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Hard and Soft Locational Factors, Innovativeness and Firm Performance: An Empirical Test of Porter's Diamond Model at the Micro-Level[§]

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Abstract

This paper investigates predictions of Porter's Diamond model regarding the impact of locational factors on innovativeness and performance at the firm level. We formulate a structural equation model based on the relationships between locational conditions, e.g., transportation infrastructure, proximity to universities and research institutes, qualified labour, on the one hand, and innovativeness measured by new product or process development, number of patents, and firm performance in terms of market growth or profit assessment, on the other hand. Based on a sample of about 2,100 East German firms, we apply the partial least squares path modelling approach to test the proposed relationships. We find that particularly cooperation intensity at the local level spurs the innovativeness of firms; whereas in contrast to Porter's predictions, our results indicate that strong local competition and a locally focused market appear to impede the innovativeness and performance of firms.

Keywords: *Hard and Soft Locational Factors, Innovativeness, Firm Performance, East German Firms, Structural Equation Modelling, Partial Least Squares Approach*

JEL classification: R30, L25, O30

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1. Introduction

Over the last two decades, the role of clusters and regional innovation systems for innovativeness and performance of firms has received much attention in the literature (Cooke and Morgan 1998, Cooke et al., 2004, Karlsson 2007, Porter 2000). It is argued that territorial agglomeration provides the best context for an innovation-based globalizing economy because of localized learning processes. Most empirical studies on territorial innovation theories have been carried out as case studies at the regional level (e.g., Asheim and Coenen 2005). However, at the firm level, the existing empirical evidence on the importance of locational factors is rather limited (Baptista and Swann 1998, Brouwer, Budin-Nadvornikova and Kleinknecht 1999, Ronde and Hussler 2005). This is probably because suitable micro-level data to test these relationships are scarce (Sternberg 1999).

The aim of the paper is to fill this gap and to provide empirical evidence on the relationship between innovativeness and the performance of firms by taking locational factors into consideration. We use data from a large survey conducted on about 6,200 East German firms in 2004. The questionnaire included many aspects of innovation activities as well as performance indicators and, additionally, had a special focus on the assessment of locational conditions with respect to 15 different locational factors, ranging from qualified labour, proximity to customers, research and development facilities, transportation infrastructure to business promotion and support by the local government. Taking into consideration that locational conditions improved significantly over the last 15 years in many East German regions, these data are ideally suited for testing the hypothesized locational effects.

The main purpose of our research is that a suitable local environment has a significantly positive impact on both firm performance and innovativeness. In order to test these relationships empirically, we formulate a theoretical concept on the complex linkages between locational factors, innovativeness and firm performance. This concept is based on Porter's framework on the factors that shape a competitive advantage for firms, the so-called Diamond model (Porter 2000). According to Porter's theory, firm performance and productivity depend on the quality of the firms' environment – namely, on locational factors, local demand conditions, strategy, structure and rivalry and related and supporting industries. As the environmental conditions are bound to the firm location, it is expected that the firms with good locational conditions are more likely to attain comparative advantages and, therefore, achieve higher performance as well as higher innovation rates than firms with less-favourable locational circumstances. In our model, we postulate that the intensive cooperation activities in different areas are conducive to the firms' innovation performance and that all these factors are positively related to firm performance. Furthermore, suitable locational factors are expected to positively affect both innovation and performance of the firms. In our own structural equation model, similar to Davelaar and Nijkamp (1989), we aim to grasp all these hypothesized complex relationships between (regional) variables and their various facets.

One particularity of our study is that we distinguish between hard locational factors (e.g., supply of qualified labour, transportation infrastructure, proximity to universities, etc.) and soft locational factors (e.g., support by the local government or development agencies, regional image, etc.). The reason is that we expect that hard and soft locational factors are not equally relevant with respect to the firms' innovation and performance. Furthermore, hard and soft factors are likely to have varying significance for firms operating with different technologies. In the empirical analysis, we accordingly estimate the structural equation model, not only for the sample with all firms, but for sub-samples of high-tech manufacturing firms, knowledge-intensive service sector firms and firms operating in less-innovative branches. It can be expected that, especially for firms from innovative branches, hard factors are more important than soft factors; whereas for firms from less-innovative branches, soft locational factors might be assessed as being equally important.

In the empirical analysis, we apply the partial least squares (PLS) path modelling approach to estimate the relationships between locational factors, innovativeness and firm performance of the structural model. The PLS method has the virtue of being robust compared to covariance-based structural approaches, e.g., LISREL (Fornell and Cha 1994), which will be explained in further detail in the following sections. PLS path modelling is a distribution-free approach, and, therefore, it does not rest on restrictive statistical assumptions. However, even if it has an exploratory nature, recent developments allow statistical testing of PLS estimates by means of bootstrapping techniques. These techniques enable us to identify significant relationships between the structural variables of the model.

We find supportive evidence for some Porter's Diamond model predictions, in particular regarding the importance of cooperation intensity in different areas for a positive innovative performance. Furthermore, we can establish a positive link between locational factors – particularly, hard factors – and the firms' innovativeness. However, regarding the postulated positive relationship between competitive environment of firms and their performance according to Porter's Diamond approach, we find the opposite effect. The stronger the competition a firm faces, as indicated by a high number of competitors or by the local presence of important competitors, the worse the performance of these firms is.

The findings of our study also have some interesting economic policy implications. Firstly, it stresses the decisive role of stimulating the networking and cooperation intensity for the innovation activities from the viewpoint of particular firms. Secondly, our study shows that improving locational conditions – that of the hard factors – do indeed benefit innovative firms, and, thus, may be used as a means of regional policy.

The paper is structured as follows: section 2 describes the theoretical concept, section 3 provides details on the data, section 4 contains the estimation results and section 5 concludes.

2. Theoretical Background

2.1 Conceptual Issues

In his cluster theory, Porter (Porter 1998b) underlines the particular importance of the inter-linkages with geographically proximate partners – other companies, specialized suppliers, and institutions like universities or trade associations – to achieve the competitive advantage for firms. In the Diamond model (see figure 1), Porter presents the environmental sources of the firms' productivity and performance that interact.

[FIGURE 1 HERE]

Firm location within a cluster enables superior or cost-effective access to specialized inputs (e.g., human resources or scientific and technological infrastructure), information and knowledge. Proximate and sophisticated customers apply pressure on firms to constantly innovate. For example, in close collaboration with local customers in the product development phase, firms can gain the competitive advantage over competitors. As well, strong competitors exert pressure on firms to constantly innovate and search for strategic differences, cost savings or quality improvements. The relationships between firms and suppliers (related and supporting industries) play a decisive role in the value chain that is crucial for innovation and improvement processes. In close collaboration, local suppliers assist firms to establish new methods and technologies. Productivity enhancement occurs also by facilitating complementarities between the activities of cluster participants (Porter 1998a, Porter 1998b and Porter 2000).

Porter's approach has been comprehensively discussed in the literature and has been criticized on several grounds (Davies and Ellis 2000, Martin and Sunley 2003). The Diamond model has a high degree of abstraction and has not been operationalized enough for empirical testing at the micro-level. Capturing the sources of locational competitive advantage, Porter does not explicitly include any dependent variables. Furthermore, the mutual relationships between the environmental determinants are problematic in terms of predicting causations (Lee, Lee and Pennings 2000).

In order to test the influence of the locational conditions on the innovativeness and firm performance for East German firms, we formulate a structural equation model that modifies Porter's Diamond model (see figure 2). The model contains seven latent variables: five of them are exogenous – *hard factors*, *soft factors*, *related and supporting industries*, *rivalry* and *demand conditions* – and two endogenous – *innovativeness* and *firm performance*.

[FIGURE 2 HERE]

According to Porter's theory, we hypothesize that the latent construct *related and supporting industries* has a positive effect on the endogenous latent variables. Similarly, the locational factors are expected to have a positive impact on both the innovativeness and firm performance. Here, we distinguish between the *hard factors* (e.g., skilled labour, proximity to research establishments) and *soft factors* (e.g., support by the local government or regional image). Hard factors are defined by those factors that exert a direct impact on the business activities of firms. All other factors that indirectly influence the firms' business activities are considered soft factors.[1] This is because we postulate that the level of relevance for innovativeness and firm performance is different. We expect the hard factors for the high-tech manufacturers to be more important than the soft ones.

However, we question Porter's postulate that local customers and strong competitors have a positive influence on the innovativeness and firms' performance. Porter's approach seems to be too simplistic. The large local market can also be a shortcoming resulting in the reduction of the product export, which is a competitive advantage in the global industries. Additionally, a strong local competitive environment can be a big drawback for the firms' innovativeness and performance. Firms often choose the strategy of competing with prices or cost reductions and not by innovations or quality improvements. As a result, they have a lack of financial resources for innovation activities.[2]

Finally, we expect innovation to have a positive influence on the firms' performance with respect to their future-oriented development. By launching new products and technologies or establishing organizational changes, firms can enhance their market position and efficiency.

2.2 Methodological Issues

As aforementioned, we estimate the developed structural equation model using the partial least squares (PLS) approach. The flexible PLS method interplay between data analysis and traditional modelling based on the distribution assumptions of observables (Wold 1982a). Contrary to the parameter-oriented covariance structure analysis (e.g., LISREL), PLS is variance-based, distribution-free and prediction-oriented (Fornell and Cha 1994). The scores of the (directly unobserved) latent variables (LV) are estimated explicitly as weighted aggregates of their observed, manifest variables (MV) (Wold 1980). In table 1, the main features of the PLS and LISREL approaches are presented.

[TABLE 1 HERE]

The PLS modelling (such as LISREL) starts with the design of the conceptual arrow scheme representing hypothetical relationships – sometimes including the expected correlation signs between

[1] For other definitions of soft and locational hard factors, please refer to Diller (1991), Funk (1995), Grabow, Henckel and Hollbach-Grömig (1995) and Dziembowska-Kowalska, J. and R.H. Funk (2000).
[2] Aghion et al., (2005) find strong empirical evidence of an inverted-U relationship between product market competition and innovation.

latent variables and between manifest variables and their latent variables (Wold 1982b). The latent constructs can be operationalized as reflective or formative measurement models. The reflective manifest variables (also called *effect indicators*) are reflected by the LV and should be highly correlated. The formative manifest variables (called *cause indicators*) are assumed to determine the LV and need not to be correlated (Bagozzi 1994, Bollen and Lennox 1991).

The PLS estimation occurs in three stages - in the first iterative stage, the values of latent variables are estimated. In the second stage, the inner and outer weights are calculated, and in the third, the location parameters (means of latent variables and intercepts of linear regression functions) are determined (Lohmöller 1989).

3. Data Description and Variables

All latent variables are operationalized as manifest variables in formative measurement models by using firm level data from East Germany, which are collected by the German Institute for Economic Research (DIW Berlin).[3] Our data set contains about 6,200 firms surveyed in 2004 (about 2,500 firms remain after deleting the observations with missing values). Table 2 contains detailed information on the assignment of indicators to their latent constructs. The *hard and soft locational factors* are measured by assessments of five (e.g., supply of skilled workers, proximity to universities or research establishments) and eight (e.g., local government promotion, support of job centres or regional image) locational factors, respectively. Cooperation activities with universities or other firms in six various cooperation fields such as basic research and product and process development are indicators of the latent variable *related and supporting industries*. Domestic turnover shares, local order inflow, turnover growth and assessment of the locational factor proximity to customers determine the local *demand conditions*. Firm *strategy and rivalry* are defined by four manifest variables; namely, firm organization (affiliation to a firm group) and three indicators relating to the firms' competition environment. Latent variable *innovativeness* of firms can be assessed in terms of product and process innovations, fundamental organizational changes, patent counts as well as share of staff deployment in R&D. In addition, we measure the *performance* of firms by (1) the assessment of the development of the competitive situation, (2) the assessment of market volume growth, (3) the investment intensity (investments over turnover), (4) the turnover growth and (5) the assessment of the profit situation. We expect all outer relations (relationships between manifest variables and their latent variables) to be positive.

[TABLE 2 HERE]

[3] The survey was carried out on behalf of the German Ministry of Education and Science.

We extract two groups of firms from the data set that are used for further tests on the model. The first group consists of about 560 firms from high-innovative industry sectors. The second one is formed by about 450 firms from the high-innovative service sectors. For the definition of high-innovative industries and services, we use the OECD classification of high and medium high technology manufacturers as well knowledge-intensive services (KIS), respectively. The list of the NACE[4] codes for these groups of firms and their numbers in the particular sectors are presented in table 3. Approximately 75% of high-innovative manufacturers in our sub-sample are from the following branches: machinery and equipment (38%), medical, precision and optical instruments (23%) and electrical machinery and apparatus (13%). The vast majority of high-innovative services are counted among other business activities such as various consultancy or technical testing and analysis (60%) and computer and related activities (28%).

[TABLE 3 HERE]

Table 4 shows means and standard deviations (SD) of these indicators. Furthermore, the results of t-tests on mean differences for the sub-groups (high-technology manufacturing, knowledge-intensive services and less-innovative branches) compared to the whole sample are provided. Regarding the importance and quality of the proximity to universities and research establishments, the average assessment of firms in innovative branches in both manufacturing and services is significantly higher than the mean of the remaining firms, i.e., firms in less-innovative branches. It is worth mentioning in this context that even firms in less-innovative branches may show a certain degree of innovativeness, though the means of indicators for new products, R&D intensity or patents are significantly below the means of firms from innovative branches. One interesting result regarding the differences in means from this table is that the assessment of the importance of related and supporting industries is on average significantly higher for innovative manufacturing firms, but not for firms from innovative service sectors. These firms place less importance on organizational innovations, and not surprisingly, also less importance on the development of new processes. Most interestingly, high-innovative manufacturers are faced with, on average, a smaller number of large competitors, which are more infrequently headquartered within the firms' proximity. However, the average competitors of high-innovative service firms are smaller and located within the firms' proximity. The assessment of the development of the competition situation, the market volume growth and profit situation is, on average, higher in innovative manufacturing. Disregarding less-innovative branches, these performance indicators are significantly lower.

[TABLE 4 HERE]

[4] NACE (Nomenclature générale des activités économiques) - Nomenclature of economic activities

4. Estimation Results

The developed structural equation model is estimated for the high-tech manufacturers, KIS firms and for all firms to check the robustness of the findings for these different groups of firms.[5] We operationalize all measurement models as formative blocks. With respect to content and indicator specification of the latent constructs, strong multicollinearity among the manifest variables should be avoided (Diamantopoulos and Winklhofer 2001). The correlations among the indicators are shown in table 5, and the multicollinearity does not seem to pose a problem.

[TABLE 5 HERE]

The evaluation of the estimation results in the structural model occurs by the determination coefficient R^2 of the endogenous latent constructs. Chin (1998) classifies R^2 values of 0.19, 0.33 or 0.67 as weak, moderate or substantial, respectively. On the basis of changes in R^2 values, the effect size f^2 of a particular exogenous LV on an endogenous LV can be calculated.[6] f^2 values of 0.02, 0.15 or 0.35 indicate a small, medium or large effect. In order to check the significance of the inner and outer weights, t-statistics are produced on the basis of the bootstrap technique by resampling with replacements from the original data (Tenenhaus et al., 2005).[7]

4.1 Structural Model

In table 6, the estimation results of the inner models are presented. In the model for the high-tech manufacturers, seven inner paths of the eleven expected are significant; six inner paths are significant for the KIS firms and for all firms all inner relations are significant.

[TABLE 6 HERE]

Accordingly, we pay particular attention to the structural models of the two sub-samples that are pictured in figure 3. As expected, in the model for the high-tech manufacturing firms, the hard factors have a significantly positive impact on both innovativeness and firm performance. The effect of the soft locational factors in this model is not confirmed. However, in the case of the KIS firms, the hard factors only positively influence the innovativeness; however, the soft factors affect both depend-

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[5] The estimations were carried out using the following software: PLSGraph 3.0 and SmartPLS 2.0 with PLS algorithm settings, path weighting scheme, standardization of manifest variables.
[6] Chin (1998): $f^2 = (R^2_{included} - R^2_{excluded}) / (1 - R^2_{included})$
[7] We chose options for the bootstrapping procedure as suggested by Tenenhaus et al., (2005); namely, 500 re-samples with the number of cases equal to the original sample size, and for sign changes the option construct level changes.

ent variables. In all models the positive impact of related and supporting industries on the innovativeness is significant, but their influence on the performance is significantly positive only in the models for all firms and high-tech manufacturers. For the high-tech manufacturers, two paths are significantly negative: *demand conditions→innovativeness* and *demand conditions→performance*. For the KIS firms these are: *demand conditions→innovativeness* and *rivalry→ performance*. The hypothesized significantly positive relationship between the innovativeness and performance is confirmed in the models for high-tech manufacturers and all firms.

[FIGURE 3 HERE]

In table 7, the calculated R^2 and f^2 values are shown. The highest R^2 value of *innovativeness* is achieved for the KIS firms; whereas *related and supporting industries* have the large f^2 effect size on the explaining of this endogenous latent variable. In the case of the high-tech manufacturers, the latent variable *related and supporting industries* has a medium effect on the innovativeness. The performance in the model for the high-tech manufacturers is mostly explained by all models; however, the R^2 value is weak. Both the hard factors and demand conditions have a small effect on the variable *performance*. In the case of the KIS firms, the constructs *rivalry* and *soft factors* have a small effect on the performance.

[TABLE 7 HERE]

4.2 Measurement Models

The estimation results for the measurement models are listed in table 8. The signs of the outer weight do not always correspond to the expectations.

For the high-tech manufacturers, the latent variable *hard factors* is formed by the proximity to universities, supply of skilled workers and proximity to research establishments. For the KIS firms, the following hard factors are crucial: the proximity to research establishments, regional transportation links (negative weight), the proximity to universities and supply of skilled workers.

For KIS firms, five out of eight indicators of the latent construct *soft factors* are significant. The impact of state government promotion and support of business development corporations are positive. The influence of local government promotion and additional education supply are negative. The significant manifest variables of *soft factors* do not need to be taken into consideration for high-tech manufacturers cohesive the non-significance of the influence on the endogenous latent variables.

In all models, the cooperation in product development and basic research contribute to elucidate the construct *related and supporting industries*. In the models for all firms and for KIS, this latent variable is additionally determined by the collaboration intensity in process development.

In the explanation of the local *demand conditions*, the domestic turnover share is bigger than the regional turnover share for high-tech manufacturers; for the KIS firms, these effects are inverted.

The latent construct *rivalry* is determined by the main competitors' headquarters within the firm proximity and number of competitors (significantly positive relationships) in all models.

The deployment share in R&D influences the innovativeness to a great extent in all models. For high-tech manufacturers, the patent counts and new products are important measures of *innovativeness* as well. New products, patent counts (at the 10% significance level) and new processes are significant for the KIS firms. In these models, the manifest variable fundamental organizational changes has the smallest significance (at the 10% level) impact.

In the case of the high-tech manufacturers and KIS firms, the assessment of the market volume development and the assessment of the development of the competition situation are the only significant indicators of the performance. In the model for all firms, the performance is explained besides by the turnover growth and assessment of the profit situation.

[TABLE 8 HERE]

4.3 Summary of Results

Our empirical analysis confirms the positive influence of locational factors and related and supporting industries, but does not confirm the positive influence of the local demand conditions and rivalry on the firms' innovativeness and performance. Indeed, we observe that firms that face strong competition are less likely to have a good performance. Furthermore, it is not local, but supra-regional demand that provides incentives for the firms' innovativeness.

According to Porter's approach, we find supportive empirical evidence that the cooperation activities with other firms and institutions (like universities or research establishments) in the collaboration areas, such as product and process development and basic research, are fundamental for stimulating and strengthening the firms' innovativeness.

The main hypothesis of this paper, i.e., the importance of hard and soft locational factors for innovativeness and performance, is confirmed by the estimates from our structural model. As expected, hard locational factors - especially proximity to universities and supply of skilled workers - are more important for high-tech manufacturing firms than the soft factors. On the other hand, for the KIS firms, both soft and hard locational factors are crucial, particularly proximity to research establishments and universities are relevant. Differing from our predictions, some locational factors, i.e., additional educational supply or local government promotion, seem to have a negative impact on the innovativeness and performance of the KIS firms. These findings may be a result of dependence on external support, e.g., local government, by firms with shrinking market volume and declining competition position in order to improve the firms' economic situation and, thereby, these locational factors tend to be negatively assessed.

With respect to the impact of demand conditions, we notice that the export-orientation - especially high export shares and nationwide orders - enables the firms to obtain higher innovation rates and better performance. This outcome seems to be intuitive and explains the estimated negative influence of good local transportation links on the innovativeness and performance, respectively. However, this result is not entirely contrary to Porter's expectations of the positive role of local demand conditions because it was not possible to include the degree of customer sophistication as a variable in our model. Thus, the importance of *local demand conditions* is not accurately captured.

Furthermore, Porter's idea that competitors cooperate and motivate each one in innovation activities for obtaining higher performance seems to collapse in the empirical outcome. On the one hand, this finding can be affected by the fact that Porter focuses on the competitive advantage at the national or regional level and not at the micro-level. From the firms' viewpoint, a high number of competitors headquartered within the firms' proximity has a negative influence on the performance of the KIS firms. On the other hand, the negative relationship between the local competition and firms' performance may result from the firms' targeting for the local markets. The relationship between competition environment and innovativeness appears to be insignificant for both high-innovative manufacturers and the KIS firms.

The positive relationship between the innovativeness and firm performance is only confirmed for high-technology manufacturers and is not the case the KIS services. This result does not mean that service firms are less innovative. In fact, there may be two reasons for this result – on the one hand, the innovations in service branches are very difficult to indicate and measure. For instance, an IT firm that develops and distributes very innovative software does not apply for patents or its programmers are not counted amongst the usual R&D personnel. Therefore, the indicators of innovativeness for service firms may be lower. Secondly, this result can be influenced because service innovations are easier for other firms to imitate than manufacturing products. Thus, the innovativeness of the KIS firms has a minor influence on the firms' performance in comparison to that of the high-tech manufacturers.

5. Conclusions

This paper provides empirical evidence on the links between locational factors, innovativeness and firm performance. According to Porter's Diamond model, which highlights the sources of locational competitive advantage, locational factors, related and supporting industries, local demand conditions as well as rivalry should be conducive for innovativeness and performance. Our empirical analysis provides supportive evidence for the role of locational factors and related and supporting industries, but not for local demand conditions and rivalry. Indeed, we find that the firms that face strong competition are less likely to exhibit good performance. Moreover, it is not local, but supra-regional demand that spurs the firms' innovativeness. The main hypothesis of this paper, i.e., the importance of hard and soft locational factors for performance, is confirmed by the estimates from our structural model. For high-tech manufacturing firms, hard locational factors - especially proximity to universities and supply of skilled workers - are more important than the soft factors. On the other hand, for the KIS firms, soft locational factors are crucial; however, hard locational factors such as proximity to research establishments and universities are also relevant. The intensity of cooperation in product development and basic research prove to be very important in order to undertake innovation activities. High export shares and nationwide orders enable the firms to obtain higher innovation rates and better performance. This explains the estimated negative impact of good local transportation links on the innovativeness and performance, respectively. However, Porter's idea that competitors cooperate and motivate each other in innovation activities for obtaining higher performance seems to collapse in the empirical results. The impact of the competition environment on the innovativeness of firms is insignificant for both high-innovative manufacturers and service firms. A high number of competitors headquartered within the firms' proximity has a negative influence on the performance of the KIS firms. The positive relationship between the innovativeness and firm performance is only confirmed for high-technology manufacturers. In conclusion, the central predictions of Porter's framework are supported by the empirical findings.

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A. Tables

TABLE 1
Main features of PLS and LISREL approaches

PLS	LISREL
variance-based	covariance-based
OLS	Maximum Likelihood
soft-modelling (distribution-free)	distribution assumption of observables
explicit estimation of LV scores	-
small-sized samples sufficient	200 and more observables required
reflective and formative LV	reflective LV; formative LV only for exogenous LV

TABLE 2
Manifest variables assignment to latent variables

LV: Hard locational factors	
	assessment of the locational factor:
hFac1	supply of skilled workers
hFac2	supra-regional transportation links
hFac3	regional transportation links
hFac4	proximity to universities
hFac5	proximity to research establishments
LV: Soft locational factors	
	assessment of the locational factor:
sFac1	additional education supply
sFac2	support of local financial institutions
sFac3	support of job centres
sFac4	local government promotion
sFac5	support of business development corporations
sFac6	state government promotion
sFac7	chambers' support
sFac8	regional image
LV: Related and supporting industries	
	cooperation intensity in:
coop1	basic research
coop2	product development
coop3	process development
coop4	equipment usage
coop5	additional education
coop6	sales
LV: Demand conditions	
dem1	domestic turnover share
dem2	local turnover share
dem3	local turnover growth
dem4	assessment of the locational factor: proximity to customers
LV: Rivalry	
r1	affiliation to a firm group
r2	main competitors' headquarters within the firm proximity (within a radius of 30 km)
r3	main competitors' size
r4	number of competitors
LV: Innovativeness	
inno1	new products in 2003/2004
inno2	new processes in 2003/2004
inno3	fundamental organizational changes in 2003/2004
inno4	number of patents in 2003/2004
inno5	deployment share in R&D in 2003/2004
LV: Performance	
perfor1	assessment of competition situation in 2005/2006
perfor2	assessment of medium-term development of market volume
perfor3	investment intensity (investments over turnover) in 2003/2004
perfor4	turnover growth in 2004 compared to 2003
perfor5	assessment of profit situation in 2003/2004

TABLE 3
NACE codes of high and medium high technology manufacturing and KIS
SOURCE: Götzfried (2004)

NACE code	Description	Number of firms
High and medium high technology manufacturing		**563**
	manufacture of	
24	chemicals and chemical products	53
29	machinery and equipment	213
30	electrical and optical equipment	10
31	electrical machinery and apparatus	74
32	radio, television and communication equipment and apparatus	36
33	medical, precision and optical instruments, watches and clocks	131
34	transport equipment	23
35	and other transport equipment	23
Knowledge-intensive services		**447**
61	water transport	-
62	air transport	-
64	post and telecommunications	-
65	financial intermediation	-
66	insurance and pension funding	-
67	activities auxiliary to financial intermediation	-
70	real estate activities	1
71	renting of machinery and equipment	28
72	computer and related activities	125
73	research and development	25
74	other business activities	266
80	education	1
85	health and social work	-
92	recreational, cultural and sporting activities	1

TABLE 4
Descriptive statistics of indicators and t-tests on mean differences

			Innovative branches				Less-innovative branches	
	All firms		Manufacturing		Services			
Indicator	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Locational factors								
supply of skilled workers	2.20	1.48	2.32	1.44	2.27	1.50	2.11	1.48
supra-regional transportation links	1.73	1.81	1.80	1.79	1.66	1.84	1.71	1.81
regional transportation links	1.77	1.81	1.55 -	1.78	1.71	1.84	1.92 +	1.79
proximity to universities	0.80	1.63	1.10 +	1.82	1.41 +	1.98	0.39 -	1.19
proximity to research establishments	0.63	1.47	1.02 +	1.77	0.92 +	1.74	0.29 -	1.03
additional education supply	1.59	1.73	1.68	1.73	1.91 +	1.78	1.40 -	1.69
support by local financial institutions	1.61	1.57	1.67	1.60	1.28 -	1.52	1.71	1.57
support by job centres	0.82	1.37	0.79	1.37	0.53 -	1.17	0.96 +	1.43
local government promotion	1.01	1.45	0.78 -	1.35	0.89	1.36	1.18 +	1.52
support by business development agencies	1.20	1.59	1.32	1.66	1.00 -	1.51	1.22	1.58
state government promotion	1.17	1.53	1.33 +	1.63	0.96 -	1.41	1.17	1.51
chambers' support	1.20	1.59	1.17	1.60	1.03 -	1.52	1.28	1.62
regional image	1.79	1.72	1.79	1.76	1.89	1.71	1.75	1.70
Related and supporting industries								
basic research	1.31	0.80	1.48 +	0.98	1.40	0.96	1.17 -	0.55
product development	2.05	1.33	2.46 +	1.41	2.02	1.31	1.84 -	1.23
process development	1.71	1.12	1.90 +	1.19	1.68	1.16	1.63 -	1.05
equipment usage	1.61	1.08	1.75 +	1.14	1.53	1.07	1.56	1.04
additional education	2.06	1.28	2.19 +	1.32	2.14	1.31	1.95 -	1.24
sales	1.91	1.30	2.06 +	1.36	1.96	1.33	1.81 -	1.25
Demand conditions								
domestic turnover share	90.26	18.92	83.21 -	23.27	94.71 +	15.16	92.13 +	16.64
local turnover share	36.59	36.29	23.77 -	31.03	45.01 +	35.67	39.85 +	37.39
local turnover growth	-0.42	6.87	-0.27	6.35	-0.85	8.35	-0.32	6.43
assessment of locational factor: proximity to customer	2.25	1.90	1.87 -	1.93	2.39	1.89	2.39 +	1.85
Rivalry								
affiliation to a firm group	0.15	0.36	0.16	0.37	0.11 -	0.32	0.16	0.37
main competitors' headquarters in the firm proximity	0.41	0.49	0.27 -	0.44	0.50 +	0.50	0.44	0.50
main competitors' size	2.13	0.66	2.24 +	0.63	1.96 -	0.68	2.14	0.65
number of competitors	1.95	0.78	1.77 -	0.78	2.00	0.75	2.03 +	0.77
Innovativeness								
new products in 2003/2004	0.73	0.44	0.81 +	0.39	0.73	0.45	0.69 -	0.46
new processes in 2003/2004	0.40	0.49	0.43	0.50	0.28 -	0.45	0.43	0.50
fundamental organizational changes in 2003/2004	0.42	0.49	0.44	0.50	0.34 -	0.48	0.45	0.50
number of patents in 2003/2004	0.31	1.49	0.57 +	1.93	0.39	2.11	0.14 -	0.62
deployment share in R&D in 2003/2004	7.47	16.09	12.18 +	17.40	12.45 +	23.46	2.88 -	8.38
Performance								
assessment of competition situation in 2005/2006	3.21	0.80	3.33 +	0.78	3.28	0.81	3.12 -	0.80
assessment of market volume development	2.98	1.08	3.28 +	1.08	3.07	1.18	2.78 -	0.99
investment intensity	0.08	0.11	0.08	0.11	0.07	0.12	0.08	0.11
turnover growth	0.11	0.38	0.14	0.40	0.12	0.44	0.08 -	0.33
assessment of profit situation	3.46	1.01	3.58 +	0.99	3.41	1.01	3.41	1.01
Number of firms	***2070***		***563***		***447***		***1060***	

NOTES: t-tests on differences of means, + significantly larger, - significantly smaller than comparison group at 5% level.

TABLE 5
Indicator correlations

LV: Hard locational factors

	hFac1	hFac2	hFac3	hFac4	hFac5
hFac1	1.000				
hFac2	**0.151**	1.000			
hFac3	**0.127**	**0.453**	1.000		
hFac4	**0.179**	**0.189**	0.076	1.000	
hFac5	**0.170**	**0.159**	0.058	**0.707**	1.000

LV: Soft locational factors

	sFac1	sFac2	sFac3	sFac4	sFac5	sFac6	sFac7	sFac8
sFac1	1.000							
sFac2	**0.149**	1.000						
sFac3	**0.116**	**0.227**	1.000					
sFac4	**0.166**	**0.211**	**0.332**	1.000				
sFac5	**0.169**	**0.235**	**0.223**	**0.278**	1.000			
sFac6	**0.143**	**0.178**	**0.200**	**0.272**	**0.454**	1.000		
sFac7	**0.242**	**0.188**	**0.236**	**0.300**	**0.319**	**0.399**	1.000	
sFac8	**0.223**	**0.198**	**0.103**	**0.192**	**0.163**	**0.193**	**0.283**	1.000

LV: Related and supporting industries

	coop1	coop2	coop3	coop4	coop5	coop6
coop1	1.000					
coop2	**0.313**	1.000				
coop3	**0.311**	**0.510**	1.000			
coop4	**0.214**	**0.242**	**0.351**	1.000		
coop5	**0.144**	**0.279**	**0.247**	**0.295**	1.000	
coop6	**0.108**	**0.229**	**0.135**	**0.272**	**0.289**	1.000

LV: Demand conditions

	dem1	dem2	dem3	dem4
dem1	1.000			
dem2	**0.406**	1.000		
dem3	-0.036	-0.004	1.000	
dem4	**0.317**	**0.548**	-0.010	1.000

LV: Rivalry

	r1	r2	r3	r4
r1	1.000			
r2	**-0.166**	1.000		
r3	**0.124**	**-0.164**	1.000	
r4	-0.059	**0.238**	0.060	1.000

LV: Innovativeness

	inno1	inno2	inno3	inno4	inno5
inno1	1.000				
inno2	**0.275**	1.000			
inno3	**0.142**	**0.195**	1.000		
inno4	**0.117**	**0.104**	**0.072**	1.000	
inno5	**0.221**	**0.084**	0.019	**0.289**	1.000

LV: Performance

	perfor1	perfor2	perfor3	perfor4	perfor5
perfor1	1.000				
perfor2	**0.379**	1.000			
perfor3	**0.111**	**0.097**	1.000		
perfor4	**0.220**	**0.255**	**0.167**	1.000	
perfor5	**0.066**	**0.130**	0.011	**0.104**	1.000

NOTES: Bold printed correlations are significant at the 1% level

TABLE 6
Estimation results for the structural model (inner relations)

	All firms		High-tech manufacturers		KIS	
LV	*Innovativeness*	*Performance*	*Innovativeness*	*Performance*	*Innovativeness*	*Performance*
Hard factors	0.200 **	0.114 **	0.184 **	0.184 **	0.124 **	0.082
Soft factors	0.062 **	0.086 **	0.045	0.053	0.136 **	0.164 **
Related and supporting industries	0.344 **	0.058 **	0.297 **	0.109 **	0.445 **	0.024
Rivalry	-0.045 *	-0.148 **	-0.058	-0.077	-0.028	-0.176 **
Demand conditions	-0.133 **	-0.128 **	-0.239 **	-0.140 **	-0.180 **	-0.064
Innovativeness	-	0.131 **	-	0.140 **	-	0.157

NOTES: t-values, ** and * refer to significance at the 5% and 10% level.

TABLE 7
The R^2 determination coefficient values and f^2 effect size values

	All firms		High-tech manufacturers		KIS	
LV	*Innovativeness*	*Performance*	*Innovativeness*	*Performance*	*Innovativeness*	*Performance*
Hard factors	0.04	0.01	0.04	**0.03**	0.02	0.01
Soft factors	0.00	0.01	0.00	0.00	0.03	**0.03**
Related and supporting industries	**0.13**	0.00	**0.10**	0.01	**0.26**	0.00
Rivalry	0.00	**0.02**	0.00	0.01	0.00	**0.03**
Demand conditions	0.02	0.01	0.05	0.02	0.03	0.00
Innovativeness	-	0.01	-	0.01	-	-0.03
R^2	*0.324*	*0.194*	*0.346*	*0.233*	*0.452*	*0.205*

NOTES: The bold printed values show the largest f^2 effect size of an independent LV on the explaining of dependent LV.

TABLE 8
Estimation results for the measurement models (outer relations)

	All firms	High-tech manufacturers	KIS
LV: Hard locational factors			
supply of skilled workers	0.221 **	0.293 **	0.249 **
supra-regional transportation links	0.255 **	0.237 **	0.208 *
regional transportation links	-0.322 **	-0.225 **	-0.396 **
proximity to universities	0.439 **	0.630 **	0.305 **
proximity to research establishments	0.494 **	0.250 *	0.611 **
LV: Soft locational factors			
additional education supply	0.181 **	0.375 **	-0.363 **
support by local financial institutions	-0.117	-0.123	-0.039
support by job centres	-0.176 **	-0.183	-0.015
local government promotion	-0.371 **	0.041	-0.514 **
support by business development agencies	0.395 **	0.031	0.552 **
state government promotion	0.842 **	0.977 **	0.637 **
chambers' support	0.377 **	0.288	0.305 **
regional image	0.107	-0.012	0.163
LV: Related and supporting industries			
basic research	0.446 **	0.466 **	0.431 **
product development	0.569 **	0.671 **	0.489 **
process development	0.272 **	0.115	0.428 **
equipment usage	0.017	0.071	-0.055
additional education	-0.046	-0.109	-0.081
sales	0.051	0.088	0.114
LV: Demand conditions			
domestic turnover share	0.560 **	0.617 **	0.415 **
local turnover share	0.447 **	0.366 **	0.567 **
local turnover growth	0.134 **	0.203 *	0.040
assessment of locational factor: proximity to customers	0.249 **	0.259 **	0.323 **
LV: Rivalry			
affiliation to a firm group	-0.090	-0.141	-0.201
main competitors' headquarters in the firm proximity	0.705 **	0.743 **	0.673 **
main competitors' size	-0.067	-0.041	-0.073
number of competitors	0.524 **	0.508 **	0.468 **
LV: Innovativeness			
new products in 2003/2004	0.298 **	0.272 **	0.237 **
new processes in 2003/2004	0.197 **	0.157 **	0.177 **
fundamental organizational changes in 2003/2004	0.101 **	0.125 *	0.122 *
number of patents in 2003/2004	0.273 **	0.373 **	0.206
deployment share in R&D in 2003/2004	0.692 **	0.710 **	0.719 **
LV: Performance			
assessment of competition situation in 2005/2006	0.289 **	0.326 **	0.260 **
assessment of market volume development	0.761 **	0.784 **	0.741 **
investment intensity	0.089	0.068	0.162
turnover growth	0.149 **	0.028	0.218
assessment of profit situation	0.106 *	0.141	-0.140

NOTES: t-values, ** and * refer to significance at the 5% and 10% level.

B. Figures

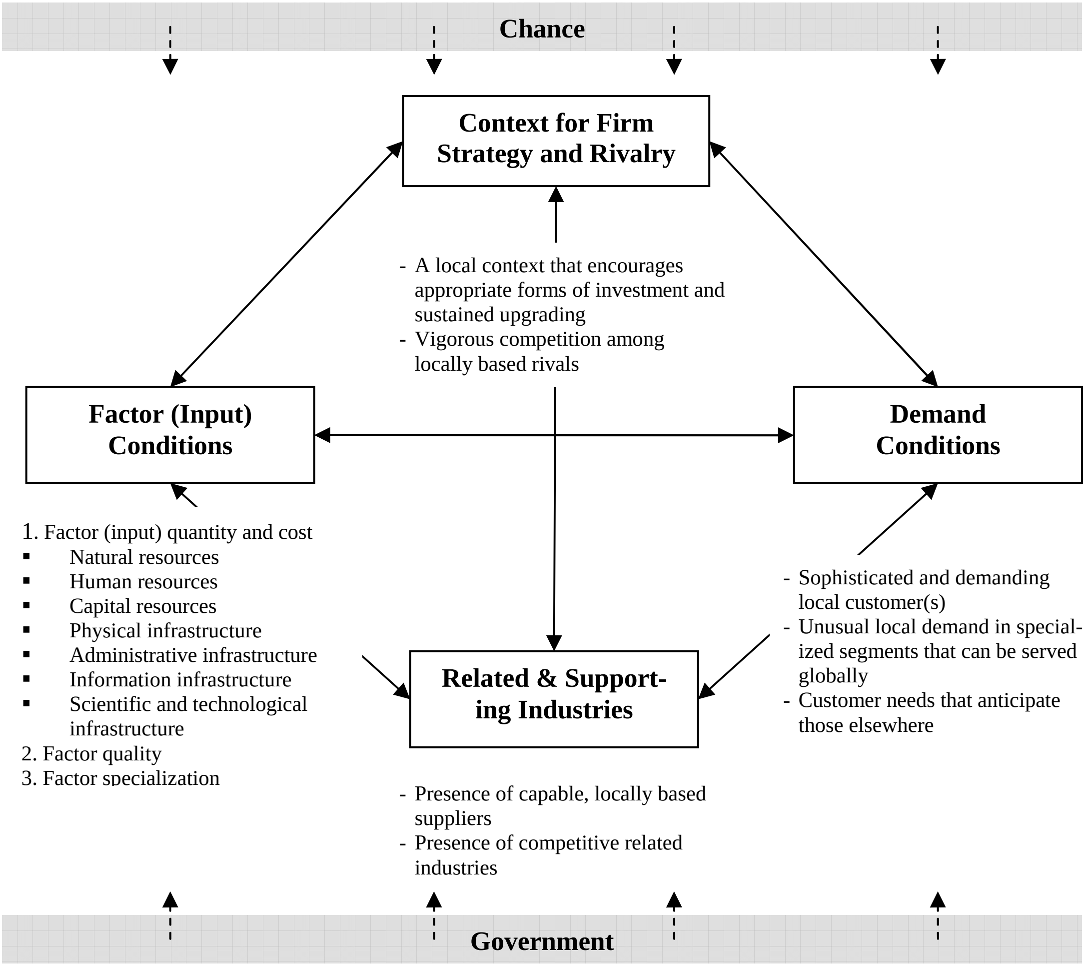

FIGURE 1 Porter's Diamond Model
SOURCE: Porter (2000)

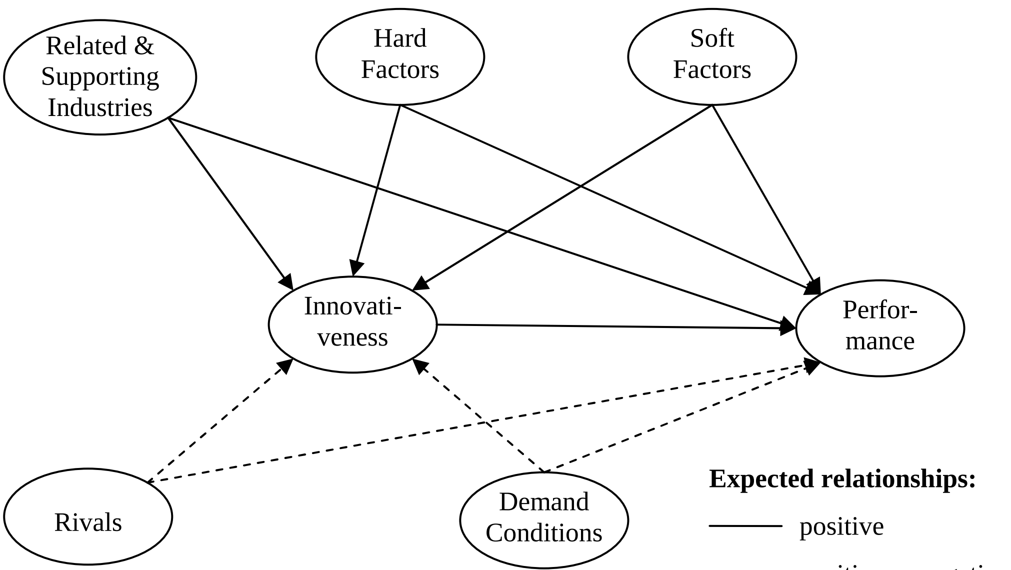

FIGURE 2 The concept of the structural equation model

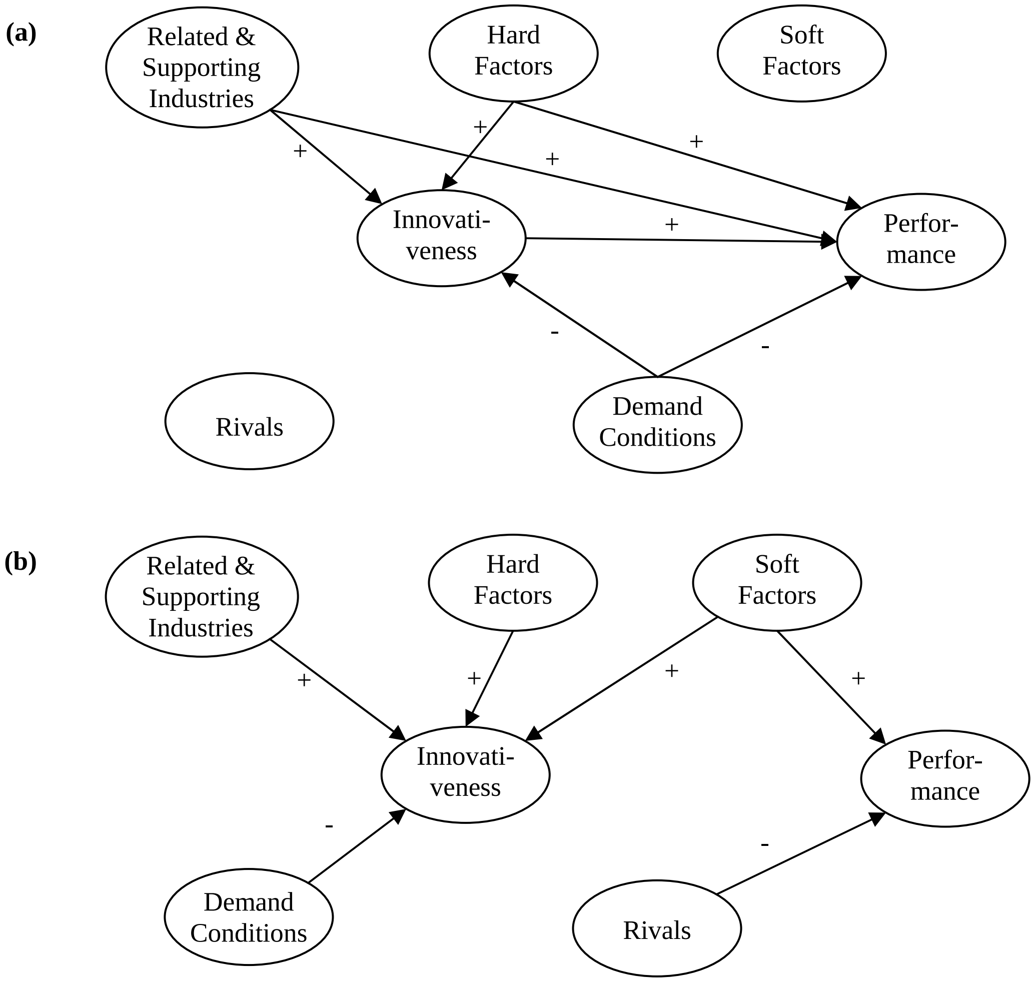

FIGURE 3 Estimation results – inner model (a) for high-tech manufacturers, (b) for knowledge-intensive services

NOTES: Only the significant paths at the 10% level are shown.