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What Shapes Firm Networks?
Cooperative Innovation in Austrian Machine-Tool and Cement Industries

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Abstract

Inter-organizational linkages, often referred to as network relationships, are considered to be of increasing importance for the competitive performance of firms, industries and nations. Two hypotheses about the conditions for the emergence of network relationships are derived from the transaction cost approach and discussed in view of two case studies relying on a medium sized machine-tool firm and a medium sized cement firm in Austria. The paper clearly illustrates the necessity to go beyond the transaction cost approach and to take into account factors such as strategic orientation, management skills and organizational issues.

Introduction and Basic Hypotheses

During the last years a growing amount of empirical studies has stressed the increasing importance of inter-organizational linkages between actors in the economic system for the competitive performance of firms, industries and nations. The observed phenomenon encompasses a great variety of actors and relationships at different levels, including user-producer linkages (Lundvall 1988, von Hippel 1988), strategic alliances (Olleros and Macdonald 1988, Rothwell 1991, Hagedoorn and Schakenraad 1990), R&D consortia (Watkins 1991), government-university-industry-relations (Ballard and James 1989, Callon 1991), production networks (Saxenian 1991) and innovation networks (Imai 1989, Camagni 1991, Fischer and Johansson 1992). These studies are conducted at the enterprise as well as at the
regional or national level (Scott 1988, Porter 1990). Illustrative cases and success stories stemming from the German automobile industry, the Californian Silicon Valley, the "Third Italy" or Japan suggest that network relations are in many ways superior to other forms of organizing economic activities, as far as the performance of the economic units is concerned.

Stimulated by these findings, increasing attention is being laid on a network perspective in general, and on the sources and causes, the functions, the limits and problems of networks in particular. Several studies embed the concept of networks in the context of technological change and innovation (see for an overview DeBresson and Amesse 1991 or Freeman 1991). This paper lies in this tradition and makes a modest attempt to address the question which conditions favour the emergence of network relations in the innovation process of firms.

The transaction cost approach (Coase 1937, Williamson 1975, 1985) plays a prominent role in studying the evolution of networks. Actors in the economic system are (at least partly) mutually dependent on specific complementary assets (Teece 1986) provided by other actors. Consequently, the actors are forced to coordinate a great variety of transactions in order to access these assets. Following Coase (1937) the central hypothesis of the transaction cost approach may be stated that individuals involved in an exchange process evaluate the transaction costs of alternative forms of organization, and then - given the production costs - organize their economic activities in such a way to minimize their transaction costs.

A high level of asset specificity, technological and market uncertainty, as well as infrequency of transaction induce high costs which make it unlikely that individuals organize their economic activities via market relations. This is particularly true for innovation activities: (1) Technological know-how is a very specific asset where market failures typically occur, and (2) returns on innovation are uncertain in changing technologies and markets. More and more scholars agree that in these contexts networks based on reciprocity and trust are a transaction cost efficient alternative to markets and hierarchies (Thorelli 1986, Jarillo 1988, Grabher 1988, Chesnais 1988). Consequently, the main function ascribed to network relations in this view is a reduction of transaction costs. Opportunism is replaced by cooperative behaviour, which makes networking a positive sum game (Landau and Rosenberg 1986).

Two operational hypotheses may be derived from the transaction cost approach with respect to external conditions favouring the emergence of network relations:
The higher the technology level of a firm, the more intensive are the corresponding network relations.

The more uncertain the technological and market environment of the firm is, the more intensive are the corresponding network relations.

Hypothesis (a) incorporates the asset specificity argument, taking technology level as a measure of know-how intensity of production, whereas hypothesis (b) stresses the uncertainty argument of the transaction cost approach.

These two hypotheses will be considered and assessed in qualitative rather than quantitative terms, by means of case studies relating to two Austrian smaller medium enterprises, one producing machine tools, the other cement. The enterprises, both located in the central region of Upper Austria, belong to the same size class (about 200 employees), but differ significantly in their technology level and the technological and market uncertainties of their environment. Both enterprises have experience in cooperation, so that differing external conditions may be expected to occur in differing cooperation patterns.

Qualitative information on the origin, the function, the expectations and returns of external relationships and network connections was gathered through personal face-to-face interviews with department, technology or marketing managers. The intensive interviews, each lasting between two and three hours, addressed questions relative to both, the technological and the economic environment of the firm, as well as the innovation strategy and internal organization.

In the following sections the two cases are presented in a comprehensive form: firstly, the market and technological environment is briefly characterized, and secondly, the evolution of important external linkages is described in greater detail. A summarizing figure is given at the end of each case.

Case A: Low networking efforts in machine-tool industry

Competition in special purpose machinery is very much internationalized. While large multinational groups clearly dominate the world market, there are some niches in which SMEs may succeed. Special purpose machinery is an industry where new technologies based on microelectronic components have been increasingly become important. Recent technical developments and high technological opportunities provide an increasingly diversified set of
sources of innovation for firms in this industry. According to the above mentioned two hypotheses, intensive external linkages of firms might be expected in this industry as a consequence of the high degree of know-how intensity and the dynamics of the markets concerned.

The firm in question is a family enterprise with about 200 employees showing nearly every attribute usually ascribed to SMEs: specialized technological core competence, weak capital base, lack of qualified technical staff, and a narrow strategic perspective, dominantly influenced by the user-producer relations.

The following remarks are related to that innovation project which played a key role for the firm in establishing external relationships in the past 5 years. The innovation project has occupied a large part of the firm's capacity for at least three years, so that linkage patterns in this project can be regarded as representative for the firm as a whole.

In 1988 the firm decided to start the development of a new product for a promising market: an automotive railway repair machine, using milling technology, which is one of the core competences of the firm. The automotive part, at least for the prototype, should come from a German partner. The German Railway showed interest in the product, but no specific attention was paid to the future marketing of the new product. Development efforts as well as external linkages concentrated on the technological side only.

After the first successful tests of the prototype the German Railway was still considered to be the prospective pioneer user of the innovative product. But due to problems with the German unification, the German Railway cut the budget for repairing railways and decided not to invest in the Austrian development. Since the marketing skills of the machine-tool-firm had always exclusively been focused on direct cooperation with the users, the management lacked now skills in entering a market with rather complex structures: On the one hand the procurement of the national railways is highly formalized, but on the other hand direct personal contacts are essential to enter the market with new products. However, the lack of these contacts, missing references and the dominant market power of an international competitor prevented the machine-tool firm from a successful market access.

Literally in the last minute the management decided to look for a strategic alliance with the dominant competitor. This competitor is a well established supplier of machines and services to several European national railways. The convincing technological and economic advantages of
the prototype (reduction of the operating costs down to 10% compared to the current technology) made it interesting for the large competitor to establish this alliance. Half a year of negotiations resulted in a formal agreement, which provides the Austrian firm the expectation of a guaranteed 20-30% capacity utilization during the next years.

![Cooperative links of the machine-tool firm](image)

The strategic alliance added an essential external linkage to the machine-tool firm. But a closer look at the linkage pattern (see fig. 1) still questions whether the technological and market conditions did lead to the expected intensity of linkages.

**Case B: Intensive R&D linkages in cement industry**

Cement is a basic product with low technology intensity. The Austrian market is rather protected and only open to foreign competitors to a small degree. The market is organized by a registered cartel for price, quotas and conditions. There is a close economic cooperation of 13 cement producers. The product has remained unchanged for a very long time, and it does
not face any additional technological opportunities. User-producer interactions are of no importance.

Competition takes place completely on the process and general cost side. As long as the price and the quotas are fixed, the firms in the market can only economize on cost reducing process innovations. This situation is responsible for the non-existence of technological cooperation between the members of the cartel.

The firm considered in our study has 190 employees, an annual turnover of about 500 mio. ATS. It is the only cement plant in a local group with emphasis on the construction industry. The management can act rather autonomously, as the decisions in the group are to a great extent decentralized.

The firm's strategy may be characterized by the predominant goal to stay small, but independent in a competitive environment of internationalized multiplant groups. This requires high skills in accessing complementary assets pro-actively in order to offset possible economies of scale of the competitors.

The main innovation activities predominantly relate on the one side to energy saving, waste reduction, recycling, and reduction of emissions, more or less strongly influenced by government regulations, and to rationalization efforts on the other. In none of these fields the firm has sufficient capacity or competence to carry out in-house research or development.

The firm's strategy has taken this fact into account for more than 30 years. Since no R&D cooperation is possible within the cartel, the management had to establish linkages with international partners, outside the Austrian market. According to the technical director, the linkages come from and are based on personalized relationships. In day-to-day business the fastest ad-hoc solutions to specific problems come via informal know-how-transfer from personal relationships to friends associated with a German plant. Since this firm is no direct competitor, little or no problems arise in this context.
Additionally, the firm has established a formalized membership in an international R&D network. The origins date back about 30 years and have again been based on personalized relationships enabling the Austrian firm to participate in the R&D activities of a Swiss cement group with more than 100 plants worldwide. The Swiss headquarter provides technical staff for research and development of 200 qualified employees. The membership of the Austrian firm is formalized in form of a contract with a rather low annual membership fee.

This membership is of mutual interest: the Austrian firm acts as a sensor for problems in an ecologically rather sensible environment, where government regulations usually have a higher standard than in other European countries. The Swiss partner, in return, provides technological expertise in nearly all fields where the Austrian firm lacks qualified personnel.

Quite in contrast to expectation related to the low technology intensity of cement production and the stable nature of the market a rather intensive linkage pattern may be observed (see fig. 2). Nearly all assets critical to commercialize an innovation (see Teece 1986) are accessed or expanded cooperatively.
Concluding remarks

An earlier investigation of the determinants of patenting activities in Austria points to the weak performance of smaller medium enterprises in invention / innovation activities (Fischer, Fröhlich and Gassler 1994). According to the latest innovation survey of the Austrian WIFO this is the size class which faces most barriers to innovation, such as capital constraints, lacking R&D capacity or lacking marketing skills (Leo, Palme and Volk, 1992). The firms in the cases presented above use cooperative linkages successfully in order to overcome these barriers. But hypotheses considered about the emergence of network relations are not supported by the case studies. The cement firm in an environment of low technological opportunities and certain markets is participating in an R&D network, whereas the machine-tool firm with high technological opportunities and far greater market uncertainties prefers to rely on its own resources unless it is forced to cooperate.

The reasons for the unexpected outcomes may be found in the internal characteristics of the firms, underlying the assumption that internal conditions affect networking activities to a higher extent than external conditions. In the two case studies some information was obtained about the strategies and the internal organization of the innovation process in the firms. The contrasting observations in the cement firm and the machine-tool firm hint to different implicit concepts of competitiveness.

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INSERT: DIMENSIONS OF COMPETITIVENESS

In traditional microeconomic analysis the concept of competitiveness is often restricted to the dimensions "price" and "quality" of products, and in modern logistics, also to "time" of delivery. This perspective is static rather than dynamic in nature.

An OECD study on "Technology and the Competitiveness of SMEs" (OECD 1992) develops a different concept, which is multidimensional and dynamic in nature. The following variables are considered best to explain the competitiveness of SMEs:
- the role played by the owner or management,
- the ability to obtain and use appropriate scientific and technological information,
- the quality of the firm's organization,
- tangible investment based on appropriate technologies, and
- flexibility

In the strategies of the machine-tool firm price competitiveness and (static) cost efficiency play an important role. The skills to cope with other dimensions of competitiveness in a more dynamic view, and thus the management of interfaces with the economic environment are somehow neglected up to now to a high degree, as the story of the strategic alliance illustrates. The lack in management capabilities, referred to as "intangible investment", seems to reduce the propensity of a firm to engage in network relationships.

The cement firm contradicts this general view. Although cost efficiency is still an important objective, other dimensions of competitiveness, such as the ability to obtain and use appropriate scientific and technological information, play a major role for the management of the firm. Accordingly, personalised relationships act as interfaces to the technological and economic environment. These relationships serve as basis for successfully participating in an international R&D network.

Even if the empirical findings of two contrasting case studies presented here may not be generalized, there are good reasons to state that the dominance of external conditions in forming network linkages (as proposed in the transaction cost approach) has to be doubted. Consequently, this asks for modifying the above hypotheses about the emergence of inter-organizational networks to integrate internal factors and focus on the requirements of an efficient management of interfaces to the environment.
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