Technological Innovation and Interfirm Cooperation

An exploratory analysis using survey data from manufacturing firms in the metropolitan region of Vienna

Dr. Manfred M. Fischer

Professor and Chair
Department of Economic and Social Geography
Wirtschaftsuniversität Wien
Augasse 2-6, A-1090 Vienna, Austria

Dr. Attila Varga

Research Scholar
Institute for Urban and Regional Research
Austrian Academy of Sciences
Postgasse 7/4/2, A-1010 Vienna, Austria

Abstract

This paper centres around two research questions: *first*, the identification of five types of networks that manufacturing firms located in the metropolitan region of Vienna may have created for different purposes; and *second*, the question to what extent the likelihood of interfirm cooperation is conditioned by the general profile of manufacturing establishments and their technological resources. The study utilizes a recent postal survey providing data on size and organization, products and markets, research and development, innovation and interfirm relationships. The analysis of the first question finds that: *first*, networking does not yet seem to be a popular managerial and organisational concept for manufacturing firms located in the metropolitan region of Vienna; *second*, networking activities are primarily based on vertical relationships (customer, manufacturer supplier and producer service provider networks) rather than on horizontal linkages (producer networks, industry-university linkages); *third*, networks focusing on the later stages of the innovation process are less common than those focusing on the earlier stages; *fourth*, firms tend to rely on sources of technology from national and – especially – international networks. It appears that metropolitan networking is less common than has been thought. For technical advance spatial proximity does not seem to be very important. Turning to the second research question of the study, focusing on the adoption of the managerial and organizational concept of networking, the results are bolstering the argument that establishment traits and technology related-capabilities do play a role. The results achieved reveal, for example, that in-house research skills are a very good predictor for industry-university relationships.

3. Introduction

The extensive use of the terms cooperation and networking may owe something to fashion, as does globalization. But it also reflects an initial – though still imperfect – recognition that technological innovations are less and less the outcome of isolated efforts of the individual firm. They are increasingly created, developed, brought to the market and subsequently diffused through complex mechanisms built on interorganisational relationships and linkages. Interfirm relations are built when costs of governance are outweighted by gains provided by the specialisation of activities, by sharing costs of joint infrastructures, interfaces and indivisibilities, and by the advanatages associated with technological externalities created by cooperation partners. Innovation-related cooperation has been around for some time, but during the past two decades there has been an upsurge of interest in this kind of collaboration. This may be attributed to several factors: particularly, to the increased pace of technological development, the rising complexity and variety in knowledge necessary for technological innovation, the trend towards the fusion of disciplines in previously separate fields, and the need to share research and development costs.

The literature on such networks has also grown rapidly in recent years. But most of it is theoretical or conceptual in nature. There is a need to move beyond theoretical reasoning and to identify the various types of networks that firms in specific regional environments create for different strategic purposes in order to gain deeper understanding on interfirm cooperation (Malecki et al. 1999). This paper makes a modest attempt to, first identify five types of networks that manufacturing firms located in the metropolitan region of Vienna may have created, and, then to explore to what extent the likelihood of interfirm cooperation is conditioned by the general profile of the establishments and their technological resources, using logit analysis.

The remainder of the paper is structured as follows. Section 2 outlines the background theory of this study which lies at the crossroads of the resource-based view of the firm and the network approach of innovation research. Section 3 follows with a brief description of the survey approach and the general traits of the manufacturing firms surveyed in the metropolitan region of Vienna. Section 4 focuses on the first question, centred on the identification of five types of networks: customer, manufacturing supplier, producer service provider and producer network relations as well as cooperations with universities/research institutions. Section 5 brings together strands of the resource-based view of the firm with analysing the second research question, results of logit analysis used to discuss the extent to which establishment traits and technology-related capabilities condition interfirm networking of various types. The final section summarizes the research findings and points to directions for future research.

4. Background theory

This paper lies in the tradition of the network approach of innovation research which departs from the single-act philosophy of innovation and views technological innovation as much a social process as a technical process. This social process of technological innovation involves interaction between individuals within the system, both internally within the firm and between members of the firm and outside organizations. The network school of innovation research (see, e.g., Häkansson 1987) attempts to explain the innovation process in terms of the network relationships between these various actors. Network principles are viewed to apply both within and between organizations. Internally, networking occurs between R&D, production and marketing through new forms of product development practice, and externally through relations between the producers, its suppliers, customers and other organisations, notably research institutions and universities (see, e.g., Lundvall 1988).

The notion of absorption capacity of a firm is central to the networking approach of innovation. The absorption capacity of an organisation refers to the ability to learn, assimilate and use knowledge developed elsewhere through a process that involves substantial investments, especially of an intangible nature (Cohen and Levinthal 1989). This capacity crucially depends on the learning experience which in turn may be enhanced by in-house R&D activities. The concept of absorption capacity tells that in order to be able to access a piece of knowledge developed elsewhere it is necessary to have done R&D on something similar (Saviotti 1998). Thus, R&D may be viewed to serve a dual, but strongly interrelated role: first, to developing new products and production processes, and second, to enhancing the capacity to learn.

The degree to which R&D is important for the development of a firm's absorption capacity largely depends on the pace of advance and the characteristics of outside knowledge (such as the degree of codification and the degree of appropriability) in a specific technology field. The faster the pace of advance of the field is, the lower is the degree of codification, the higher is the degree of appropriability and the greater is the effort needed to keep up with the developments. The more tacit a specific piece of knowledge, the more time and effort are usually required to learn the code of that piece and to transform it into commercially and firm specific relevant knowledge.

Firms, especially smaller firms, that lack appropriate in-house R&D capacities have to develop and enhance their absorption capacity by means of other sources, such as by learning from customers and from suppliers, by interacting with other firms and by taking advantage of knowledge spillovers from other firms and industries (Lundvall 1988). These sources provide the know-why, know-how, know-who, know-when and know-what important for entrepreneurial success (Johannisson 1991, Malecki 1997). Network arrangements of different kind provide a firm that assistance necessary to take advantage of outside knowledge.

The paper links strands of the resource-based view of the firm with analyzing the likelihood of interfirm cooperation. The resource-based view of the firm, with its focus on firm-specific characteristics for analyzing firm behaviour and competitive strategy, has its roots in the work of Penrose (1959), Nelson and Winther (1982) and other work on industry life cycles, and has been developed by Wernerfelt (1984), Barney (1986), Teece (1988) among others, largely as a reaction to Porter's (1980) ‚competitive forces‘ scheme of firm strategy. In Porter's framework, the performance of a firm is essentially determined by the structure of the industry within which it operates, namely by the five forces of entry barriers, substitutes, buyers´ and suppliers´ bargaining power, and intra-industry rivalry. Thus, the primary determinants of success are external to the firm, resting on characteristics of the industry structure rather than on the firm's internal managerial, technological, marketing, and other resources. Therefore, the competitive forces view of the theory of the firms say little, if any, on the firm's ability to innovate (Mowery et al. 1998).

In contrast, the resource-based view of the firm argues that a business firm is best viewed as a collection of tangible and intangible resources that each firm develops in an idiosyncratic way. It emphasizes the inherent inmobility of such resources and the long time horizon involved in generating new resources through continual learning and search activities. Such resources may be physical such as product designs or production techniques, or intangible such as knowledge of specific user needs or idiosyncratic routines for handling the marketing and distribution of products. Such capabilities are context-specific and partially knowledge-based. Much of the relevant knowledge – especially the newer parts that we consider the frontier – resides within tacit forms in the minds of experienced individual researchers or engineers. This person-embodied knowledge is generally difficult to transfer and is often only shared by colleagues if they know the code through common practice. On the one side a given type of knowledge may become more codified as it matures, on the other side the act of embodying it into specific goods and services may reintroduce some tacitness again (Fischer 1999).

Market transactions for the sale or acquisition of such firm-specific resources are difficult to organize and are subject to considerable risks of failure (Teece 1982). The same characteristics that enable a firm to extract a sustainable rent stream from its resources make it also difficult for firms to acquire technological knowledge from external sources through market channels (Morwey et al. 1998).

5. Sampling methodology and general traits of the sureyed firms

Any empirical study of innovation and network activities requires primary data collection, postal or interview based surveys, taking the individual manufacturing firm as unit of analysis. We have chosen a postal survey of manufacturing firms as the appropriate methodological tool for eliciting basic quantitative data. The postal questionnaire has undergone several rounds of development and revision within the framework of an international project on the Regional Innovation Potential and Innovative Networks in Metropolitan Regions, and was finally conducted from September 4 to December 15 1997 in the metropolitan region of Vienna (i.e. the city of Vienna and related communities). The key questions included the organizational structure, product and process mix, as well as the nature and extent of innovation and network activities. Data were collected from the population of 908 manufacturing firms with at least 20 employees, as identified by the Firm and Product Database Register (1995) organized and managed by the Department for Systems Research at the Austrian Research Centre Seibersdorf. 204 firms returned the completed questionnaire, resulting in a response rate of approximately 22.5 percent. This response rate is relatively low, but statistically still acceptable. Anecdotal evidence does indicate that industrialists are receiving postal surveys in ever increasing numbers and this has an effect on response rates.

Table 1 presents a breakdown of the sample responses and illustrates the response rates for seven industry sectors, using the standard NACE classification on the basis of information such as product description as provided by the firms, and for four firm size classes as measured by employment. The sample can be seen broadly to reflect the overall structure of the total population. As expected, the lower response rate by small local manufacturing units may be attributed to the fact that such firms are less likely to undertake any kind of formal R&D activity, since they tend to lack the resources for this. They therefore might display a tendency to dismiss the questionnaire as irrelevant to their circumstances. This is a general problem and not one that is specific to this study. A telephone based survey of a small subsample of 90 non-respondents, however, indicates that the problem is not significant. The majority of surveyed firms are very small (67.2 percent less than 100 employees, compared to 68.4 percent of the identified population), and many of these (49.6 percent of those with a known starting year) have been in business since 1970. In terms of organisational status, 111 firms (55.0 percent) were independent, the remainder operated within a wider parent company group as a main plant (36.1 percent) or as a branch plant (8.9 percent).

Table 1: Response patterns and representativeness of responding manufacturers

	Total Number of Registered Firms 1995		Number of Responding Firms 1997		Represen-tativeness Ratio
Industry Sector					
Textiles & Clothing	*72*	*(7.93 %)*	*13*	*(6.37 %)*	*18.05 %*
Food Industry	*112*	*(12.33 %)*	*24*	*(11.76 %)*	*21.43 %*
Wood, Paper & Printing	*198*	*(21.81 %)*	*49*	*(24.02 %)*	*24.75 %*
Chemicals, Plastics & Rubber	*185*	*(20.37 %)*	*38*	*(18.63 %)*	*20.54 %*
Electrical and Optical Equipment	*115*	*(12.67 %)*	*28*	*(13.73 %)*	*24.35 %*
Basic Metals and Metal Products	*108*	*(11.89 %)*	*24*	*(11.76 %)*	*22.22 %*
Machinery & Transport	*118*	*(13.00 %)*	*28*	*(13.73 %)*	*23.73 %*
Total	*908*	*(100.00 %)*	*204*	*(100.00 %)*	*22.47 %*
Employment Size					
≤ 49	*396*	*(43.61 %)*	*88*	*(43.14 %)*	*22.22 %*
50 – 99	*225*	*(24.78 %)*	*49*	*(24.02 %)*	*21.78 %*
100 – 499	*232*	*(25.55 %)*	*54*	*(26.47 %)*	*23.28 %*
≥ 500	*55*	*(6.06 %)*	*13*	*(6.37 %)*	*23.64 %*
Total	*908*	*(100.00 %)*	*204*	*(100.00 %)*	*22.47 %*

Note a: number of responding manufacturing firms divided by total number of registered firms multiplied by 100

Table 2 shows a brief profile of the surveyed firms utilizing five indicators. The first three indicators attempt to capture the resources to which the manufacturing firms have access for the purposes of innovation:

- the presence of continuous on-site R&D facilities,
- R&D employment in terms of the R&D personnel ratio, and
- R&D expenditure in terms of the R&D expenditure intensity [in percent of sales turnover].

Another set of two indicators focuses on innovation activities or outcomes and includes

- the actual introduction of new products [averaged over 1994-1996] per 1,000 employees [i.e. the product innovation rate], and
- the share of turnover accounted for by new or improved products [averaged over 1994-1996].

The second of these measures is an indicator favoured by many of the management experts as a measure of a firm’s innovativeness and is a widely accepted measure in the benchmarking literature (see, for example, Zairi 1992). It relates product innovations to economic activity. It is accepted that the definition of what constitutes a new or improved product is problematic and this is something what has to be taken into account when considering the figures provided in Table 2. In some industry sectors such as food industry and textiles & clothing new and especially improved products may appear rapidly while in others four or five years developmental cycles may be the norm and in such as machinery and transport, for example, very long leading times are still the case.

Table 2: Innovation and R&D activities of surveyed firms (1994 – 1996)

	Innovation Rate [a]	Share of Turnover by Product Innovations	Firms with Continuous On-Site R&D 1997 [c]		R&D Personnel Ratio [b]	R&D Expenditure Intensity
Industry Sector						
Textiles & Clothing	60.43	0.23	2	(15.38 %)	17.76	4.69
Food Industry	32.33	0.31	3	(12.50 %)	25.48	1.72
Wood, Paper & Printing	25.95	0.05	4	(8.16 %)	11.43	1.43
Chemicals	22.45	0.14	5	(13.16 %)	52.62	4.90
Electrical & Optical Equipment	6.13	0.51	7	(25.00 %)	250.41	15.80
Basic Metals & Metal Products	11.71	0.51	2	(8.33 %)	115.07	2.17
Machinery & Transport	3.97	0.50	7	(25.00 %)	24.77	2.44
Employment Size						
≤ 49	105.51	0.17	7	(7.95 %)	51.09	2.05
50 – 99	75.37	0.18	7	(14.29 %)	29.31	2.98
100 – 499	6.02	0.23	11	(20.37 %)	31.75	3.01
≥ 500	2.12	0.42	5	(38.46 %)	136.04	7.77
Production Size						
Custom Production	26.75	0.27	11	(12.09 %)	36.40	4.49
Batch Production	13.69	0.42	6	(10.71%)	174.52	11.18
Custom & Batch Production	33.68	0.12	1	(12.50 %)	30.87	2.58
Mass Production	5.58	0.24	10	(29.41%)	66.20	6.67

Note a: denotes number of new products per 1,000 employees
Note b: per 1,000 employees
Note c: percentage of all firms of the corresponding raw category

Following Malecki and Veldhoen (1993) we classified firms as innovative, based on the following criterion: if product innovations introduced during the past three years comprised more than 20 percent of the firm's yearly turnover. Defined in this way, there were only 50 (26.5 percent) innovative firms, 64.0 percent of these were smaller than 100 employees; 16 had fewer than 50 employees. The sectoral distribution indicates a predominance of innovative firms in electrical and optical equipment (ÖNACE 30-33; 11 firms), machinery and transport (ÖNACE 29, 34-35; 11 firms) and basic metals and metal products (ÖNACE 27-28; 3 firms). These three sectors account for 50 percent of all the innovative firms. Of the non-innovative firms, 45.3 percent are engaged primarily in custom production, 26.6 percent in batch production and another 5.0 percent in custom and batch production. This suggests that flexible production, particularly of custom products for individual customers, is the norm rather than the exception among the firms surveyed, whether or not the concept of 'new/improved' products is appropriate.

R&D may be misleading or is at least incomplete as an indicator of technological capability, because it does not include network activities, learning, informal R&D and other means of enhancing a firm's knowledge base (Malecki 1997). Firm performance may be best viewed as a product of the interplay between in-house R&D efforts to innovate and external innovation networks for knowledge transfer. The knowledge needed to compete comes most often from customers, suppliers (manufacturing suppliers and producer service providers) and from other firms and institutions. The innovativeness supported by interfirm networks not only supports existing firms, it also offers opportunities to open up new businesses in order to serve newly identified markets. The importance of networks and of innovative niches sparks innovation in both high-technology industries and in traditional sectors.

6. Networks and network formation

In recent years, new forms of interfirm agreements bearing on technology have developed alongside the traditional means of technology transfer – licensing and trade in patents – and they often have become the most important way for firms, regions and countries to gain access to new knowledge and key technologies. The network form of governance can overcome market imperfections on the one side and the rigidities of the vertically integrated hierarchy on the other. The limitations of these two modes of transactions in the context of knowledge and innovation diffusion have pushed interfirm agreements to the forefront of corporate strategy in the last decades (Chesnais 1988).

There are many definitions of *innovation networks* (see DeBresson and Amesse 1991, Freeman 1991), the one offered by Tijssen (1998) captures the most important points of the network mode. He suggests to define a 'network as an evolving mutual dependency system based on resource relationships in which their systemic character is the outcome of interactions, processes, procedures and institutionalization. Activities within such a network involve the creation, combination, exchange, transformation, absorption and exploitation of resources within a wide range of formal and informal relationships.' In a network mode of resource allocation, transactions neither occur through discrete exchanges nor by administrative fiat, but through networks of individuals or institutions, engaged in reciprocal, preferential and supportive actions (Powell 1990).

Networks show a considerable range and variety in content. The content differs according to specific circumstances. Its nature will be shaped by the objectives for which network linkages are formed. For example, they may focus on a single point of the R&D-to-commercialisation process or may cover the whole innovation process. The content and shape of a network will also differ according to the nature of relationships and linkages between the various actors involved (see Chesnais 1988). At the one end of the spectrum lie highly formalised relationships. The formal structure may consist of regulations, contracts and rules that link actors and activities with varying degrees of constraint. At the other end are network relations of a mainly informal nature, linking actors through open chains. Such relations are very hard to measure (Freeman 1991).

Networks are for firms a response to quite specific circumstances. Where complementarity is a prerequisite for successful innovation, network agreements may be formed in response to firm specific proprietary tacit knowledge. The exchange of such complementary assets can take place only through very close contacts and personalized and generally localised relationships (OECD 1992). When technology is moving rapidly, flexibility and reversibility along with risk sharing represent another reason for preferring a network mode. Interfirm agreements are easier to dissolve than internal developments or mergers. The network mode provides much higher degrees of flexibility (OECD 1992). Porter and Fuller (1986) stress speed among the advantages that networks have over acquisition or internal development through arm's length relationships. The timing advantage of networks is becoming increasingly important as product life cycles have shortened and competition has intensified. High R&D cost may be another distinct reason for networking and force management, especially in the case of smaller firms, to pool resources with other firms, in some cases even with competitors (OECD 1992).

Evidence available through the survey of manufacturing establishments indicates that natework activities of manufacturing firms in the metropolitan region of Vienna are organized around five types of networks (see Fischer 1999):

- *customer networks* which are defined as the forward linkages of manufacturing firms with distributors, marketing channels, value-added resellers and end-users, that may facilitate the process of acquiring information about markets, a critical input in the process of new and incremental product innovation,

- *manufacturing supplier networks* which are defined to include subcontracting, arrangements between a client (the focal manufacturing firm) and its manufacturing suppliers of intermediate production inputs,

- *producer service provider networks* which are defined to include arrangements between a client (the focal manufacturing firm) and its producer service partners (esp. computer and related service firms, technical consultants, business and management consultants, market research and advertising),

- *producer networks* which are defined to include all co-production arrangements (bearing to some degree or another on technology) that enable competing producers to pool their production capacities, financial and human resources in order to broaden their product portfolios and geographic coverage, on the one side and to outsource less essential functions to allow management and production to become more focused in areas of greater priority on the other,

- *co-operations with research institutions or universities* (pre-competitive stage) pursued to gain rapid access to new scientific and technological knowledge and to benefit from economies of scale in joint R&D.

Firms pursue such co-operative arrangements in order to tap into sources of know-how located outside the boundaries of the firm, to gain fast access to new technologies or new markets, to benefit from economies of scale in joint R&D and/or production, and to share the risks for activities that are beyond the scope or capabilities of a single firm. The picture which emerges from the evidence of the current study is that of a maze of different networks. They range from highly formalized to informal network relations, from highly specialized and rather narrow networks to looser and much wider networks such as, for example, technical alliances involving firms as corporate entities, from networks focusing on the pre-competitive stage of the innovation process to those involving the competitive stage.

Table 3: Network Activities of Manufacturing Firms

		Customer Networks		Manufac-turing Supplier Networks		Producer Service Provider Networks		Producer Networks		Co-operations with Research Institutions	
Pre-Competitive Stage			c		c		c		c		c
Information Exchange	**a**	199		135		165		66		61	
	b	64	(26.1 %)	45	(23.0 %)	63	(34.5 %)	27	(30.3 %)	25	(32.8 %)
Identification of New Ideas	**a**	190		122		148		64		57	
	b	57	(25.8 %)	39	(24.6 %)	57	(34.5 %)	25	(28.1 %)	20	(31.6 %)
Research and Development	**a**	179		118		148		49		56	
	b	55	(25.7 %)	37	(23.7 %)	56	(34.5 %)	20	(26.5 %)	22	(30.4 %)
Competitive Stage											
Prototype Development	**a**	175		108		96		37		47	
	b	53	(24.6 %)	34	(23.1 %)	36	(32.3 %)	16	(27.0 %)	20	(31.9 %)
Pilot Projects	**a**	167		97		101		28		47	
	b	51	(25.1 %)	30	(24.7 %)	41	(34.7 %)	12	(32.1 %)	20	(29.8 %)
Market Introduction	**a**	183		82		105		49		19	
	b	56	(26.2 %)	25	(25.6 %)	38	(34.3 %)	20	(22.4 %)	9	(31.6 %)

Note: **a** denotes the number of such network activities of the manufacturing firms
Note: **b** denotes the number of manufacturing firms with such network activities,
Note: **c** denotes the share of such network activities with a focus on the metropolitan region of Vienna,

Table 3 provides some empirical evidence on the above five types of networks, from the point of view of the focal manufacturing firm, and highlights the fact that

- co-operation in the pre-competitive stage [i.e. in the early stages] of the innovation process is generally more common than in the competitive stage. External information tends to be particularly relevant during the early stages of the innovation process when perception of problems and evaluations of technological possibilities take place.

- Customer and user-producer [i.e. manufacturing supplier and producer service provider] relationships are much more frequent than horizontal co-operations such as producer networks and research institution-industry linkages. Customer networks represent the most frequent form of interfirm co-operation, with activities with customers and suppliers constituting 35.3 percent of all such activities. Manufacturing suppliers and producer service providers have strong incentives to establish close relationships with user firms and even monitor some aspects of their activity. Knowledge produced as a result of learning-by-using can only be transformed into new products if the producers have direct contact with users. In turn, user firms will generally need information about new products or components. This may not only mean awareness, but also quite specific inside information about how new, user-value characteristics relate to their specific needs.

- 37.7 percent of the manufacturing firms are integrated into customer networks, 27.9 percent into manufacturing supplier networks, 46.6 percent into producer service provider networks, and only 18.6 percent have set up co-operative relations with research institutions and/or departments of universities, despite the active promotion of university-industry programmes in Austria.

Consumer and user-producer relationships basically involve two types of transactions. One is interdependent, functioning as a cooperative or relational mode, relying on tacit performance agreements, trust and reciprocal adjustment and is more common in the high-tech sector, where short product cycles and continuous innovation are crucial. The second is more of a contractual, competitive or ‘arm’s-length’ mode, where interfirm trust and familiarity may be very limited, or missing altogether. The first type in various ways expects subcontractors to add value beyond the simple transaction requirements, such as providing knowledge and expertise on the development of the goods they supply, coordinating design and quality control with the contractors’ own production routines, and having the willingness to coordinate or reduce output whenever market demand subsides, regardless of initial expectations. It seems that both types of transactions are common and tend to coexist in the metropolitan region. This reveals some of the complexity of networking activities, where a firm may dualistically engage in both types of transactions, and where the determination to engage in one or the other form may hinge on previous interfirm experiences, perceived reputation, initiation of competitors’ arrangements or even managerial personalities and friendships (Suarez-Villa and Fischer 1995).

Locating near-by is widely acknowledged to be important for linkages as it allows better possibilities to implement innovations and adjustment in production more quickly. A near-by location can provide better access to a partner’s operation, possibly allowing familiarization with processes and procedures that increase personal trust and promote mutually helpful arrangements. But overall considered, external networks operating at the scale of the metropolitan region of Vienna are less prevalent than might have been expected. Only about one quarter [third] of the customer and manufacturing supplier and producer network [producer service providers and industry-university] connections are localised within the metropolitan region. This demonstrates quite clearly a lack of local networking, or local systems of integration, in terms of the product development process. The frms tend to rely far more often on national and especially international linkages in both the pre-competitive and competitive stages of the innovation process. About half of the customer, manufacturing supplier, producer network and industry-university linkages were established and maintained with partners in the European Union, Central Eastern Europe and in the rest of the world. This lends some credence to the argument that local as well as nonlocal sources of innovative activity are crucial to occur and that external economies can be enjoyed not only at a local scale. The ability of firms to enjoy such benefits at a larger scale may stem from the use of telecommunication as – partial – substitutes for face-to-face contacts. But we are still far from understanding the details related to the confunctioning of proximity versus distance effects in various stages of the innovation process (see Oinas and Malecki 1999).

7. Exploring the role of firm characteristics on the likelihood of networking

In the above section we have revealed some empirical evidence on customer, manufacturing supplier, producer service provider and producer network relations and industry-university relations of manufacturig firms located in the metropolitan region of Vienna. In this section attention is turned to the research question to what extent the likelihood of networking is influenced by firm-specific attributes as suggested by the resource-based view of the firm. The restricted nature of the postal survey limits the number of independent variables available; however the following variables were incorporated: organisational structure, turnover, employment size as a proxy for scale economies, years in operation proxying a learning by doing effect, ownership and export intensity, as basic profile attributes along with some proxies for technological resources and opportunities such as R&D expenditure, in-house research capacity, presence of on site R&D facility, technological opportunities and innovation competence as defined in Table 4. The research question is analysed via logit modelling as an attempt to overcome the difficulties inherent in bivariate analysis with the rigour of multiple-regression modelling for categorical data with a dichotomous response variable (for more detail, see, e.g., Fischer and Nijkamp 1985). In the model results that follow, with the exception of the continuous variables, the parameter estimates may be interpreted with respect to the reference category. The reference category is a function of the particular parametrization used by estimating the model and is set to zero. The reference category consists of domestic independent establishments in the low technology sector with no on site R&D facilities and a lower level of export orientation.

Table 4: Firm-specific variables included in the logit analysis

Independent Variable	Variable Type	Variable definition
Basic profile attributes		
Organisational structure	dummy	=1 denotes multi-unit =0 otherwise
Turnover	continuous	annual turnover [averaged over 1994-1996]
Employment size	continuous	Total employment per establishment [natural logarithm]
Years in operation	continuous	Establishment age, calculated as ‘1998 minus years formed’
Ownership	dummy	=1 denotes foreign [some share of total capital] =0 otherwise
Export intensity	dummy	=1 denotes high export intensity [over 50% of turnover] =0 otherwise
Proxies for technological resources and opportunities		
R&D expenditures	continuous	annual R&D expenditure in % of turnover [averaged over 1994-1996]
In-house research skills	continuous	research personnel in % of R&D personnel [averaged over 1994-1996]
Presence of on-site R&D facility	dummy	=1 denotes presence =0 otherwise
Technological opportunities	dummy	=1 denotes high technology sector [using the definition of Hatzichronoglou 1997] =0 otherwise

Innovation competence	continuous	share of turnover accounted for by new or improved products [averaged over 1994-1996]

Table 5 indicates the degree to which firm-specific atttributes increase or decrease the probability (strictly the logarithmic odds) of external networking. There is no intention that the results presented in this table should in any sense represent an 'optimal' model. Rather, the approach is essentially exploratory and the intention is to demonstrate which variables are important and to identify the magnitudes and directions of these. In the case of customer network relations, it should be clear from Table 5(a) that employment size and ownership are the dominant variables, and technological resources are not significant. The model simplifies to the size effect, the larger the establishment the higher the probability of networking with customers and to a strong ownership effect reflecting the fact that the probability of networking is much higher in foreign owned rather than in domestic firms. There is also a strongly positive, but relatively weak age effect.

Table 5(b) shows that size is also an important significant factor in the case of manufacturing supplier relations, slightly less pronounced as in the case of customer networks. It seems that size matters simply because it captures subcontracting practices. High tech firms show significantly higher probabilities than firms in low tech sectors.

Table 5(c), on the other hand, indicates that there is very little variability in the case of producer service provider linkages. A low level of rho-squared adjusted is accompanied by a predictive success of 66%. Only in-house research skills is significant. The statistical results summarized in Table 5(d) exhibit the higher probability of high-tech firms to engage in producer networks. Firms working in areas where technology is evolving rapidly, as in most

Table 5: Network activities of manufacturing firms: parameter estimates (t-values in brackets)

Variable	(a) Customer Networks	(b) Manufacturing Supplier Networks	(c) Producer Services Provider Networks	(d) Producer Networks	(e) Industry-University Linkages
Constant	-3.7463	-6.9695	-1.963	-13.975	-8.232
	(-2.409)	(-3.072)	(-1.414)	(-0.103)	(-2.824)
Organisational structure	-0.9154	-0.2639	0.5881	-0.2677	-2.6137*
	(-1.342)	(-0.422)	(0.968)	(-0.358)	(-2.189)
Turnover	-0.0004*	-0.0013*	0.0001	-0.0002	0.0008
	(-2.483)	(-1.806)	(0.671)	(-0.679)	(1.193)
Employment (Log)	2.4916*	2.3333*	0.4878	0.6636	2.6558*
	(2.971)	(2.187)	(0.71)	(0.705)	(2.025)
Years in Operation	-0.0129*	0.0007	-0.0046	-0.0031	-0.0118
	(1.975)	(-0.118)	(0.813)	(0.423)	(1.2)
Ownership	1.3886*	0.1642	0.5114	-0.243	3.0574*
	(2.083)	(0.245)	(0.853)	(-0.314)	(2.64)
Export intensity	0.0051	-0.1258	0.3168	-1.111	0.8508
	(0.007)	(-0.174)	(0.457)	(-1.368)	(1.009)
R&D expenditures	0.0782	-0.0153	-0.0756	-0.001	0.1529*
	(1.233)	(-0.274)	(-1.32)	(-0.017)	(1.778)
In-house research skills	-0.4801	2.0556	3.6755*	1.6291	5.1576*
	(-0.321)	(1.442)	(2.197)	(1.012	(2.183)
On-Site R&D facility	-0.4035	1.5816	0.987	11.133	1.1803
	(-0.476)	(1.365)	(1.238)	(0.082)	(0.879)
Technological opportunities	0.6227	1.1366*	-0.3887	1.6934*	1.1318

	(0.983)	(1.687)	(-0.65)	(2.24)	(1.223)
Innovation competence	-0.0086	0.0077	0.008	0.0024	-0.0668*
	(-0.717)	(0.584)	(0.709)	(0.172)	(-2.562)
Number of Observations	82	82	82	82	82
Log-Likelihood	-43.8317	-42.7876	-48.4179	-35.2948	-25.2023
Likelihood Ratio Test Statistic	25.231	19.713	16.0587	13.1127	42.9008
Rho Squared	0.2288	0.2472	0.1481	0.379	0.5566
Adjusted Rho Squared	0.1321	0.1504	0.0514	0.2823	0.4598
Prediction Success (%)	68	74	66	79	84

* significant at the 10 % level

high-tech sectors, have to be able to keep upreast of technological developments. The knowledge intensity of production does not necessarily imply the capacity of every firm to carry out in-house R&D, but it certainly requires firms to belong to one or several networks where R&D is being done. The removal of all the other variables has negligible impact in the goodness of fit.

Table 5(e) reveals that the model for industry-university linkages is by far the most complex, with five significant variables, in-house research, skills being by far the most important one. As one might anticipate, larger in-house research capacity increases the probability of cooperation with research institutions/universities. Size is again an important factor. Independent firms are more likely to engage in cooperation as do internationally owned firms rather than domestic ones. Innovation competence has a significant, but weak effect whereby establishments with higher competence show a lower probability of networking. This result suggests that firms exhibiting a higher level of innovation success appear to cooperate less likely with research institutions.

8. Concluding remarks

The relationship that manufacturing firms build with other organisations such as customers, manufacturing suppliers, producer service providers, competitors and research institutions enable them to deal with changes in technologies, markets and other aspects of the business environment. In this paper, we have reported results of an attempt to identify networking activities of manufacturing firms located in the metropolitan region of Vienna. The results achieved so far, seem to suggest that: *first*, networking does not yet seem to be a popular managerial and organisational concept for the manufacturing firms in the metropolitan region of Vienna; *second*, network activities, if any, are primarily based on vertical relationships with customers, manufacturing suppliers and producer service providers rather than on horizontal relationships; *third*, networks focusing on the later stages of the innovation process are less common than those focusing on the earlier stages; *fourth*, firms tend to rely on sources of technology from national and – especially – international networks. Local networking is less common than has been thought. The concept of the innovative milieu seems to have little bearing on the reality of how manufacturing establishments pursue product development. This result is reinforcing findings by Alderman (1999) for the Northern region, the West Midlands and parts of the South East in UK as well as by Malecki and Veldhoen (1993) for the area of Gainesville, Florida.

Turning to the second research question of the study, focusing on the adoption of the management and organisational concept of networking, the results of the logit analysis have bolstered the argument that establishment traits and technology related capabilities do play a role. Employment size is a dominant variable in the case of both customer and manufacturing supplier relations. It seems that size matters simply because it captures subcontracting and customizing practices. In-house research skills have been found to be most important in the case of producer service provider relations and cooperations with research institutions/universities, while the high tech firms reveal a higher probability than low tech firms to form producer networks.

The study has explored broad facets of networking activities of manufacturing establishments within the metropolitan region of Vienna. In-depth interviews may be necessary to gain further understanding of network activities, especially on the process of network formation and issues such as trust building. Studies in other parts of the countries and in other metropolitan areas may also be needed to shed light on the extent to which the conclusions can be generalized.

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