feel that the situation is unfair or unequal, co-operation

disappears (Ohmae, 1989). This equity is not easily obtained especially if the partners are of different size and characteristics. Nor is it possible to join forces in the pursuit of common aims if each party has a different competitive strategy. Reciprocity is obtained efficiently if the partners are of equal dimensions, have complementary common resources, assets and aims (Hamel *et al.*, 1989).

The stability of the alliance, however, does not only depend on the trust and reciprocity between the parties, but on the lasting nature of the relation (Axelrod, 1984) which is normally based on the social recall or, what amounts to the same, the company capacity to remember which partners have been flexible in the past and which have been irrationally selfish (Ouchi, 1984). If a company takes advantages of its partners, in the future when it attempts to create a new alliance its potential partners will recriminate it for its past opportunistic behaviour and will refuse to negotiate a co-operative agreement. Hence, fairplay in the transaction is not guaranteed by the threat of litigation but rather by the expectation of future mutually advantageous transactions (Axelrod, 1984). The stability of the alliance is reaffirmed when three conditions are fulfilled: the partner is identifiable in the market, its long-term profitability depends on establishing new alliances and when potential partners are in a position to learn that this partner is not trustworthy, without incurring high costs.

Two facts strengthen the stability of the alliances even further: the existence of a sponsor and a good institutional leadership. It is essential that each partner has at least one internal sponsor, responsible for the alliance over a long period of time. This sponsor has to be firmly convinced that this form of co-operation is advantageous for his company and the agreement is worth developing (Ohmae, 1989). On the other hand, a good institutional leadership during the setting up of the alliance manages to set the common aim and establish trust between the parties. This leadership will depend on the type of co-operation agreed upon. For example, an alliance to create a common research laboratory must have a charismatic leader who could be an outstanding scientist prestigious enough among his fellow researchers under his supervision (Ouchi, 1984). In other circumstances, the leader could be a person capable of bringing together divergent opinions or integrating different cultures.

Another possibility is to give proof of commitment to the agreement by means of a stock exchange protocol including restrictions for its later sale. The stock exchange between the co-operating companies shows their intention not to behave in an opportunistic way. If one of the companies makes a decision which prejudices the other it will also be affected since the market value of the stock in its possession falls. Furthermore, should there be a breach of contract, the firm may have

left a significant proportion of its public capital in hands which are no longer friendly. In the same way, the investments specific to the agreement made by all the partner companies encourage them to maintain an attitude of co-operation (Pisano, 1989).

5. References

ABELL, D. E. and HAMMOND, J. S.: Strategic market planning, Prentice-Hall, Englewood Cliffs, 1979.

AXELROD, R.: The evolution of co-operation, Basic Books, EE.UU., 1984.

BADARACCO, J. L.: The knowledge link, The Harvard Press, Cambridge, Massachusetts, 1991.

BROZEN, Y.: "Invention, innovation, and imitation", American Economic Review, vol. 41, n. 2, may, 1951, pp. 239-257.

BUZZELL, R. D. and FARRIS, P. W.: "Marketing cost in consumer goods industries", in H. THORELLI (ed.), Strategy + structure = performance, Indiana University Press, Bloomington, 1977.

CARPENTER, G. S. and NAKAMOTO, K.: "Consumer preference formation and pioneering advantage", Journal of Marketing Research, august, 1989, pp. 285-298.

CHANDLER, A. D.: Scale and scope: The dynamics of industrial capitalism, Harvard University Press, Cambridge, Massachusetts, 1990.

COCKBURN, I. and GRILICHES, Z.: "Industry effects and the appropriability measures in the stocks market valuations of R&D and patents", American Economic Review, vol. 78, 1988, pp. 419-423.

COHEN, W. M. and LEVINTHAL, D. A.: "Absorptive capacity: A new perspective on learning and innovation", Administrative Science Quarterly, vol. 35, 1990, pp. 128-152.

COMANOR, W. S. and WILSON, T. A.: "The effect of advertising on competition: A survey", Journal of Economic Literature, vol. 27, June, 1979, pp. 453-476.

DAVIS, L. and NORTH, D.: Institutional change and American economic growth, Cambridge University Press, Cambridge, 1971.

DIERICKX, I. and COOL, K.: "Asset stock accumulation and sustainability of competitive advantage", Management Science, vol. 15, n. 12, December, 1989, pp. 1504-1513.

EATON, B. C. and LIPSEY, R. G.: "Exit barriers are entry barriers: The durability of capital as a barrier to entry", Bell Journal of Economics, autumn, 1980, pp. 721-729.

FREEMAN, C.: The economics of industrial innovation, Penguin Books, 1974.

FUDENBERG, D.; GILBERT, R.; STIGLITZ, J. and TIROLE, J.: "Pre-emption, leapfrogging and competition in patent races", European Economic Review, vol. 22, 1983, pp. 3-31.

GHEMAWAT, P. and SPENCE, A. M.: "Learning curve spillovers and market performance", Quarterly Journal of Economics, vol. 100, 1985, pp. 839-852.

GHEMAWAT, P.: Commitment: The dynamic of strategy, Free Press, New York, 1991.

HAMEL, G.; DOZ, Y. L. and PRAHALAD, C. K.: "Collaborate with your competitors -and win",

Harvard Business Review, January-February, 1989, pp. 133-139.

HAMEL, G. and PRAHALAD, C. K.: Competing for the future, Harvard Business School Press, Massachusetts, 1994.

HOLLANDER, S.: The sources of increased efficiency: A study of DuPont rayon plants, MIT Press, Cambridge, Massachusetts, 1965.

KATZ, M. L. and SHAPIRO, C.: "Technology adoption in the presence of network externalities", Journal of Political Economy, vol. 94, 1986, pp. 822-841.

KERIN, R. A.; VARADARAJAN, P. R. and PETERSON, R. A.: "First-mover advantage: A synthesis, conceptual framework, and research propositions", Journal of Marketing, vol. 56, October, 1992, pp. 33-52.

KOGUT, B. and ZANDER, U.: "Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test", Organization Science, vol. 6, n. 1, 1995, pp. 76-92.

LEONARD-BARTON, D.: "Core capabilities and core rigidities: A paradox in managing new product development", Strategic Management Journal, vol. 13, 1992, pp. 111-125.

LEVIN, R.; KLEVORICK, A.; NELSON, R. and WINTER, S.: "Appropriating the returns from industrial research and development", Brookings Papers on Economic Activity, vol. 3, 1987, pp. 783-820.

LIEBERMAN, M. B. and MONTGOMERY, D. B.: "First-mover advantages", Strategic Management Journal, vol. 9, summer, 1988, pp. 41-58.

LIPPMAN, S. A. and RUMELT, R. P.: "Uncertain imitability: An analysis of interfirm differences in efficiency under competition", The Bell Journal of Economics, vol. 13, 1982, pp. 418-438.

MACAULAY, S.: "Non-contractual relations in business: A preliminary study", American Sociological Review, vol. 28, spring, 1963, pp. 55-67.

MANSFIELD, E.: "Technical change and the rate of imitation", Econometrica, October 1961, pp. 741-766.

MANSFIELD, E.: "How rapidly does new industrial technology leak out?", Journal of Industrial Economics, 31, 1985, pp. 217-223.

MANSFIELD, E.; SCHWARTZ, M. and WAGNER, S.: "Imitation costs and patents: an empirical study", The Economic Journal, vol. 91, 1981, pp. 907-918.

MARITI, P. and SMILEY, R. H.: "Co-operative agreements and the organization of industry", The Journal of Industrial Economics, vol. XXXI, n. 4, June 1983, pp. 437-451.

MARQUIS, D. G. and STRAIGHT, D. L.: "Organizational factors in project performance", MIT Sloan School of Management Working Paper No. 133-65, 1965.

MOKYR, J.: The lever of riches. Technological creativity and economic progress, Oxford University Press, 1990.

MUELLER, W. F.: "The origins of the basic inventions underlying Du Pont's major product and process innovations, 1920-1950", in R. R. NELSON (ed.): The rate and direction of inventive activity: Economic and social factors, Princeton University Press, Princeton, 1962.

OHMAE, K.: "The global logic of strategic alliances ", Harvard Business Review, march-April, 1989, pp. 143-154.

OUCHI, W. G.: The M-form society: How American teamwork can recapture the competitive edge, Addison-Wesley, Reading, Massachusetts, 1984.

PISANO, G. P.: "Using equity participation to support exchange: Evidence from the biotechnology industry", Journal of Law, Economics and Organization, vol. 5, 1989, pp. 109-126.

POLANYI, M.: The tacit dimension, Doubleday, New York, 1967.

PUCIK, V.: "Strategic alliances, organizational learning, and competitive advantage: The human resource management agenda", Human Resource Management, vol. 27, spring, n. 1, 1988, pp. 77-93.

ROBERTS, E. B. and MIZOUCHI, R.: "Inter-firm technological collaboration: The case of Japanese biotechnology", International Journal of Technology Management, vol. 4, n. 1, 1989, pp. 43-61.

ROSENBERG, N.: Inside the black box: Technology and economics, Cambridge University Press, Cambridge, Massachusetts, 1982.

SCHANKERMAN, M. and PAKES, A.: "Estimates of the value of patent rights in European Countries during the post-1950 period", The Economic Journal, vol. 16, n. 384, 1986, pp. 1052-1076.

SOLO, R.: "The capacity to assimilation an advanced technology, American Economic Review, Papers and Proceedings, may, 1966, pp. 91-97.

TEECE, D. J.: "Applying concepts of economic analysis to strategic management", en J. H. PENNINGS (eds.): Organizational strategy and change, Jossey-Bass, San Francisco, 1985.

VON HIPPEL, E.: The sources of innovation, Oxford University Press, New York, 1988.

WERNERFELT, B.: "Brand loyalty and users skills", Journal of Economic Behavior and Organization, vol. 6, 1985, pp. 381-385.

YIP, G. S.: "Gateways to entry", Harvard Business Review, September-October, 1982, pp. 85-92.