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## **INSTITUTES OF INNOVATIVE DEVELOPMENT: THEIR ROLE IN REGIONAL CLUSTERS**

**ABSTRACT:** *The role of technological innovation in enhancing competitive advantage at the level of individual companies and industries, regions, and even countries, has increased interest in the innovation component of the cluster, and has led to revision of the concept of the treatment of cluster effects and of approaches to their study. As a result of theoretical research and analysis of practical situations, in the late 1990s W. Feldman and J. Audretsch developed a theory of economic development through the establishment of innovation clusters. In this paper we aim to identify the quantitative link between the participation in innovation clusters and universities, research centres, and other institutes of*

*innovative development; we will also try to find the key factors affecting them. We used econometric procedures for 413 companies (based on the data of accounting and statistical reports) of the Perm region (Russia). The regression outcomes allow defining the ‘stimulating’ factors affecting participation in cluster relationships. The quantitative analysis was supplemented by in-depth interviews on different types of relationship forms among companies and institutes promoting innovation within the framework of a cluster concept.*

**KEY WORDS:** *innovation clusters, innovation infrastructure, institutes for innovative development, regional innovation system*

**JEL CLASSIFICATION:** D02, D22, D24

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## **1. INTRODUCTION**

Today there is a general consensus that the most competitive companies are those which generate innovation in cooperation with other participants in markets within localized regions. In work investigating this area of research, Ellison et al. (2010) have discovered positive spillovers for companies located close to universities, research centres, and other institutes of innovative development. While the links between innovation and growth have been discussed during last 20 years, the more recent works of Porter (2002), Sunley (2003), and Hoffe and Chen (2006) concentrate on the ways in which localized knowledge and technology spillovers may promote innovation. This relationship has been taken as an evidence of competition spurring technological progress, product cycles where growth is faster at earlier stages, and the importance of entrepreneurship for area success (Acs, Armington, 2004; Ellison et al., 2010).

Motivated by two concepts – open innovation within the localized region or innovation clusters, and innovation systems, this paper attempts to evaluate the role for innovation cluster participants of external sources of knowledge from different institutes. To do this we introduce a framework based on the concept of regional innovative systems. Despite the fact that different forms of cooperation can enable special resources and competences, we could not discover sufficient evidence to confirm the positive impact of cooperation indicators on a company's financial results and its innovation absorption capacity (Immarino et al., 2000).

The paper is organized as follows. The next section provides a brief review of the existing literature on spillover effects within localized regions. Section 3 outlines the scheme illustrating the relationship between cooperation among cluster participants and company performance. Section 4 discusses the data and methods. Sections 5 and 6 present the results of the econometric and qualitative analysis. Concluding remarks are provided in the last part, Section 7.

## **2. LITERATURE BACKGROUND**

Do companies grow faster if they are concentrated geographically? This is one of the most fundamental questions for economists posed by economic geographers. It is also the issue at the heart of a theoretical research programme that emerged in the late 1990s by conjoining models from 'new economy' theories and geography.

The research has established that companies, due to the geographic proximity<sup>1</sup> of clients, suppliers, competitors, universities, and other institutions, provide localized knowledge externalities or spillovers that give positive economic value. As a result, companies in these locations enjoy higher productivity, experience greater innovation and growth, and pay higher wages.

A growing literature documents these advantages; however, these topics imply more than a mere academic interest. Our results also suggest that a small set of observable measures usefully characterize the determinants of innovative capacity. In this context the study of various forms and practices of cooperative innovation behavior, such as innovation clusters, is of special significance (Chesbrough, 2006; Immarino, McCann, 2006; Lundvall, 1992; Audretsch, Feldman, 1996; OECD, 2006). This approach allows us to determine the motives for interaction between companies and external sources of knowledge, and to evaluate the impact of clustering on innovation by companies in order to develop an adequate regional policy. The result is a competitive advantage in the form of specific assets and competences of a company (Gupta, 2008). Porter (2002) also incorporates a more nuanced treatment of the impact of the microeconomic environment in evaluating the relationship between competition, innovation, and realized productivity growth. This framework suggests that the microeconomic environment in a nation's industrial clusters will be an essential determinant of the rate of innovation in the private sector. This depends on innovation incentives such as intellectual property protection and also consistent pressure from intense local rivalry and openness to international competition. This stimulates innovation by raising the bar for products and processes (Porter, 2002). Among its advantages is the possibility of explaining the dynamics of industrial clusters, centred on one or several large companies of traditional industries and supported by many small companies and institutions. A review of studies of regional innovation systems suggests that the success of clusters is primarily determined by the availability of a developed infrastructure and a flexible and informal interaction among participants (Kaibori, 2001).

On the other hand, the approach to regional innovation systems focuses on textured description of an organization and the patterns of activity that contribute to innovative behaviour in specific countries, and identifies those institutions and actors that play a decisive role in particular industries (see Merges et al., 1994, for the most comprehensive account in the literature). The literature on regional

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<sup>1</sup> Geographic proximity is a necessary but not sufficient condition for the development of the system and improvement of cluster performance (Immarino, McCann, 2006).

innovation systems emphasizes the active role played by government policy and specific institutional actors. Particular institutional and policy choices highlighted in this literature include the nature of the university system (Merges et al., 1994), the extent of intellectual policy protection (Merges et al., 1994), the historical evolution of industrial research and development (R&D) organization (Mowery et al., 1989), and the labour division between private industry, universities, and government in R&D performance and funding (Mowery et al., 1989).

There are a number of related papers that together present a coherent body of evidence. Simonen and McCann (2008) analyze the co-learning effect, based on Finnish data from 1996 to 2002, and report that R&D cooperation is obligated to the existence of face-to-face contact. The relationship intensity is associated with spatial proximity. Based on a panel of nine Swedish plant-level data (2,731 objects) and hierarchical cluster analysis methods with such criteria as modern technologies, human capital investment, marketing expenditures, and external knowledge (patents, trademarks, and so on), Hollenstein (2003) finds a positive impact on the dependent variable (as measured by knowledge capital intensity). He also observes a positive influence of IT-cluster participation on labour productivity. This practice closely correlates with the cooperation process Bengtson et al. (2004) based on regression analysis results from data on 144 Swedish industrial companies (different in size, sector, etc.). They confirm the hypothesis of positive interaction among customer-supplier networks within cluster and their innovation activity. An additional result shows that the more competitive a sector is, the higher the level of cooperation. Maggioni and Riggi (2006), using panel data for 2,949 Italian companies, report that the innovation cluster participation for small and medium enterprises (SMEs) has a positive correlation with networks of external knowledge sources, implying a positive impact on productivity. However for large companies this link does not exist while internal R&D is present (Maggioni et al., 2006).

These perspectives offer common insights into the innovative process. For example, all of them agree upon the centrality of R&D manpower and the need for a deep local technology base. Without skilled scientists and engineers operating in an environment with access to cutting-edge technology, a country is unlikely to produce an appreciable amount of state-of-the-art innovative output. Beyond these common elements, Porter highlights the way the flow of innovation is shaped by specialized inputs and knowledge, demand-side pressures, and competitive dynamics and externalities across related companies and industries. In contrast, the literature on national innovation systems stresses the role played by a nation's common institutions and policies in affecting the innovative output.

Whereas the cluster theory focuses on the economic impact of geography (i.e., the tendency of spillovers to be localized), the literature on regional innovation systems draws more attention to the political implications of geography (i.e., the impact of policies and institutions is circumscribed by national borders).

### **3. RESEARCH DESIGN**

The link between common innovation infrastructure and innovation clusters is reciprocal: for a given cluster innovation environment, the innovative output will tend to grow with the strength of the common innovation infrastructure (and vice versa). The strength of linkages determines the extent to which the potential for innovation induced by the common innovation infrastructure is translated into specific innovative outputs in the innovation clusters. It is difficult to identify comparable measures of the strength of overall linkages across regions, given the myriad forms such linkages may assume. In our empirical work we do not attempt to construct a summary measure, yet we focus on specific linkage mechanisms for which data is available.

The cluster theory emphasizes the microeconomic underpinnings of innovation in country-specific industrial clusters. This relationship depends on subtle interactions among input supply and local demand conditions, presence and orientation of related and supporting industries, and the nature of local competitive rivalry. The literature on regional innovation systems, built on rich descriptive accounts of the organization of innovation in specific countries, tends to emphasize the role of the overall national policy environment (e.g., intellectual property or trade policy) and the educational sector, as well as more idiosyncratic institutions that affect innovation but for which international comparison is difficult (e.g., the rules of specific funding agencies in individual countries). Meanwhile, despite the common features of the concept of innovation clusters and regional innovation systems, there are significant differences between them. In particular, the former focuses on studying the behaviour of companies, while the latter focuses on the external environment and the role of the innovation infrastructure of the cluster (Freeman, 1995; Scott, 2006).

Before the description of the research framework, let us now turn to identification of the assumptions about innovation clusters that we set out in our research:

- Firstly, we rely on the allocation of types of innovation clusters in which a company is not necessarily linked by technological chains. Participants in the

latter may or may not have technological relations, and both may be members of the same business associations that work with the same universities and demand the same innovation infrastructure.

- Secondly, we investigate a group of companies in different industries with a definite set of properties - neighbourhood location, interaction with other market participants, innovation - and compare it with other enterprises. In other words, these businesses have a high probability of forming part of different types (sectoral, inter-industry) of innovative cluster in the region.

Therefore, in this paper we define innovation clusters as “the set of interrelated organizations that promote innovation in a sector of the economy” (Aydalot, Keeble, 1998).

Any link between innovations in clusters and regional innovation system factors is unlikely to be simple. A regional innovative capacity depends on the more specific innovation environment in a country’s industrial clusters. The productivity of a strong national innovation infrastructure is higher when specific mechanisms or institutions, such as a strong domestic university system and funding mechanisms for new ventures, transfer ideas from the common infrastructure into commercial practice. Following this fact, the prominent hypothesis tested during the research was:

Hypothesis 1: Under other equal conditions, factors of the regional innovation system and of company attitudes have significance for innovation cluster participation.

Therefore, in this paper we aim to identify the quantitative link between companies’ competitiveness and these institutions, within the framework of the cluster concept; we also try to find the key factors affecting them and describe the mechanisms of cooperation via interview results. Before the empirical study results, in the next section we will present the data employed.

#### **4. DATA SOURCES AND METHODS**

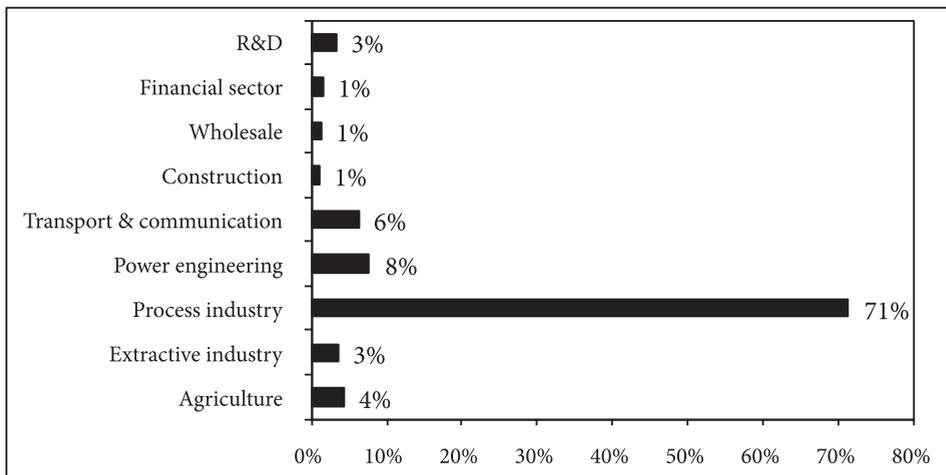
The dataset in this study was provided by Russian Federal Agency of Government Statistics (Rosstat) and its regional department (Permstat), and also supplemented by indicators from a combination of detailed longitudinal databases FIRA PRO and SPARK-INTERFAX, based on companies’ annual statistical and financial reports. Owing to the nature of innovation clusters and in line with our objectives

we have used multiple qualitative data. The data includes information on 401 small, medium, and large enterprises in different industries, classified according to the three-digit Standard Industrial Classification codes (SIC) over the 2005-2007 period.

The employment of existing statistical data is limited due to the lack of information on the majority of small companies that make up a significant share of the total output of some industries. Thus, an important criterion used to select companies for the following review was the high cover ratio of statistical indicators of the given companies. The data set compiled by the author reports the gross value-added (GVA) of 23 sectors across the Perm region, and includes the following information:

- Common indicators – structure of ownership, company age, industry and enterprise code.
- Economic indicators – export, company profitability, and unit labour costs.
- Specific indicators – total labour productivity, R&D expenditures, participation in business associations, business incubators, venture funds, universities or research centres' presence, co-operative innovation projects, localization and specialization coefficients, and others. Figure 2 shows the companies' distribution.

**Figure 1.** Distribution of objects under observation, in percentage of the total number of companies in the sample



As seen in Figure 1, the sample is balanced towards the processing industry. However, the sample study is representative of the Perm region economic structure. Table 1 helps us to characterize the type of company used in our research. It presents several descriptive statistics of the sample, where the mean and the standard deviation of the variables are detailed.

**Table 1.** Sample Descriptive Adjectives (2007 data)

Indicator	Number of objects under observation	Minimum	Maximum	Mean	Median	St. deviation
Total factor productivity (with value added), thousand rubles.	374	-264.29	15,447.83	599.26	300.78	1,418.26
Period of enterprise presence in the market or company's age in years	401	2	27	9.7	10.00	4.6
Employees, units	397	2	15,527	704	164.00	1,632
Unit labour costs (calculated with value added), thousand rubles.	379	-30.03	44.00	.55	.52	2.91

The model is oriented to the analysis of the properties of an environment and the internal features of the companies which can influence the expectancy of entering into a group of companies in an innovation cluster.

We have verified company size and industry diversification via the headcount indicator and the industry code, respectively. We have also checked for our results' robustness to the omission of all control variables.

For the qualitative part, we have selected companies on the basis of identification of innovation cluster members:

- Interviews with representatives of enterprises (department heads, CEOs and their deputies) included questions regarding types, forms, motives, and barriers of cooperation with different types of partners (15 interviews)

- Interviews with representatives of regional and municipal governments and innovation environment (business incubators, universities and research institutes, venture funds) included questions aimed at assessing the role of clusters in the region's development and the problems and forms of support for enterprises (4 interviews).

All interviews were conducted between September 2009 and March 2010.

## **5. EMPIRICAL RESULTS: THE QUANTITATIVE PART OF THE RESEARCH**

Our empirical results are presented in three parts. First, we present the results of the innovation cluster participants' identification. Second, we explore the relationship between innovation cluster participation and different factors, reflecting several determinants of innovation development institutes. Third, we present the results of the qualitative analysis.

Before the implementation of regression analysis procedures, we divide the sample into two subsamples with the following rule:

A company can be referred to as a regional innovation cluster participant, given that the following features are applicable in general:

- Participation in regional business or industrial associations.
- Joint innovation projects (with partners within the Perm region).
- R&D expenditure positive value.

Therefore, the first group consists of regional innovation cluster participants, while the second group is combined with other companies. Classification criteria were selected by expert opinion capture, research review, and available data from Rosstat.

The first criterion corresponds to positive network effects from informal 'gatherings' and information exchange with all the company's stakeholders, including competitors. Research results from the Gallup Organization show that 55% of European cluster participants report the importance of this factor (OECD, 2006). The second criterion can be considered as the major relationship indicator. Many researchers argue that the number of joint innovation projects among enterprises and universities has grown dramatically during the past ten years (Boschma, 2005). Following European research, 25% of cluster participants

feature close cooperation with other local companies, while 36% of companies collaborate with public scientific centres and laboratories. Finally, application of the third criterion results from the positive relationship between a high level of R&D expenditure, radical innovation, and high cooperation level (Maggioni et al., 2006).

Let us now turn to the total factor productivity, calculated as the value added per employee, for our subsamples. According to the established approach to the competitiveness theory based on papers by Audretsch and Feldman (2003), the higher the agglomeration and degree of R&D joint expenditure, the more competitive the company, measured by productivity.

Table 2 gives descriptive adjectives of subsamples. In general, the average rate of productivity growth in innovative clusters of gross value-added enterprises is 27.9% higher than in other enterprises. These results do not conflict with other empirical studies. The values of other indicators also show similar results. The analysis shows that cluster participation has a positive influence on competitiveness and economic indicators.

**Table 2.** Subsample Descriptive Adjectives

Subsamples	Number of objects under observation	Minimum	Maximum	Mean	Median	St. deviation
<b>Total factor productivity growth rate from 2005 to 2007 in years, %</b>						
1*	61	2.2369	.9437	.7131	.0302	.7215
0 **	340	2.9774	.7378	.5009	.0051	.6598
<b>Unit labour costs (calculated with total revenue) in 2007. thous. rub. per employee</b>						
1	61	.7648	.2208	.1855	.0126	.1620
0	340	13.2000	.3318	.2671	.0021	.7536
<b>Operating margin in 2007. %</b>						
1	61	50.89	3.01	5.35	-69.61	18.56
0	340	218.09	.07	3.80	-592.35	41.88
<b>Unit capital expenditure in 2007. thous. rub. per employee</b>						
1	61	1,627.54	67.05	11.14	-779.68	282.33
0	340	5,122.31	54.15	.37	-1,049.30	438.82

\* 1 – innovation cluster participants; \*\* 0 – other companies

We also arrived at the following results:

- 15% of companies in the sample could be associated with participants in regional innovation clusters.

- More than 80% of participants are represented by the processing industries, chemical and machinery & equipment manufacturing companies constituting 19.7% and 18%, respectively.

The next step of the quantitative part of the research is the investigation of the relationship between cluster participation and exogenous factors like different institutes for innovative development. The model is designed to analyze the properties of an environment and the internal features of the companies that can influence the expectancy of fitting into a group of enterprises in the regional innovation cluster. Regression outcomes allow us to define the ‘stimulating’ factors affecting participation in the cluster relationship.

For this purpose we use binary logistic regression for the 2007 data. The equation describes the general specification adopted for aggregate empirical testing of the indicators of innovation cluster effect. Our core econometric specification is as follows:

$$P\{InCl = 1\} = \frac{1}{1 + \exp\{-X'\beta\}}, \quad (1)$$

where dependent variable ( $Y_i$ ) is the dummy for innovation cluster members. It takes value 1 if a company is classified as a member of any innovation cluster in the Perm region, 0 if not.  $X$  matrix includes the values of independent variables, while  $\hat{\alpha}$  is the vector of estimated coefficients (see Appendix for detailed description).

The Ordinary Least Squares (OLS) method is used for the regression equation coefficient estimation. There is no statistically significant spatial correlation between the independent variables. We have tested different specifications of our general model to find the most valuable of them in terms of robustness and effectiveness of estimates; in this paper we only show the most significant of them.

In the hypothesis validation we expect statistical significance of the models in general, and the variables reflecting the institutes for innovative development also need to be statistically significant. The results of the regression analyses are given in Table 3.

**Table 3.** Regression results<sup>o</sup>

Independent variable	Equation 1	
	$\beta$	Sig.
Capital investment	.271	.000***
Company size	.643	.024**
Business incubators	.380	.507
Employment size	-.408	.387
Venture funds	.000	.086*
Transfer technology centres	.747	.000***
Exports	1.430	.001***
Universities or research centres	2.680	.000***
Industry membership	0.245	0.861
Constant	-12.388	.000***
$\chi^2$	164.674	
Prob ( $\chi^2$ )	0.000***	
Nagelkerke R-square	<b>0.601</b>	
Number of observations	397	

<sup>o</sup> Dependent variable: regional innovation cluster membership; Chi-square test was used

\* Significant at 0.1; \*\* Significant at 0.05; \*\*\* Significant at 0.001.

The explanatory models' power is 60%. They are significant at the 1% probability level. Therefore, we can confirm Hypotheses 1 and define the significant factors as the exogenous factors of innovation cluster development for the Perm region companies.

We have found a strong positive statistically significant link for the dependent variable with export activity, universities or research centres, and capital investments<sup>2</sup>. Such factors as venture funds' presence and company size also have a significant link with the dependent variable.

Despite the obtained results, the 'nature' of the innovation cluster within the framework of regional innovation systems requires supplementing the quantitative results with the qualitative research results. In this research we used in-depth interviews with participants in the innovative clusters in the region, which will be described in the next section.

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<sup>2</sup> It should be noted that the problem of endogeneity appears.

## 6. EMPIRICAL RESULTS: THE QUALITATIVE PART OF THE RESEARCH

In this paper we are trying to shed light on several subjects regarding the relationships between companies and different types of innovation institutes, including universities, research institutes, means of infrastructure innovation support, and regional and municipal government. We would like to show processes that cannot yet be reflected by statistical indicators.

We have divided all institutes into three groups:

- Financial support.
- Regional and municipal policy.
- Inter-firm institutes, universities, and research centres.

We have found that the elements of the innovation cluster such as venture capital funds, technology transfer centres, business incubators, and other financial institutions, in fact have little effect on the probability of participation in the cluster collaboration, as demonstrated by the quantitative analysis. This differs from the findings of overseas studies. The answer to this lies in the fact that “*major consumers of data services and our customers are small companies*”<sup>3</sup> [Head of a venture fund], whereas the clusters’ members are mainly dominated by large and medium-sized companies. Nevertheless, any cluster needs a ‘replenishment’ of the innovative environment, including the creation of small businesses, and institutions of networking. The creation of an “*urban investment centre that provides interaction with potential and actual investors, conducting general measures to promote the business climate*” [Deputy Head of the Municipal Government] could be considered as an element of the environment. Therefore, in general, according to cluster members, close interaction of organizations took place in spite of unfavourable institutions, rather than based on some kind of “*thick market environment*” [Head of a venture fund].

Our respondents noted that it is necessary to compensate for a number of missing elements of innovation infrastructure as well as for coordination among them. Is state intervention in these processes necessary? Which instruments of regional policy can contribute to cooperation development? We have obtained a variety of answers to these questions. For example, “*if the government wants in any way to help, it could take some innovation infrastructure items, such as scholarships and grants for students and young researchers, support engineers*

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<sup>3</sup> Quotations from interviews are in italics.

*after graduation*” [Chief Engineer, chemical industry]. Other answers included the following: “*I think these may be different tax preferences or lobbying for some programmes*” [CEO, machinery], and “*the meetings and round table discussions with city-forming enterprises and local suppliers should be more frequent. There could be sound conclusions on innovation development in the government*” [Head of small and medium sized enterprise, chemical industry]. Our investigation is partly comparable with the evidence from European studies (OECD, 2006). Most managers (45%) in the European companies surveyed believe the most valuable instrument to be state support in the form of organization of public events. Companies also reported that the transfer of information (43%) and the financing of joint projects (40%) provided the establishment of networks with universities and other companies.

Informal contacts, built on the basis of social networks, have made a stronger contribution to successful long-term relationships than formal structures (e.g., strategic alliances or non-profit partnerships). In particular, networks of universities, research centres, and enterprises are created by graduates of multiple meetings at conferences or exhibitions, participation in joint projects in the past, and participation in the same business associations. At the same time, cooperation among companies and universities has been mainly traditional in nature: students can receive training at enterprises, while employees improve their skills in universities. Different kinds of business associations are a much more suitable instrument (from a business perspective). All the respondents noted the importance of business associations in creating “*communities*”, as well as receiving opportunities “*to communicate with other successful people, to strengthen personal relationships*”. “*You can establish new relations, or learn something new about our business*”. The results of the interviews allow us to draw conclusions about the presence of stable relationships with universities and research institutions, although their potential is not being utilized to the full.

## **7. CONCLUSION**

We can draw a number of conclusions based on the theoretical and empirical parts of our research.

This paper has discussed innovation cluster analysis within the framework of the concept of the regional innovation system. Today there is a broad umbrella for a wide variety of similar yet different concepts and methodologies. A deeper understanding of the way the companies benefit from co-locating is required to

avoid confusion, formulate a meaningful framework, and select the appropriate methodology.

By using data on R&D cooperation as a proxy for face-to-face contact and knowledge spillovers, and combining this with information on a company's behaviour and regional innovation system, our results shed some light on the exogenous factors of cluster participation through which innovation takes place. We empirically investigate the impact of relationships among companies and institutes on innovative development within the regional spatial concentration of economic activity. We use cross-section OLS estimation and data set for the Perm region (Russia) featuring sectoral disaggregated information.

For the Perm companies our results suggest that R&D cooperation and cluster participation with other establishments is substantially associated with innovation and competitiveness. Moreover, our findings suggest that face-to-face knowledge exchanges between companies, universities, and research centres may therefore be of more importance for innovation than many authors would assume. Essentially, our findings are similar to those from recent research on high technology industries (Audretsch et al., 2003).

We have revealed external and internal factors that can influence the probability of participation in innovation clusters. Our findings suggest that export activity and innovatory infrastructure presence, like venture funds and universities, are important for innovation cluster creation. Our quantitative results were partly confirmed by the qualitative research (e.g., the importance of informal relationships).

This research can serve as an additional substantiation of the concentration process. These results can also serve as an argument for interaction and innovatory infrastructure development when working out industrial and regional policy.

**APPENDIX**

**Variable list**

Variable	Variable description
<i>Dependent variables</i>	
CLUSTER	Innovation cluster membership (dummy)
<i>Independent internal variables</i>	
SIZE	Company size (number of employees)
INDUSTRY	Industry Membership
CAPEX	Capital investments
EXPORTS	Exports (dummy)
<i>Independent external variables</i>	
VIF	Venture funds
TTC	Technology transfer centres
BI	Business Incubators
UNIV	University or research centre

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