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The impact of a company's business strategy on its technological competence, network competence and innovation success

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Abstract

This paper discusses the dual nature of the key to competitiveness in the network economy: On the one hand, a company needs technological competence in order to add value to products and processes. On the other hand, companies need to develop network competence in order to link their organization to other players in the market to allow interactions beyond organizational boundaries. In this paper, a basic framework for the successful implementation of a technology-oriented business strategy is developed, consisting of four elements: business strategy, network competence, technological competence and innovation success. The model is empirically tested using a database of 308 German companies. The results show that both network competence and technological competence have a significant positive impact on a company's innovation success. Furthermore, the results suggest that a company's technological strategy supports the development of both network and technological competencies.

Keywords: Network; Technology; Competence; Innovation success; Strategy

1. Introduction

The explanation of firms' innovation success has a long research tradition and has lately received renewed attention due to increasing innovation costs, decreasing innovation times and increasing technology complexity. Researchers can be roughly divided into two camps: One group is looking into the internal success factors of innovations by, for example, analyzing the innovation process, corporate culture, cross-functional teams and technological competence (Brown and Eisenhardt, 1995; Cooper, 1997; Cooper and Kleinschmidt, 1995). The other set of explanatory variables is found on the boundary of the organization, and in its network, by analyzing a firm's interaction with other organizations. This group of researchers is examining innovations as the result of interorganizational collaborations between various companies (Biemans, 1992; Czepiel, 1975; DeBresson and Amesse, 1991; Gemünden et al., 1999; Håkansson, 1987, 1989; von Hippel, 1988). The innovation process can involve collaboration with many different types of partners, each offering significant resources. Fig. 1 illustrates how the innovating firm can be embedded in an innovation network of cooperating partners (adopted from Gemünden et al., 1992). In a nutshell, research results indicate that an early (Handfield et al., 1999; LaBahn and Krapfel, 2000; Mabert et al., 1992) and intensive collaboration (Clark and Fujimoto, 1991; Heydebreck, 1996; Langerak et al., 1999; Wasti and Liker, 1977) leads to shorter innovation processes, reduced innovation costs and higher innovative output. Thus, innovation development has to be seen and understood in a wider context than that of a single company, one that has been called a company's technological interweavement or innovation network (Gemünden and Heydebreck, 1994; Heydebreck, 1996). The impact of collaboration on innovation success varies in the different innovation stages (Gruner and Homburg, 2000) and for different innovation aims (Gemünden et al., 1996).

Given these two areas for improvements in innovation success, we need to analyze the underlying competencies on which their impact is based. In addition, we also need to understand the relative importance of these two different arenas. In this paper, therefore, we analyse two different competencies: one describing the inside view and one describing the outside view. Furthermore, we look into the notion of technology-oriented strategy as a driving force of both competence development and innovation success (for a discussion of competencies, see Heene and Sanchez, 1997).

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The paper addresses two main research questions: Which competencies does a company need in order to achieve innovation success? What role does a company's business strategy play in competence development and innovation success?

The paper is organized as follows: First, we develop a basic model describing the impact of technological and network competencies on a company's innovation success. We then incorporate business strategy in our model. Subsequently, the results of an empirical test of the model are discussed. Finally, we outline managerial implications and issues for further research.

2. Theory and hypotheses

2.1. A company's competencies and their impact on innovation success

The term "core competence" was introduced into management studies by Prahalad and Hamel (1990), though the discussion of a firm's competence has a longer tradition (for a historical overview, see Carlsson and Eliasson, 1991; Eliasson, 1990; Rasche and Wolfrum, 1994; Winter, 1987). The concept takes a starting point in the resource-based view of competition, which explains a company's success in terms of its (internal) competencies.

Competence is often understood as a series of processes or activities (Day, 1994; Li and Calantone, 1998; Prahalad and Hamel, 1990). Alternatively, competence can been defined as a potential, or qualification, to perform activities, i.e. "having the ability, power, authority, skill, knowledge, etc., to do what is needed" (The New Oxford Dictionary of English, 1998). In this paper, the term competence is used to mean not only *having* knowledge or possessing skills and qualifications, but also *using* those qualifications. Thus, competence becomes a two-dimensional construct. Possessing qualifications but not using them, or performing tasks without having the appropriate qualifications, results in incompetence (cf. Gemünden and Ritter, 1997, pp. 297).

Competence can be measured in two ways: In terms of the degree of task performance and qualifications (the inside view) or, because competencies cannot be observed from the outside (Day, 1994; Prahalad and Hamel, 1990), it can be evaluated in relation to competitors, i.e. a company's competence in a particular field is seen as greater or less than its competitors'.

Several studies have looked at the content or types of competency (e.g. Malerba and Marengo, 1995). While the focus has traditionally been on *technological* competencies and their impact on innovation and corporate success, recent studies have taken a broader view by also including *managerial* competencies (cf. Carlsson and Eliasson, 1991; Dosi and Teece, 1993; Malerba and Marengo, 1995, Sanchez and Heene, 1997). Based on the foregoing discussion, two types of internal competency are of particular interest for innovation success: technological competence and a marketing or network competence, which allows a firm to develop and use its innovation network.

2.1.1. Network competence

Traditionally, research into marketing competencies has focused on a company's ability to attract customers and sell them products and services. As a rule, authors do not consider customers' contribution to product and process innovation. Nor do they consider technological knowledge and information provided by *other* partners, particularly by suppliers, research institutions and partners in systems selling. Moreover, the specific capabilities involved in managing a network of *innovation* partners are not addressed either. In terms of achieving innovation success, the foregoing discussion on the network nature of innovation management suggests that we need to take a broader network perspective.

Of particular relevance to a company's innovation success is its ability to develop and use technology-oriented interorganizational relationships to link the company's (technological) competencies with those of its partners in the innovation network. Ritter (1998) has developed a concept of a company's network competence, which captures the level of network management task performance and the network management qualifications possessed by the people handling a company's relationships. This concept extends earlier notions of marketing competencies, because it highlights the interactions by which firms acquire information, exchange offerings and collaborate technologically. This view also takes account of the fact that interorganizational relationships have specific problems (e.g. opportunistic behavior, asset specifity, cf. Williamson, 1979), especially as relationships are investment processes, which include sunk costs. This underlines the need for a firm to develop a competence in managing its network.

Network competence enables a company to establish and use relationships with other organizations. This results in a high degree of technological interweavement, which is, in turn, a major contributing factor to innovation success (Biemans, 1992; Gemünden et al., 1996; Heydebreck, 1996). Furthermore, companies with a high level of network competence follow more realistic and more market-oriented innovation development paths and establish a better relationship marketing strategy for selling innovative products (Ritter, 1998; Ritter and Gemünden, in press). In addition, network-competent companies can be assumed to have a greater level of market knowledge competence in, which, in turn, contributes to innovation success (Li and Calantone, 1998). This leads to our first hypothesis:

Hypothesis 1: The degree of a company's innovation success is positively correlated with its level of network competence.

2.1.2. Technological competence

By technological competence means that a company's ability to understand, use and exploit relevant state-of-the-art technology internally. This competence enables a company to become a market pioneer through new product development and the use of new production processes. Thus, companies with a high level of technological competence will have greater innovation success than companies with only a low level of technological competence (for empirical results, see Malerba and Marengo, 1995). This results in the second hypothesis.

Hypothesis 2: The degree of a company's innovation success is positively correlated with its level of technological competence.

2.2. The impact of business strategy

Business strategy can be described as a company's behaviour in the market, including policies, plans and procedures (for definitions and typologies of strategy, see Brockhoff and Chakrabarti, 1988; Brockhoff and Leker, 1998; Conant et al., 1990; Ford, 1988; Gemünden and Heydebreck, 1995; Hinterhuber, 1982; Porter, 1980; Schewe, 1996). Given the aim of this paper to analyze the impact on innovation success, we focus on the technological dimensions of business strategy. In particular, we hypothesize that a technology-oriented strategy involves both placing greater importance on R&D and new product development and a desire to be the technological leader in the market.

Hambrick (1983) found that prospectors, who can be regarded as (technology) leaders for our purposes, have large product R&D expenses. Similarly, McDaniel and Kolari (1987) report that prospectors perceive new product development as very important. We therefore assume that a company with a technology-oriented strategy will make more resources available to R&D, employ more highly qualified personnel and create a corporate culture amenable to learning and creativity. This leads to the following hypothesis:

Hypothesis 3: The degree of a company's technological competence is positively correlated with the strength of its technology-oriented strategy.

Apart from the relationship between strategy and technological competence, several studies have shown that business strategy is linked to marketing competence. For example: The degree of organizational scanning is significantly higher in prospecting organizations (Hambrick, 1982). The perceived importance of marketing research is greater in prospecting companies (McDaniel and Kolari, 1987), and prospectors evaluate their distinctive marketing competencies as significantly greater in several dimensions compared with organizations using other strategies (Conant et al., 1990). Even though the definitions and operationalizations of marketing competence vary significantly between studies, some elements of network competence are included. It is therefore reasonable to assume that the reported positive relationship between strategy and marketing competence also holds for network competence.

The importance of technology-oriented relationships and their contribution to innovation success is well documented (Gemünden et al., 1996; Håkansson, 1989; Hippel, 1988; Shaw, 1985). Moreover, Gemünden and Heydebreck (1995) and Heydebreck (1996) have shown that technology-oriented companies have a high degree of technological interweavement. We therefore expect companies with a technology-oriented strategy to adopt organizational antecedents of network competence (Ritter, 1999) both in order to gain network competence and to facilitate the flow of technological expertise across organizational borders. These arguments can be summarized in the following hypothesis:

Hypothesis 4: A company's network competence is positively correlated with the strength of its technology-oriented strategy.

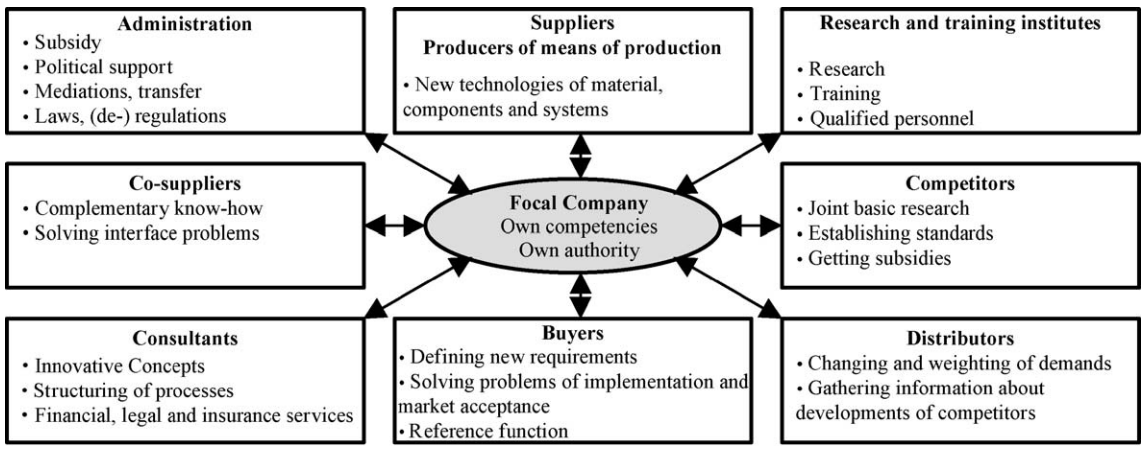

Fig. 1. Potential innovation partners and their contributions.

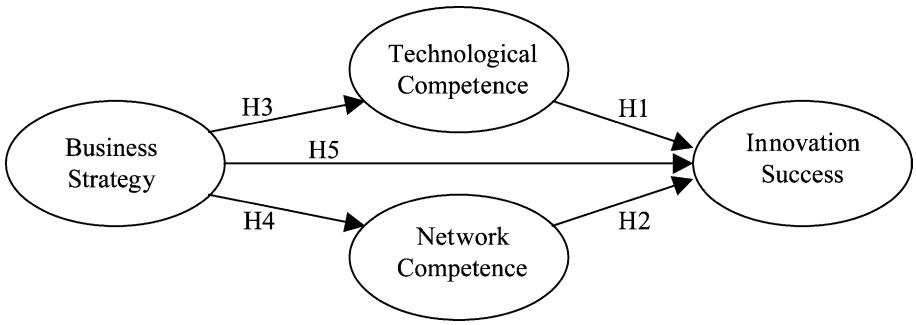

Fig. 2. The theoretical model.

Finally, we follow the widespread assumption that, in competitive markets, a (technologically) leading strategy is a successful one. Therefore, we propose a direct relationship between technology-oriented strategy and innovation success in the following hypothesis:

Hypothesis 5: A company's innovation success is positively correlated with the strength of its technologically oriented strategy.

The above hypotheses are summarized in Fig. 2. This theoretical framework will be empirically analyzed in Section 3.

3. The empirical study and results

3.1. Data collection and sample

A questionnaire was designed and pretested on 14 companies. We then contacted 741 German companies in mechanical and electrical engineering, measurement technology and control engineering to ask them to participate in the study. Of these, 308 companies agreed, giving a response rate of 43.3%. The data was collected between August and December 1997 using standardized personal interviews.

We used a key informant approach (cf. John and Reve, 1982; Phillips, 1981), asking for respondents with an overview of the company, the technological network and innovation success. Half of our respondents were CEOs, with another quarter being heads of their company's R&D department. In all other cases, the respondent was in the sales, production or controlling department. We believe that this approach results in a very high quality of answers given.

Our sample consists mainly of medium-sized companies: 40.7% have between 50 and 249 employees, and 24.9% between 250 and 999 employees. The remaining companies are either very small (24.2% with less than 50 employees) or larger corporations with more than 1000 employees (10.1%). Nearly half of the companies in the sample are in mechanical and installation engineering (44.5%). Most of the interviewed companies have been established for between 10 and 50 years (62.8%).

3.2. Operationalization and measurement model

All constructs were measured using seven-point multiitem scales (see Appendix A). Multiitem measures were developed based on Cronbach's alpha and item-to-total correlations exceeding appropriate levels (Cronbach's alpha > .70, cf. Nunnally, 1978, p. 36; item-to-total correlation>.30, cf. Kumar et al., 1995). Convergence validity was checked through exploratory factor analyses, in which only one factor is be extracted and the explained variance should exceed 0.50.

In addition, confirmatory factor analyses using LISREL, with covariance matrix as the input and Maximum Likelihood as the estimation method, were carried out to test the operationalization for each multiitem measure (see results in Table 1). In the context of scale validation, CFA is considered superior to the more traditional criteria mentioned above (cf. Gerbing and Anderson, 1988). Because of sample size constraints, CFA were evaluated separately for each construct (see Bagozzi and Baumgartner, 1994).

Several fit indices can be used to assess the adequacy of the model: The ratio of c^2 over the degree of freedom (*df*) is used as a descriptive measure of overall fit. Values of this

Table 1
Results of the confirmatory factor analysis using LISREL—item level

Construct	Number of items	Number of subconstructs	χ^2/df (*P*)	GFI	AGFI	CFI	RMSEA	RMR (standardized)
Innovation success	6	2	7.16 (.00)	0.94	0.85	0.94	0.14	0.05
Network competence	9	2	3.31 (.00)	0.94	0.90	0.95	0.08	0.04
Technological competence	8	2	6.67 (.00)	0.91	0.83	0.85	0.14	0.07
Business strategy	4	1	0.91 (.40)	0.99	0.98	1.00	0.00	0.01

Table 2
Results of the confirmatory factor analysis using LISREL—model level

Construct	Indicator (S = sum scale; I = item)	Standardised factor loading	Item-to-total correlation	Cronbach's alpha (α standardised)	Variance explained by first factor (exploratory factor analysis)	Construct reliability	Average explained variance
C1	1 (S)	.88	0.62	.74	81.0	0.77	0.63
Innovation success	2 (S)	.71	0.62				
C2	3 (S)	.83	0.60	.72	79.7	0.75	0.60
Network competence	4 (S)	.72	0.60				
C3	5 (S)	.77	0.48	.65	73.9	0.65	0.49
Technology competence	6 (S)	.63	0.48				
C4	7 (I)	.64	0.51	.73	56.2	0.77	0.45
Business	8 (I)	.75	0.59				
Strategy	9 (I)	.65	0.48				
	10 (I)	.65	0.53				

ratio smaller than 3 indicate an acceptable model fit (Medsker et al., 1994), but higher values are also considered sufficient (Hildebrandt, 1983). The goodness-of-fit index (GFI), the adjusted goodness-of-fit index (AGFI) and the Comparative Fit Index (CFI) should exceed a minimum value of 0.9 (Bagozzi and Youjae, 1988). For the root mean square error of approximation (RMSEA), values up to 0.08 indicate a reasonable model fit (Browne and Cudeck, 1993). Root Mean Square Residual should not exceed 0.10. Table 1 shows the results of scale validations. Overall, most of the criteria are met, and the scales can be accepted, since not all criteria need to be fulfilled.

To further validate our measures, we correlated the developed scales with other potential measures. In the case of business strategy, we asked the respondents about the importance of new products for competitive advantage. The correlation between the two measures is significant ($r = .39$, sig.=.000, $n = 308$), which further validates our measure. The level of network competence was related to the degree of the firm's technological interweavement, i.e. the extent to which the firm interacts with its environment to gain innovation inputs (Gemünden et al., 1992). An overall scale for interaction with customers, suppliers, competitors and research institutions was built, using four multiitem scales. The overall construct correlates significantly with the level of network competence ($r = .43$, sig.=.000, $n = 308$). The firm's technological competence was related to its percentage of R&D expenses. Both measures correlate significantly ($r = .34$, sig.=.000, $n = 268$). Finally, for the validation of innovation success, respondents indicated the percentage of sales accounted for by new products (all products introduced to the market less than 3 years ago). A similar measure was obtained for process innovations, i.e. the percentage of production produced on machines less than 3 years old. For firms that have existed for 5 years or more, both measures show a significant correlation with the scales used in this study (product innovation success: $r = .42$, sig.=.000, $n = 298$; process innovation success: $r = .45$, sig.=.000, $n = 235$). Given these results, the operationalization is statistically acceptable.

For all constructs that are composed of several factors (subconstructs), the mean of the corresponding items for each factor were computed and used as inputs for the structural equation model. First, the measurement model was tested for validity and reliability, following the procedure suggested by Anderson and Gerbing (1988). The results of a confirmatory factor analysis using LISREL showed that the measurement model meets the widely employed guidelines. The global fit criteria indicate a good fit between the data and the proposed model [$c(29)^2 = 66.27$; P=.000; GFI = 0.959; AGFI = 0.922; NFI = 0.931; CFI = 0.958; RMSEA = 0.064, RMR = 0.039]. Regarding detail fit criteria (cf. Table 2), a few measures fall

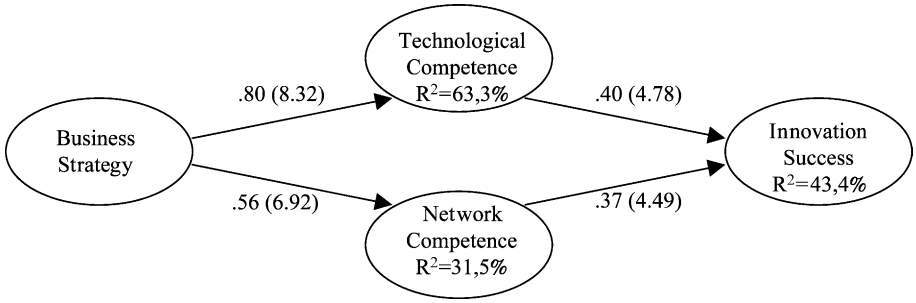

Fig. 3. Results of the structural model.

Table 3
Results of discriminant validity measures

	Average explained variance	C1	C2	C3	C4
		0.63	0.60	0.49	0.45
C1	0.63				
C2	0.60	0.32			
C3	0.49	0.33	0.37		
C4	0.45	0.29	0.26	0.55	

short of the desired thresholds, but this is regarded as acceptable in research practice.

3.3. Data analysis and results

Data were analyzed using LISREL 8.30 (Jöreskog and Sörbom, 1996). The covariance matrix of the 10 indicators was entered into a Maximum Likelihood analysis. The test of the developed model indicated that the relationship between business strategy and innovation success is not significant. We therefore excluded this relationship. Fig. 3 shows the test results regarding the (reduced) structural model, indicating the structural equation coefficients, the t values and the explained variance (Table 3) of the endogenous constructs η_1 to η_3. An adequate level of fit in the structural model is indicated by the fit criteria [$c(31)^2 = 78.08$; $P = .000$; GFI = 0.952; AGFI = 0.914; NFI = 0.916; CFI = 0.944; RMSEA = 0.070, RMR = 0.047].

As shown in Fig. 3, the results support Hypotheses 1 and 2. Both network competence and technological competence have a significant positive impact on innovation success. We can see that the impacts of both types of competencies are about equal. This shows the importance of considering both types of competencies as an explanation of innovation success, which depends as much on internal technological strength as on the ability to access the technological resources of others through interorganizational relationships.

Strategy has a strong impact on network competence and technological competence. Companies that strive for technological leadership build up greater levels of competence, presumably by making more resources available, developing a supportive corporate culture and employing more highly skilled people (for antecedents of network competence, see Ritter, 1999). This confirms Hypotheses 3 and 4.

We also tested a model including a direct relationship between business strategy and innovation success. The results showed that a technology-oriented strategy has no direct impact on innovation success. Thus, Hypothesis 5 is not supported. Based on the model as a whole, the following explanation can be given: Strategy supports competence development, which, in turn, leads to innovation success. Success comes from converting strategy into action.

The model explains a good proportion of innovation success and network competence and a large proportion of the variance in technological competence. This indicates that the analysis has included the major drivers of the constructs in question.

4. Managerial implications and further research

Our theoretical discussion and the results of the empirical study have two major implications for management.

Firstly, a company's technological competence is not the only factor of its innovation success. In the network economy, increasing attention must be paid to a company's ability to interact with its environment. Failing this, the company's strategic flexibility will be limited to its in-house resources. This is inefficient given the increasing pace of change in today's markets and the complexity of today's technologies. It has been shown that network competence enables a firm to establish and use technology-oriented interorganizational relationships with *partners who possess critical resources*.

Secondly, business strategy is not directly related to innovation success. This result highlights the fact that it is not enough to just claim technological leadership. Such a strategy supports the development of important competencies, which then enables a company to achieve innovation success. A clearly formulated strategy will include the importance of competence development, as well as making sure that contributing factors are in place. For example, to support network competence access to resources, network-oriented human resource management, integrated communication structures and an open corporate culture are required (cf. Ritter, 1998; Ritter and Gemünden, 1998). In short: The mission statement must be translated into action.

The limitations of this study call for further research in the following areas: Firstly, the study looked at the role of competencies in innovation success, the focus being on the sources of innovation in terms of internal (technological competence) and external (network competence) factors. Other factors also play a role in a company's innovation success, however, including internal management processes for new product and process development. Some authors have claimed that modularity in product design is a critical success factor (Sanchez, 1996, 1999) because it allows the decoupling of processes for developing new products, enabling those processes to become concurrent, autonomous and distributed, thereby enabling modular organization designs to be adopted for product development. By including these factors, we can develop a broader frame of reference, which would allow further insights into the mechanisms that trigger innovation success.

Secondly, only technology-oriented business strategy has been analyzed. The remaining question concerns the impact of other strategies on a company's competencies and its innovation success. Furthermore, do companies with different strategies benefit from having these competencies?

Thirdly, our analysis focused on innovation success. Further research could examine the impact on corporate success. Even though innovation success is known to be a major contributor to corporate success, other sources of corporate success need to be considered at the same time.

Finally, industry-specific or environmental characteristics were not included in our model. There is evidence that market and technology dynamics can moderate the impact of strategy and competencies, as well as affect a firm's competency development.

Our study combines internal and external elements that are proposed to have a positive impact on innovation success. We were able to show that both play an important role. Given the fast pace of change in today's world, the dynamics of competence development will become a major managerial concern and an academic challenge in the future.

Appendix A. Measures

The questionnaire survey used in this publication was conducted in German. The following items were translated for documentation purposes only.

A.1. Innovation success

Product Innovation Success (1 = *strongly disagree*, 7 = *strongly agree*, Cronbach's alpha=.72)

- Compared with our competitors, our product modifications and innovations have a better market response.
- Our competitors have more success with their product innovations (reverse scored).
- Our products are of state-of-the-art technology.

Process Innovation Success (1 = *strongly disagree*, 7 = *strongly agree*, Cronbach's alpha=.78)

- We have very modern production facilities.
- Our production facilities are more advanced than those of our competitors.
- Our production facilities are of state-of-the-art technology.

A.2. Network competence

Network Management Task Execution (1 = *not at all*, 7 = *very intensive*, Cronbach's alpha=.89)

To what extent are the following activities performed?

- Planning
- Organization
- Staffing
- Controlling
- Initiation
- Exchange
- Coordination

Network Management Qualifications (1 = *not at all*, 7 = *to a very high degree*, Cronbach's alpha=.74)

To what extent do the people performing the above activities have the following qualifications?

- Special qualifications
- Social qualifications

For all activities, multiitem scales were used. Due to limitations of space, we are unable to list them all. A complete list and statistical information can be found in Ritter (1998). These scales have been retested with several groups of respondents from various countries, see Ritter et al. (in press).

A.3. Technological competence

Technological Collaboration Reasons (1 = *strongly disagree*, 7 = *strongly agree*, Cronbach's alpha=.77)

- Because we are the only firm with whom such products and processes can be developed.
- Because we are the only firm which can use the results of this development project.
- Because we have excellent technological know-how.
- Because we are known for successful innovations.

Technological Expertise (1 = *strongly disagree*, 7 = *strongly agree*, Cronbach's alpha=.64)

- We are very satisfied with the exclusiveness of our technological know-how.
- Our production processes are highly complex.
- Our products are highly complex.
- Considerable user know-how is required to use our products.

Business Strategy (1 = *strongly disagree*, 7 = *strongly agree*, Cronbach's alpha=.73)

- We are the technological leader in our industry.
- We place high emphasis on our R&D activities.
- We take technological risks.
- We constantly develop our products.

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