JENA ECONOMIC RESEARCH PAPERS

2009 – 040

Networks and innovation: the role of social assets in explaining firms´ innovative capacity

by

Uwe Cantner
Elisa Conti
Andreas Meder

www.jenecon.de

ISSN 1864-7057

The JENA ECONOMIC RESEARCH PAPERS is a joint publication of the Friedrich Schiller University and the Max Planck Institute of Economics, Jena, Germany. For editorial correspondence please contact markus.pasche@uni-jena.de.

Impressum:

Friedrich Schiller University Jena
Carl-Zeiss-Str. 3
D-07743 Jena
www.uni-jena.de

Max Planck Institute of Economics
Kahlaische Str. 10
D-07745 Jena
www.econ.mpg.de

Networks and innovation: the role of social assets in explaining firms' innovative capacity

Uwe Cantner*, Elisa Conti** and Andreas Meder***

Abstract. The claim of a positive association between a firm's social assets and its innovative capacity is a widely debated topic in the literature. Although controversial, such an argument has informed recent innovation policy across Germany, increasingly directed to cluster formation. In the light of the growing attention and financial efforts that cluster-based innovation policies are receiving, it is worth answering two main questions. First, are firms with a relatively high level of social capital likely to be more innovative? Second, do companies pursuing innovation in partnership innovate more? This paper empirically answers these questions by exploring a cross-sectoral sample of 248 firms based in the Jena region. On the one hand, the extent to which a firm is integrated in its community life does not contribute to an explanation of its innovative performance. On the other hand, directed cooperation with the specific goal of innovating shows a positive impact on innovative performance. However, the correlation between the extent of the network of co-innovators and firms' innovative capacity presents an inverted U-shaped relation: there is a threshold in the number of co-innovators justified by the costs of innovating by interacting. A policy lesson can be drawn from these findings: cluster-based policies are to be treated with caution as firms face costs of networking and not merely benefits.

Key words: innovation, social capital, innovation network, innovation cooperation, cluster-based policy.

JEL classification: O33, L14, R5

Acknowledgements: We thank the VW-Stiftung in funding the project "Second order innovation", especially the position of Andreas Meder. We thank the DFG for funding the position of Andreas Meder when the VW project expired. We would also like to thank Marco Guerzoni, Post Doc at the Friedrich Schiller University Jena, for his valuable ideas and suggestions.

* Friedrich Schiller University Jena, Department of Economics and Business Administration, Carl-Zeiss-Str. 3, D-07743 Jena; ph.: +49 (3641) 943-200; fax: +49 (3641) 943-202; e-mail: uwe.cantner@uni-jena.de

** IULM University, Department of Economics and Marketing, via Carlo Bo 8, 20143 Milano; ph.: +39 (0)2 891412753; fax: +39 (0)2 891412770; e-mail: elisa.conti@iulm.it

*** Graduate College EIC, Friedrich Schiller University Jena and Thuringian Ministry of Economic Affairs, Max-Reger-Str. 3, D-99096 Erfurt; ph.: +49 (361) 37-97213; e-mail: Andreas.Meder@tmwta.thueringen.de

1. Introduction

Innovation policy is increasingly directed towards the promotion of social networks, based on the argument that they foster knowledge flows and innovation. This trend characterizes several European countries, and it is particularly evident in Germany. Indeed, since the middle 1980s and early 1990s, there has been a shift in the focus of German innovation policy, from a firm or sectoral approach towards the promotion of networks of innovative activities and cooperation between firms, research centers and development agencies (Dohse, 2007). In the light of the growing relevance and financial support that cluster-based policies are receiving, both at federal and state (Länder) level, it is important to gain a deeper understanding of whether social networks are effectively responsible for the increase of innovative performance.

Our paper investigates this issue by adopting a micro-level approach, where the networking effects are observed as determinants of the innovative capacity from the perspective of the firms. In order to understand the extent to which social assets contribute to the enhancement of innovation, qualifications are needed. More specifically, the paper considers two types of social networks. First, it explores whether being an open firm with intense contacts to key regional stakeholders – here used as a proxy for social capital – increases the likelihood of innovating. Second, the analysis is focused on those horizontal and vertical relationships confined to cooperation agreements undertaken with the specific goal of innovating in partnership.

Previous literature highlighted that interacting is an important source of learning and knowledge (Lundvall, 1992; Cooke, 2002), but it also involves costs and benefits (Laursen and Salter, 2006). Specifically, Laursen and Salter suggested that, after a certain level, returns from cooperation activities decrease. This argument is in line with Nooteboom (2000), who states that the surplus of an engagement in cooperation depends on the learning capacities and the probability to innovate within the cooperation. If two actors cooperate multiple times, their understanding of each other increases while the stock of potential knowledge decreases. Brokel and Meder (2008) identify a phenomenon on a regional level that they call "over cooperativeness". Regions with a high degree of intra- and inter-regional cooperation tend to show a lower innovative performance.

Thus, we are interested in the influences of informal social networks and of more formal R&D cooperation on innovative performance. These are tested empirically by looking at the innovative capacity of firms and investigating the effects of a firm's internal determinants of innovation. This paper employs a cross-section sample of 248 firms, located in the free-district city of Jena, the Saale-Holzland-Kreis (SHK) and two nearby areas of "Weimar Land": Mellingen and Apolda. There are two main reasons why this region was chosen. First, it is in Eastern Germany, where additional cluster-based policies are adopted, with respect to Western Länder. Among them, InnoRegio and Innovative Regional Growth Poles are significant cluster-based programs set by the

Federal Government in support of Eastern regions to favor regional convergence (Dohse, 2007). Second, the availability of a new dataset (see section 3 for a detail of the database used) on the firms' innovative activity allows a quantitative analysis of the topic.

The paper is structured as follows. Section 2 is a conceptual framework where theoretical arguments and previous empirical works are presented in order to position the analysis and hypotheses. Section 3 presents the sample under investigation and describes the variables employed; section 4 examines the outcomes of the regression analysis. Conclusions and policy recommendations follow in sections 5 and 6.

2. The role of social capital and networks of firms in the innovative process

Since Marshall (1890), the leading role of technological progress and knowledge in explaining different levels of economic development across countries and regions has been a widely accepted argument in different strands of literature. If the early neoclassical framework treated technological progress as exogenous, later approaches (Romer, 1986; Lucas, 1988) started exploring its determinants; according to the latter framework, technological progress comes from knowledge embedded in human capital and, therefore, it is fostered through investments in human resources and R&D.

Although that kind of analysis remains at an aggregate level, its influence on the micro-level has been great. Indeed, the firm's innovative process, as well as regional innovation, generates from knowledge embedded in human capital and from R&D investments (Rodríguez-Pose, 1999). Besides these internal determinants of innovative activity, the understanding of networks of enterprises and institutions in fostering innovation has become of interest in many disciplines. In particular, this is the perspective at the core of the economics of innovation and new economic geography (Morgan, 1997). Both disciplines agree on overcoming the linear model of innovation – where the innovative process was conceived as internal to the firm boundaries and proceeding without any feedback loop from research to marketing – to consider it as an interactive process (Lundvall, 1992), including feedback lopes between different stages of the innovation process (Klomp and van Leeuwen, 2001).

This paper draws from three main strands of literature. First, the economics of innovation theories are employed to understand the determinants of innovative capacity. In particular, the costs and benefits of innovating by interacting are analyzed. Second, the new economic geography literature is considered for its focus on the spatial dimension of such an interaction by arguing that proximity increases the opportunities of "face to face" contacts, which are a crucial precondition for the exchange of tacit knowledge (Storper, 1995, 1997). Besides these two strands of literature, a third framework is considered to support the findings of this paper: the social capital literature, with a focus on the role of social networks and trust in either fostering or hindering innovation (Granovetter, 1973, 1985).

2.1 The determinants of innovation

According to the literature on the economics of innovation, the crucial variables in explaining the innovative process are both internal and external to firms' boundaries. Size, R&D intensity, past innovation, expectations and absorptive capacity are the internal factors traditionally considered when explaining the innovative capacity of a firm (Rodríguez-Pose, 1999). We will consider them in our empirical analysis as control variables. Let us briefly discuss their expected influence on a firm's innovative performance. The consideration of *firm size* as an indicator for firm innovative capacity has been discussed under the heading of the Neo-Schumpeter hypotheses, which can be traced back to Schumpeter (1942). An ultimate answer to what kind of relationship we can expect has as yet not been found. Archibugi et al. (1995) confirm the Schumpeterian hypothesis of a positive correlation between firm size and innovative activity, whereas Hansen (1992), Pagano and Schivardi (2001) empirically demonstrate the opposite.

For the effect of a firm's *R&D intensity* on innovative capacity, it is widely agreed in the respective literature that a positive correlation prevails. Two other effects on a firm's innovative capacity have to do with innovative performance in the past and with expectations for the future. The former concept has much to do with innovation as a cumulative process, providing for "what the firm can hope to do technologically in the future is narrowly constrained by what it has been capable to do in the past" (Dosi, 1988: 1130). Hence, to account for that effect, we consider *past innovation* as an important proxy of a firm's ability to innovate. Last, but not least, we take into account *future expectations*. As argued and empirically tested by Schmookler (1962), "new goods and new techniques are unlikely to appear, and to enter the life of society without a pre-existing – albeit possibly only latent – demand" (Schmookler, 1962: 1). In other words, innovative activity is fostered by gain expectations derived from the presence or the potentiality of a market for that specific innovation.

2.2 The role of social capital

Explaining innovation through firms' characteristics and internal processes only leads to partly satisfactory answers. For this reason, in this paper we more closely look at some external factors, most prominently at inter-firm networks and institutions as important sources of technological change. These have received considerable attention since the contributions of Freeman (1991), Lundvall (1992) and Nelson (1993), among others. In the pursuit of innovation, firms are embedded in networks of relationships with a heterogeneous array of economic agents; competitors, private and public research centers, users, suppliers, regional agencies for knowledge diffusion are the main co-innovators of the firm (Freeman, 1991). The mechanism driving a firm benefit from being in a network can be summarized as *technological spillovers*, i.e. positive externalities associated to the latent public good component of knowledge (Nelson 1989). The extent of the benefits from these spillovers depends on an internal determinant of the innovative process: *absorptive capacity*. Cohen and Levinthal (1989, 1990), Levin (1988), Levin and Reiss, (1988) argue that the extent of the gains from joint innovation is relative to the firm's own innovative capacity and to its own investments in R&D. Indeed, R&D is not conducive to the development of new products or processes only, but also enhances the firm's ability to assimilate new knowledge.

Looking at interfirm networks and institutions in principle means investigating the impact interactions have on innovative performance. Hence, it is worthwhile understanding which factors facilitate such contacts. First of all, geography matters: proximity magnifies the intensity of these relationships and favors knowledge spillovers (Marshall, 1920; Porter, 1990; Storper, 1997). The main argument put forward is that innovation is a result of the exchange of tacit knowledge (Polanyi, 1967) through face to face contacts, the likelihood of which increases with decreasing distance (Storper, 1997; Crescenzi et al., 2007).

Knowledge exchange is not a matter of spatial proximity only, as cultural and social contiguity play relevant roles. The literature on social capital has stressed the role of social networks of trust in fostering innovation, due to the reduction of transaction costs, typically search and information costs, bargaining costs, enforcement and policing costs (Durlauf and Fafchamps, 2004; Rodríguez-Pose and Storper, 2006). However, this argument does not allow the conclusion that having a high level of social capital in an economy necessarily leads to an increase in the innovative performance. Indeed strong social ties might hinder innovation due to the redundancy of the exchanged information (Granovetter, 1973, 1985). As social capital is not good or bad *per se* for innovation, but depends on its quality and intensity, the assessment of its role remains an empirical question.

The empirical literature, having measured social capital with different proxies, ended up with different and often incommensurable results. For instance, Cooke and Willis (1999) assess Danish, Welsh, and Irish government policies to promote innovation in SMEs by increasing their level of social capital through networking. By using inter-firm networks as proxies for social capital, their findings confirmed the argument that social capital is innovation enhancing. On the other hand, Florida et al. (2002) reach the opposite conclusion; in a study of the level of both innovation and social capital in different metropolitan areas in the United States, they conclude that there is a negative association between these two variables. They justified the findings with Granovetter's argument on the weakness of strong social ties. Furthermore, Landry et al. (2000), using participation in business networks, personal acquaintance with the actors involved in promoting innovation and trust as proxies for social capital, found a positive association between the first two dimensions and innovation, while trust was found to be not significant. Based on these theoretical arguments and facing the empirical results mentioned, we put forward the following hypothesis on the relationship between a firm's social capital and innovative performance:

Hypothesis 1: *There exists a positive relationship between a firm's degree of social capital and its innovative capacity*, due to the beneficial effects deriving from intellectual, social and technological spillovers and to the reduction of transaction costs.

2.3 Costs and benefits of networking activities

There are clearly methodological concerns arising when attempting to assess the role of geographical and social networks of economic agents in their pursuit of innovation. The intrinsic intangibility of social capital and, more broadly, of social relationships is a knotty obstacle for developing a common understanding of their impact on innovative change. However, as innovation policies across OECD countries are increasingly directing their focus and financial resources towards cluster-based initiatives, a deeper understanding is desirable. A closer analysis to the firm perspective through examining the specific costs and benefits of engaging in innovating by interacting instead of those related to more general social relationships might shed some light on policy decisions.

Firms engage in cooperative activities not only to reduce the financial effort in R&D and to share the risk of a highly uncertain activity, but they also aim at acquiring complementary technological and market competence (Hagedoorn and Schakenraad, 1990). Mowery (1989) emphasizes such benefits by arguing that joint innovative projects aim at making firms access knowledge and skills that are useful but not particularly developed inside the firms' boundaries. Furthermore, as highlighted by Nelson and Winter (1982), joint innovation projects represent sources of variety, which might lead to a higher extent of market diversification. Finally, firms may choose to undertake joint innovation projects for strategic market reasons, for instance, for the purpose of decreasing market competition (Kline, 2000).

However, implementing joint innovation projects is not without its costs. First of all, the activity of searching for innovative partners is time consuming and intrinsically uncertain because firms have to make extensive efforts for starting profitable relationships. The costs are not limited to the selecting phase only. Indeed, once a firm starts to cooperate, there are costs associated with the increasing complexity of information: the more are the sources of information and innovation, the more complex is its elaboration (Koput, 1997). This complexity potentially leads to decreasing returns deriving from extending the number of innovative partners. Furthermore, building and fostering external relationships is a time-consuming activity that might divert attention from other activities. Over-searching outside the firm boundaries can thus become counterproductive (Laursen and Salter, 2006).

From the theoretical framework outlined, the possibility emerges that innovative cooperation is done at a cost, and whether it is profitable for a firm depends on weighing costs and benefits. More specifically, it seems to be a threshold in terms of partners' number, after which it becomes too costly managing external relationships. This is what has been empirically demonstrated by Laursen and Salter (2006) by statistically analyzing a sample of 2707 UK manufacturing firms. They first show that the relationship between search breadth[1] and innovative performance presents an inverted U-shaped relationship, i.e. extending the sources of information and knowledge implies decreasing returns and after a certain threshold it becomes negative. Second, the association between search depth[2] and innovative performance is characterized by the same shape: not only extending the number of innovative sources leads to decreasing returns, but also deepening such innovative cooperation results in the same effect. Finally, they tested the robustness of their results by analyzing the extent to which formal external collaboration in joint-innovative projects are beneficial for the firm activity. Once again, they reached the conclusion of the existence of a threshold in the optimal number of innovative partners.

The thesis of Laursen and Salter (2006) on the U-shaped relation between the extent of co-innovators and innovative performance will guide the empirical analysis of our second research question, stated in the following hypothesis:

Hypothesis 2: *There exists an inverted U-shaped relation between the extent of the network of co-innovators and firms' innovative capacity,* deriving from weighing costs and benefits of innovating in partnership.

3. Empirical analysis: the innovative district of Jena region

3.1 Sample under examination

The empirical analysis of this paper is based on a dataset which was built within the project "2nd order innovations" financed by the Volkswagen Foundation. The aim of this project was an analysis of the development of regional innovation systems. In carrying out the project, three regions (Northern Hesse and Jena in Germany and Alpes-Maritime in France) have been analyzed. The survey is addressed to firms belonging to knowledge intensive-sectors[3], according to Cantner et al. (2003a), and based in Jena, in the Saale-Holzland-Kreis (SHK) and in Apolda and Mellingen. This regional setting was included because of its exposed position in Eastern Germany with respect to its innovative capacity. Without having specific actors of regional business development agencies (as in Northern Hesse) or specific financial support (as in Alpes-Maritime), this region prospers quite well in terms of innovative success, while it is surrounded by regions far less innovative (Cantner et al. 2003b). In these respects, the region of Jena is, somehow, unique in Eastern Germany.

[1] External search breadth is "the number of external sources or search channels that firms rely upon in their innovative activities" (Laursen and Salter 2006: 134). It is one of the independent variables considered in the study and created by simply adding up all the sources of innovative activities.
[2] External search depth is "the extent to which firms draw deeply from the different external sources or search channels" (Laursen and Salter 2006: 134).
[3] The economic sectors included in the survey are: manufacturing, with limitation to those sectors having NACE-code: from 15 to 37, energy and water supplier (NACE-code: 40 and 41), IT services (NACE code: 72), research services (NACE-code: 73) and architecture, engineering and technical services as knowledge intensive service provider (NACE-code: 74).

After a first round of telephone interviews aimed at finding out the firms' willingness to participate in the project, data collection was carried out through questionnaires, via either (e-) mail or personal interviews. This first phase had lasted from January to May 2006, reaching a sample of 248 firms, representing the 26,5% of the referring population. Firms were investigated along four main dimensions:

1. *Firms' characteristics*: variables such as size, sector, past business development and expected future development are explored in this section.
2. *Innovation activity*: innovation is here investigated with a multi-dimensional approach: product, process, and organizational innovation activity is analyzed; to complement the innovative profile of the firms, questions on the scopes, benefits and limitations of implementing innovation are also included.
3. *Cooperative innovation*: the role of firms' networks as one of the main external sources of the innovative activity is explored in this third section by asking firms about the ratio, the benefits and the costs of implementing joint-innovation projects with other firms and institutions; furthermore, the extent to which respondents trust regional, national and foreign partners is assessed.
4. *Regional activities and integration*: regional interaction goes well beyond joint innovative projects; for this reason, the last section of the questionnaire investigates other potential reasons for cooperating with regional actors and the extent to which the sample firms do it; this analysis is complemented by assessing the importance of location factors and the extent to which the region under analysis is satisfactorily endowed.

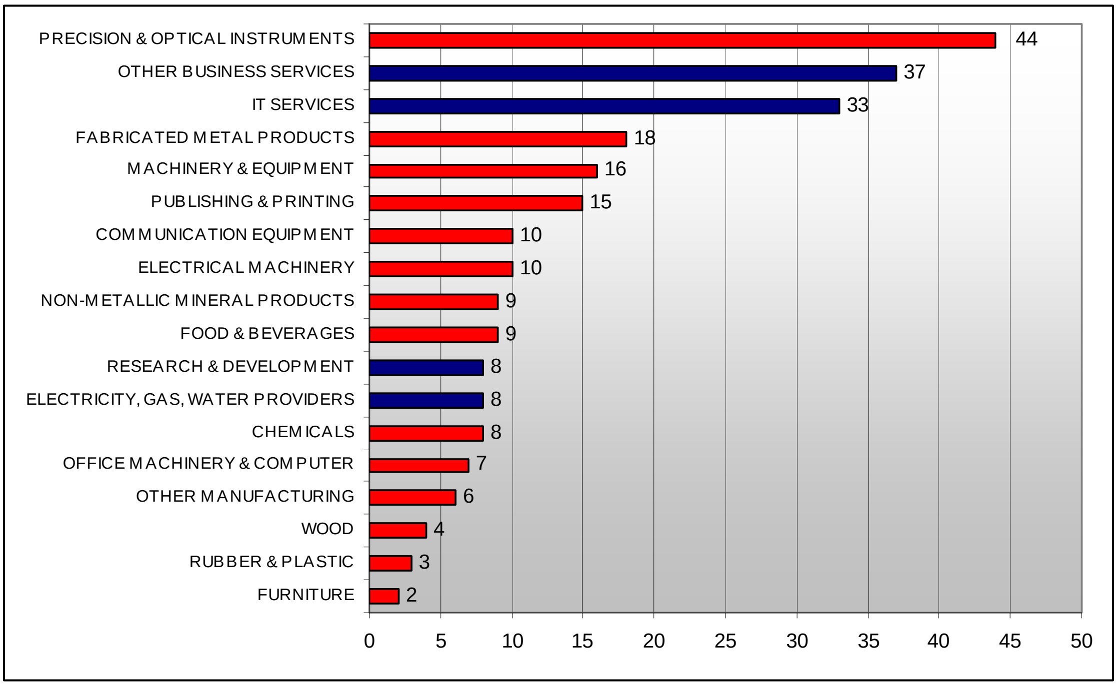
The resulting sample is characterized by a majority of small enterprises[4], most of them individual firms (70%), with a mean of 39,3 employees and 12,360 thousand euro of turnover. When analyzed in terms of the number of employees, small firms represent the 81,1% of the sample, followed by 17,7% of medium enterprises, while firms with more than 250 employees are the remaining 1,2%. If firm size is determined by turnover, small firms show an even more significant percentage of 88% of the sample, while the share of medium sized firms shrinks to 9,1%.

Regarding the sectoral composition**,** graph 1 illustrates the absolute frequencies of the sample under analysis in terms of belonging sector, where red indicates manufacturing firms and blue represents the sub-sectors of service activities. As can be seen, 65% of the sample is represented by manufacturing firms (red bars in graph 1), of which 27,3% are optical, medical and precision measurement instruments producers. The region of Jena has indeed a long tradition in optics, precision instruments, and lenses, which can be traced back to the mid-nineteenth century when Carl Zeiss was founded. Today there exists an opto-electronics cluster (Hassink and Wood 1998; Hendry et al. 2000; Brenner 2007), where a leading role is played by the historic firm and the former state-owned Carl-Zeiss, which was split-off after reunification with a couple of larger

[4] The criteria adopted in this paper for classifying firms as small, medium or large are drawn from the Reccomendation 2003/361/EC

firms (such as Carl-Zeiss and Jenoptik), and from which a constellation of small and medium spin-offs have emerged. The cluster is strengthened and fostered by public and private research centers focusing on the opto-electronics sector, such as the University of Jena, two Max Planck Institutes and a Fraunhofer Institute[5]. Furthermore, an attentive policy is carried out by the state government and special agencies for economic development (Hendry et al. 2000).

After the opto-electronics industry, representing around the 18% of the entire sample, are the business service companies (especially firms providing knowledge intensive services such as architectural, engineering and technical services) with a 15% sample share, and the IT service sector with a share of 13,4%.



Graph 1: Sectoral distribution of the sample

Source: Jena Firm database

From the 230 variables generated by the questionnaire, an extraction has been done based on their suitability in testing the two hypotheses of this paper, using the conceptual background proposed in the previous section. A description of the employed variables and their transformations follows in the next section, together with the methodology adopted.

3.2 Statistical analysis and findings

Using the sample of 248 firms described in the previous paragraph, the two hypotheses put forward above are tested through regression analysis by employing three diverse

[5] The Fraunhofer IOF of Jena is an institute for applied-research in the field of opto-electronics and precision instruments.

techniques: Ordinary Least Squares (OLS), Poisson, and Negative Binomial (Negbin) regression models. The choice of these methodologies is justified in the next paragraph, where the measure of innovation selected for the paper analysis and used as response variable is described.

3.2.1 Dependent variable and the regression models employed

As already highlighted in the theoretical framework, this paper adopts a multi-dimensional perspective of innovation, by considering product, process and organizational innovation. Furthermore, in building a proxy for a firm's innovative capacity we can determine whether the innovation is radical or incremental.

Firms were asked whether they launched new products or realized improvements on existing ones in the last three years. In case of an affirmative answer, they were asked to specify whether the product was new for the market or for the enterprise, and whether it was an improvement of an existing product. The same question was made referring to process innovation. Finally, a question on whether firms implemented new organizational forms is also considered as a means to create an indicator for innovative capacity. To compute the indicator, we uses the following variables coded as binary, 0 being the absence of a specific kind of innovation and 1 the presence:

Table 1: List of binary variables used for building the indicator of a firm innovative capacity

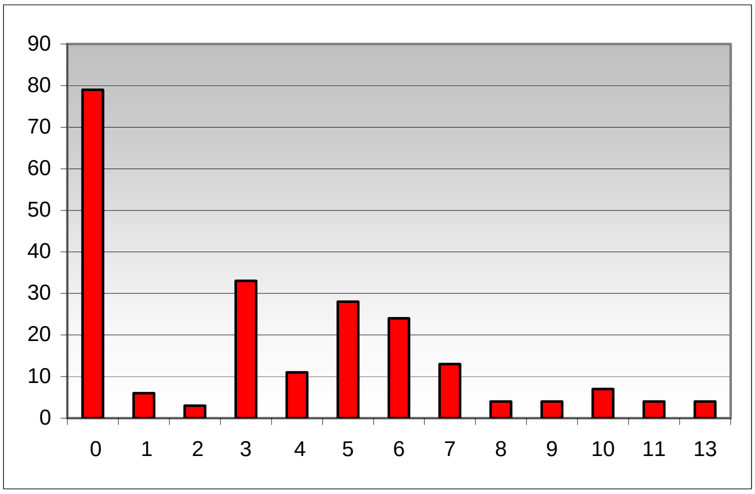
BINARY VARIABLES - description	PRESENCE	ABSENCE	SCORE
New product for the market	1	0	3
New product for the enterprise	1	0	2
Improvement of existing own product	1	0	1
No product innovation	1	0	0
Organizational innovation	1	0	1
New process for the market	1	0	3
New process for the enterprise	1	0	2
Improvement of existing own process	1	0	1
No process innovation	1	0	0

Source: Based on firm questionnaire, own elaboration

The indicator of a firm's innovative capacity (*Innodg*) is built by simply summing up (see table 1) the scores of the above listed binary variables. With the scores assigned, we attempt to account for the degree of innovativeness and relevance for the market, with increasing values corresponding to more radical levels of innovation. By so doing, the innovative capacity of a firm results in an ordinal-level variable within a range of 0-13.

As *Innodg* is ordinal, truncated and can take only positive values, applying OLS regression analysis is questionable, although it has been used. To account for this, Poisson and Negbin regression models are used to verify the robustness of the OLS findings.

Observing the distribution of *Innodg* (graph 2), the pattern seems to resemble a Poisson distribution. However, after running a Kolmogorov-Smirnov test and getting a probability of Z-test lower than 0,001, the Poisson distribution does not result in an optimal fit. Thus, Negbin regression fits the data better when the observations are over-dispersed with respect to the Poisson regression model and when many observations take value 0. This is the case for *Innodg*, the mean of which is equal to 3,47, the variance 11,31, and about 30% of the observations score 0, as shown in graph 2.



Graph 2: Distribution of innovative capacity (*Innodg*)

Source: Based on firm questionnaire, own elaboration

Finally, the opportunity of using multinomial regression analysis, where the different types of innovation would be used as categories, has also been explored. However, the lack of exclusivity of the three categories – product, process and organizational innovation – made this statistical methodology inappropriate.

3.2.2 Independent variables

The determinants of innovation described in the theoretical framework are the explanatory variables used in the model. The dimensions that this paper aims at investigating are important external determinants of innovation, namely social capital and cooperative relationships in joint innovation projects. The first external dimension is more comprehensive and captures firm openness in terms of social relationships with all the regional stakeholders; the second one is more specific in its scope and captures the networking activity aimed at developing innovation in partnership. In addition, internal determinants of innovation, firm size and sectoral dummies are the control variables employed in the regression equation. The next paragraphs describe how the independent variables have been selected and built.

Social capital

Social capital is a less straightforward variable in the model. Indeed, as already highlighted through the theoretical and empirical literature review, the intangibility of such an asset requires some proxies. From the dataset, two variables could have been used as proxies: relational assets and degree of trust in regional partners.

The first dimension of social capital can be rooted in Bordieu's understanding. He defines it as a resource based on the intensity and quality of an individual's social network (Bordieu, 1980) and later he extends this concept to groups and organizations. The proxy here employed captures the *intensity of social relationships with regional stakeholders* (*SC_rel*). To build this variable, firms' answers to the question on the intensity of their relationships with the main regional stakeholders have been used in the following way. First, the intensity of each social contact has been weighted by assigning value 0 when respondents declared having no contacts, 1 when the frequency of contact corresponded to "time to time", 2 when firms acknowledged recurring to a specific stakeholder. The complete list of regional stakeholders and the relative scores, used for building this proxy, are shown in table 2.

Table 2: List of regional stakeholders

REGIONAL STAKEHOLDERS	Never	Time to time	Often
Chamber of Commerce (IHK)	0	1	2
Public Authorities and Political Parties Local	0	1	2
Unions and Firm Networks (like Optonet)	0	1	2
Regional Organization for Economic Development (Techonology Transfer Agencies)	0	1	2

Source: Based on firm questionnaire, own elaboration

Second, the scores for each institution are summed up. The resulting indicator ranges from 0 (absence of regional interaction) to 8 (highest level of integration within the regional community) and is treated as an interval-level variable in the regression analysis. This methodology has been already employed in the literature (Landry et al. 2000).

Two regional players – private and regional research institutes – are excluded from the construction of the above described indicator in order to create a supplementary variable: the *intensity of relationships with research centers* (*RES_rel*). This variable is built in the same way as the previous one, and ranges from 0 to 4. The choice of isolating these two regional players from the construction of *SC-rel* is justified by the hypothesis of more significant technological spillovers from research centers to firms rather than from other regional institutions.

Extent of co-innovators

Joint innovative activity is measured by an indicator capturing the *size of a firm's innovative cooperation network* (*INNO_par*). This variable is built by elaborating the responses to a question asking firms to indicate the number of regional (a), national (b) and international (c) partners in innovative projects in the last three years. The same question requires firms to specify the typology of partners among the following categories:

- customers
- suppliers
- competitors
- other firms
- public research institutes
- private research institutes

Following the methodology suggested by Laursen and Salter (2006), we build an indicator of the extent to which firms rely on co-innovators, by simply summing up the numbers of each partner category. The indicator does not reflect the differences in typology of co-innovators because the hypothesis tested in the paper consists of complementary knowledge increasing a firm's innovative capacity to a certain threshold, when its complexity becomes more costly than beneficial; in other words, to answer the research question, the specific sources of knowledge are of little importance, while their heterogeneity and extent are the key information. Finally, a further clarification is needed: the indicator is limited to regional innovative partnerships for consistency, with the geographical unit of analysis characterizing the measurement of firms' social capital.

3.2.3 Control variables and their selection process

Firm size is the first control variable in the model, expressed in terms of *number of employees*. The preference for this dimension rather than turnover is justified by a higher number of observations: 98% of the firms specified their size in terms of employees against 84% in terms of turnover. Due to the highly skewed distribution of the variable, a lognormal distribution better represents the pattern; the resulting variable used in the regression equation is thus logarithm of number of employees (*logEMPL*).

The *sector* is included by creating a categorical variable with three categories: service sector (*service*), precision and optic instruments sector (*optic*) and other manufacturing activities, this latter as reference category. Most of the empirical studies attempting to assess the determinants of a firm's innovative capacity limit their analysis to manufacturing sectors only (Laursen and Salter, 2006; Ronde' and Hussler, 2005). After testing that the findings of this paper do not change significantly by limiting the analysis to manufacturing firms only, observations belonging to the service sector are included in the analysis. Finally, due to the presence of an optic cluster and being that this sector is the most represented in the sample, it is differentiated from other manufacturing ones and a category for optic activities has been created.

The measure of R&D intensity selected as control variable is the *share of R&D staff* on the total number of employees (*R&D staff*). An alternative measurement is the share of innovation costs in turnover. Through a bivariate correlation test, the hypothesis of an high degree of correlation between this latter variable and the share of R&D staff is verified (Pearson correlation =0,7 with $p < 0,001$) and thus R&D costs on turnover are not considered in the analysis. The choice between the two ways of measuring R&D intensity can be justified in terms of consistency with the other control variables in the model; indeed, as size has been included referring to number of employees, using the share of R&D staff is sounder.

According to Schmookler's analysis (1962), the last independent control variable inserted in the regression equation is *future development in terms of profit* (*futdev*). This is an ordinal variable with the following five degrees of expected trend: "highly decreased", "decreased", "equal", "increased", and "highly increased".

Following the literature on the determinants of innovation, an attempt to insert a proxy for the absorptive capacity of the firm is made. In particular, by elaborating the answers to question 20 on the methods successfully applied for the exchange of knowledge within the firm, such a proxy is formed. Due to the high level of missing values, the variable is excluded from the analysis. Furthermore, no indication on past innovation is found in the available data to be used as control variable.

In table 3 a descriptive statistics on the variables finally used in the analysis is given.

Table 3: Descriptive Statistics

	No of firms	**Minimum**	**Maximum**	**Mean**	**Std. Dev.**
Innodg	220	0	13	3,472	3,364
logEMPL	243	0	3,15	1,075	0,681
optic	247	0	1	0,178	0,383
service	247	0	1	0,348	0,477
R&D staff	243	0	1	0,242	0,324
futdev	232	1	5	3,530	1,036
SC_rel	191	0	8	2,183	1,790
RES_rel	194	0	4	0,995	1,189
INNO_par	235	0	25	1,511	3,105
Valid N (listwise)	157				

4. Model estimation and findings

The resulting equation by employing the variables described in the previous paragraphs becomes:

$$
\begin{aligned}
(1) \qquad Innodg_i &= \alpha + \beta_1 (\log EMPL)_i + \beta_2 (optic)_i + \beta_3 (service)_i \\
&+ \beta_4 (R\&Dstaff)_i + \beta_5 (futdev)_i \\
&+ \beta_6 (SC\_rel)_i + \beta_7 (RES\_rel)_i \\
&+ \beta_8 (INNO\_par)_i + \beta_9 (INNO\_par^2)_i \\
&+ \beta_{10} (INNO\_par \times optic)_i + \varepsilon_i
\end{aligned}
$$

where two transformations of the explanatory variables summarized in table 3 are included. First, the square term of *INNO_par* is included, $INNO\_par^2$, to test the second hypothesis of the paper – a negative coefficient would indicate an inverted-u relationship. Second, the interaction term of the same variable with the optic activities, *INNO_par×optic*, is used to test whether network effects are more significant for the sector clustered in the Jena region. This model is estimated by OLS, Poisson as well as Negbin.

Besides showing the results of these models, a reduced equation, where the social assets are not considered, is explored to assess their importance in explaining firms' innovative capacity. The resulting equation is:

$$
\begin{aligned}
(2) \qquad Innodg_i &= \alpha + \beta_1 (\log EMPL)_i + \beta_2 (optic)_i + \beta_3 (service)_i \\
&+ \beta_4 (R\&D\,staff)_i + \beta_5 (futdev)_i + \varepsilon_i
\end{aligned}
$$

Table 4 presents the results of the reduced model and the full one. Furthermore, the estimated regression coefficients and z-test resulting from employing Poisson and Negbin models are presented in the same table to show that the main conclusions that can be drawn from OLS regressions hold.

First, comparing the two OLS results, we see that external determinants of innovation (*SC_rel*, *RES_rel*, *INNO_par*) contribute additional power in explaining a firm's innovative capacity. Indeed, the adjusted R squared has increased from 0,341 to 0,490.

The main findings using OLS regression analysis are sound within the theoretical framework of the paper. There have been minor changes in the coefficients of the variables already included in the reduced model in that they have slightly diminished. More specifically, a significant and positive relationship exists on our data set between the share of *R&D staff* and the firm innovative capacity, *Innodg*. A positive association is also found with firms' expected gains, *futdev*. Furthermore, the estimated coefficient of *logEMPL* is sound within the Schumpeterian hypothesis: there is a positive correlation between size and innovative capacity, controlling for the other explanatory variables inserted in the models. Belonging to service sectors (*service*) instead of manufacturing does not either improve or worsen the likelihood to innovate. Finally, being a company working in the manufacturing of medical, precision and optical instruments (*optic*), i.e. the main cluster in the region under analysis, is not significantly correlated with the firm innovative capacity. These findings can be justified by the fact that the sample under analysis is already limited to high-innovative sectors only.

Table 4: Regression results

Dep. variable	*Innodg*	*Innodg*	*Innodg*	*Innodg*
MODEL	OLS	OLS	Poisson	Negbin
Intercept	-1,737**	-1,186	-0,357	-0,581
	(-2,167)	(-1,490)	(-1,332)	(-1,306)
logEMPL	1,933***	1,108***	0,096	0,088
	(6,271)	(3,195)	(0,987)	(0,498)
optic	-0,068	-0,056	-0,266	-0,281
	(-0,120)	(-0,073)	(-1,499)	(-0,813)
service	-0,498	-0,270	-0,023	-0,073
	(-1,117)	(-0,613)	(-0,197)	(-0,344)
R&D staff	4,584***	3,444***	0,020***	0,044**
	(6,652)	(4,803)	(3,032)	(2,114)
futdev	0,615***	0,426**	0,243***	0,272***
	(3,195)	(2,169)	(4,226)	(2,773)
SC_rel	–	0,022	0,029	0,049
		(0,172)	(0,988)	(0,795)
RES_rel	–	0,482**	0,100**	0,022
		(2,392)	(2,081)	(0,226)
INNO_par	–	0,780***	0,200***	0,298***
		(4,430)	(5,868)	(3,739)
INNO_par^2	–	-0,026***	-0,007***	-0,011***
		(-3,132)	(-4,573)	(-3,130)
INNO_par × *optic*	–	-0,350*	-0,109***	-0,190**
		(-1,884)	(-3,160)	(-2,306)
Adjusted R^2	0,341	0,490		
Pseudo R2			0,346	-1.79
observations	153	153	153	153

t- tests (OLS) and z-test (Poisson, Negbin) in parentheses

Notes: * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

At the core of this paper is the analysis of firms' external relationships as assets in the innovation process. The additional variables included in the full model (*SC_rel*, *RES_rel* and *INNO_par*) and two transformations of the extent of the network of co-innovators (*INNO_par*^{2} and *INNO_par* × *optic*) are hence the true foci upon which to draw conclusions. From an analysis of the estimated coefficients and their significance, it emerges that our hypothesis 1 is falsified by the findings. The lack of significance for the correlation between firms' degree of integration within the regional community (*SC_rel*) and their innovative capacity does not allow for the conclusion that social capital is likely to foster innovation. On the other hand, when the relational assets are qualified in terms of contact intensity with research centers (*RES_rel*) the association becomes significant and positive (β_7 =0,531).

The results of the regression analysis support our hypothesis 2: strong statistical evidence supports both the association between the innovative capacity of firms and the number of co-innovators, and the inverted-U shaped relation. First, the regression coefficient of *INNO_par* is statistically significant at the 1% level, showing that pursuing innovation with partners increases innovative performance, *ceteris paribus*. Second, the regression coefficient of the squared term (*INNO_par*^{2}) is also significant at the 1% level and is negative, meaning that the rate of positive returns deriving from extending the number of co-innovators decreases with the network's growth. Indeed, due to the increase of information and knowledge sources, firms face greater costs of selection. Furthermore the degree of novelty of the exchanged information tends to decrease with an increase in the number of sources and, consequently, productivity follows the same trend. Our results are also consistent with Laursen and Salter's conclusions on the effect of the breadth of the sources of knowledge on firms' innovative performance (Laursen and Salter, 2006). Also, our finding is in a line with the theoretical conclusion of Nooteboom (2000) and the empirical findings on the regional level of Broekel and Meder (2008)

Finally, *INNO_par*$\times$*optic* is included in the model as an interaction term of *INNO_par* with *optic*, under the hypothesis of a major significance of its effects within the sector clustered in the Jena region. Unexpectedly, the sign of the interaction term is negative and significant at the 10% significance level, showing that the positive effects of innovating by interacting with regional partners, albeit not strongly significant, are diminished in the case of the optic sector. Considering that only about 18% of the sample is represented by firms in the optic and precision instruments sector, the low significance and the negative coefficient could be due to a small number of observations. In addition, as the *INNO_par* comprises regional actors only, the extra-regional dimension not taken into account here may have a considerably higher and positive effect. Further research on this issue is needed.

To conclude the analysis, the results of OLS regression analysis are compared to those based on Poisson and Negative binomial regression analysis. First of all, the main thesis of this paper is confirmed no matter which model is used: having co-innovators increases firm innovative capacity but the network expansion is associated with decreasing returns. Therefore, hypothesis 2 explored in the paper holds and the findings of the OLS model are robust. Second, there is agreement among the three models on the insignificance of the association between social capital endowment and innovative performance. The major difference comparing the results emerging from different models is the role of size in explaining innovation. If the OLS models verifies the Schumpeterian hypothesis, employing Poisson or Negbin regression analysis results in lack of significance of firm size. As already highlighted in the theoretical framework, the literature is polarized on this topic and, therefore, both results are acceptable.

To sum up the main findings of regression analysis, social networks do not have a unique correlation with innovative capacity. Qualifying the nature and the scopes of external ties is necessary for concluding something meaningful on the likely effects of such ties. In particular, when trying to capture firms' social assets in a generic way, i.e. with all the regional stakeholders and for different goals, the beneficial effects of social sources of technological and market knowledge appear irrelevant. These findings challenge the argument that being in an innovative community (or milieu) automatically fosters innovative capacity. On the other hand, when the regional partners are involved in more formal co-innovation projects, with specific and shared innovative targets, the returns at the firm level are positive.

5. Limitations of the findings

The main weakness of these findings consists in the impossibility of concluding something certain about the direction of the causality. Indeed, having used data referring to a single year survey, the analysis lacks of an inter-temporal dimension. For instance, the paper cannot state any ultimate conclusions on whether firms are more innovative because they frequent more intensively research institutes or the other way around: those firms that are already more innovative are likely to have more intense contacts with private and public research centers. The common sense answer is that both are true and this is an example of co-causality. Although sensible, this conclusion cannot emerge from the data under examination. The same can be said about the exploitation of external sources of knowledge through networking. To capture these issues with a proper regression model, panel data are required.

A second limitation consists of the employment of only one proxy for capturing a degree of social capital. The empirical literature assessing the role of social assets have indeed mostly rooted in a multi-dimensional perspective of the phenomenon and, hence, have attempted to measure it through more than a single proxy (Putnam, 1993; Cooke and Willis, 1999; Landry et al., 2000). On the one hand, although a weakness when compared with other studies, the use of a single proxy better delimits the borderless concept of social capital. Indeed, through creating alternative measures of it, the empirical literature has ended up by labeling very heterogeneous phenomena with a unique name. On the other hand, it could easily be argued that what has been measured in this paper cannot be labeled social capital, as it does not encompass the heterogeneous meanings that different literature has associated with it.

Finally, more control variables on the internal determinants of the firm's innovative capacity would have strengthened the analysis, made the findings even more consistent, and increased the adjusted R-squared. The lack of availability of data, due to either high percentages of missing values (such as in the case of the tools used in order to make knowledge circulate within the firm borders) or lack of variables (for instance, past innovation), has been an obstacle in exploring the external dimensions of innovative activities.

6. Conclusions

One of the arguments widely employed to justify cluster-based policies consists of the pivotal role that social networks play in enhancing firms' innovative capacity. This paper questions such an argument by investigating the issue from the micro-level perspective. More specifically, the main concerns consist of understanding whether all types of social ties are beneficial for a firm's innovativeness and whether the number of social ties matters. To rephrase, the aim has been two-fold: on the one side, the interest is on qualifying those relationships that are worth fostering innovation at the firm level; and, on the other hand, the concern is the exploration of a potential quantitative threshold in the innovative network.

The findings are consistent with the theoretical literature and robust, not dependent on the model employed for the analysis. Being an open firm with a high level of social capital does not present a significant positive correlation with innovative capacity. Hence, attending business networks events, having deeper contacts with the IHK or with local development agencies does not increase, *ceteris paribus*, the likelihood of innovating. On the other hand, when the interaction consists of more formal collaborations for implementing co-innovation, the results are strongly significant.

These findings are evidence of the fact that knowledge is not "something in the air" and that a stronger integration within the regional community life does not automatically lead to higher innovative performance. The transfer of knowledge is something more complex and costly, because tacit knowledge does not freely spill over within a district. For this reason, specific efforts are needed to benefit from external sources of knowledge, especially in an innovative milieu such as the Jena region. Furthermore, actors seem to require such specific resources more in formal oriented types of interaction, such as R&D cooperation, than in informal interactions. Probably, in a more dynamic perspective, social capital may foster innovative performance because of its importance as a premise of formal cooperation interactions.

Even more significant are the findings on the extent of the network of co-innovators. The positive returns in terms of innovative capacity decrease with an increase in the number of partners, due to a diminishing degree of novelty of information and a growing complexity in selecting and managing what is relevant and productive. This implies that it is not always beneficial to enlarge social networks with the justification that they enhance innovation.

These findings do not have the claim of informing cluster-based innovation policies, as the limitations highlighted in the previous paragraph state clearly that further research is needed in order to identify the causality mechanism and to control for additional variables. However, they provide empirical evidence on the importance of not over-evaluating the beneficial effects with respect to innovation that cluster-based policies can bring about. In particular, it has been demonstrated that firms face costs of interaction and these should not be forgotten when designing policies fostering the networking of economic activities.

BIBLIOGRAPHY

ACS, Z. J. and AUDRETSCH D.B. (1988), Innovation in Large and Small Firms: An Empirical Analysis, American Economic Review, 78, 1998, pp. 678–690.

ACS, Z.J. and AUDRETSCH, D.B. (1987), Innovation, market structure and firm size, The Review of Economics and Statistics, 69, 1987, pp. 567-574.

ARCHIBUGI, D., EVANGELISTA, R. and SIMONETTI, R. (1995), Concentration, firm size and innovation - Evidence from innovation costs, Technovation, 15, 1995, pp. 153-163.

BOURDIEU, P. (1980), Le capital social, Actes de la Recherche en Sciences Sociales, 31, 1980, pp. 2-3.

BRENNER, T. (2007), A methodology to identify local industrial clusters and its application to Germany, in: Horst Hanusch and Andreas Pyka (Eds.): Elgar Companion to Neo-Schumpeterian Economics, Cheltenham, UK, Northampton, MA, USA, Edward Elgar, 2007, pp. 556-573.

BROEKEL, T. and MEDER, A. (2008), The Bright and Dark Side of Cooperation for Regional Innovation Performance, Papers in Evolutionary Economic Geography, Utrecht University, 11/2008, 2008.

CANTNER, U., GRAF, H. and FORNAHL, D. (2003 a), Innovationssystem und Gründungsgeschehen in Jena: Erste Erkenntnisse einer Unternehmensbefragung, Jenaer Schriften zur Wirtschaftswissenschaft, 2003-6, 2003

CANTNER, U., HELM, R. and MECKL, R. (2003 b), Strukturen und Strategien in einem Innovationssystem: Das Beispiel Jena. Verlag Wissenschaft & Praxis: Sternenfels, 2003.

COHEN, W.M. and LEVINTHAL, D.A. (1989), Innovation and learning: The two faces of R&D, The Economic Journal, 99, 1989, pp. 569–596.

COOKE, P. (2002), Knowledge economies - Clusters, Learning and Cooperative Advantage. Routledge: London, 2002.

COOKE, P. and WILLIS, D. (1999), Small Firms, Social Capital and the Enhancement of Business Performance through Innovation Programmes, Small Business Economics, 13, 1999, pp. 219-234.

CRESCENZI, R., RODRÍGUEZ-POSE, A. and STORPER, M. (2007), The territorial dynamics of innovation: A Europe-United States comparative analysis, Journal of Economic Geography, 7, 2007, pp. 673-709.

DOHSE, D. (2007), Cluster-based technology policy - The German experience, Industry and Innovation, 14, 2007, pp. 69-94.

DOSI, G. (1988), Sources, procedures, and microeconomic effects of innovation, Journal of Economic Literature, 26, 1988, pp. 1120-1171.

DURLAUF, S. and FAFCHAMPS, M. (2004), Social capital, Cambridge, Ma: NBER Working Paper, 2004.

FLORIDA, R., CUSHING, R. and GATES, G. (2002), When social capital stifles innovation, Harvard Business Review, on-line version, 2002.

FREEMAN, C. (1991), Networks of Innovators: a Synthesis of Research Issues, Research Policy, 20, 1991, pp. 499–514.

GRANOVETTER, M. (1973), The strength of weak ties, American Journal of Sociology, 78, 1073, pp. 1360-1380.

GRANOVETTER, M. (1985), Economic action and social structure: the problem of embeddedness, American Journal of Sociology, 91, 1985, pp. 481-510.

HAGEDOORN, J. and SCHAKENRAAD, J. (1990), Inter-firm partnerships and cooperative strategies in core technologies, in: C. FREEMAN, and L. SOETE (Eds.), New Explorations in the Economics of Technical Change. Pinter: London, 1990, pp. 3-37.

HANSEN, J.A. (1992), Innovation, firm size, and firm age, Small Business Economics, 4, 1992, pp. 37-44.

HASSINK, R. and WOOD, M. (1998), Geographic clustering in the German optoelectronics industry: its impact on R&D collaboration and innovation, Entrepreneurship and Regional Development, 10, 1998, pp. 277-296.

HENDRY, C., BROWN, J. and DEFILIPPI, R. (2000), Regional Clustering of High Technology-based Firms: Opto-electronics in Three Countries, Regional Studies, 34, 2000, pp. 129-144.

KLINE, J.J. (2000), Research joint venture and the cost paradox, International Journal of Industrial Organization, 18, 2000, pp. 1049-1065.

KLOMP, L. and VAN LEEUWEN, G. (2001), Innovation research technological opportunities simultaneous-equation models economic performance, International Journal of the Economics of Business, 8, 2001, pp. 343-364.

KOPUT, K.W. (1997), A chaotic model of innovative search: some answers, many questions, Organization Science, 8, 1997, pp. 528-542.

LANDRY, R., AMARA, N. and LAMARI, M. (2000), Does social capital determine innovation? To what extent?, paper prepared for presentation at the 4th International Conference On Technology Policy and Innovation, Curitiba, Brazil, August 28-31, 2000.

LAURSEN, K. and SALTER, A. (2006), Open for innovation: the role of openness in explaining innovation performance among U.K. manufacturing firms, Strategic Management Journal, 27, 2006, pp. 131-150.

LEVIN, R.C. (1988), Appropriability, R&D spending, and technological performance, The American Economic Review, 78, 1988, pp. 424–428.

LEVIN, R.C. and P.C. REISS (1988), Cost-reducing and demand-creating R&D with spillovers, Journal of Economics, 19, 1988, pp. 538–556.

LUCAS, R. E. (1988), On the mechanism of economic development, Journal of Monetary Economics, 22, 1988, pp. 3-42.

LUNDVALL, B.A. (1992), National Systems of Innovation: An Analytical Framework. Pinter: London, 1992.

MARSHALL, A. (1890), Principles of economics. London ; New York : Macmillan and Co, 1890.

MORGAN, K. (1997), The learning region: Institutions, innovation and regional renewal, Regional Studies, 31, 1997, pp. 491-503.

MOWERY, D.C. (1989), Collaborative ventures between US and foreign manufacturing firms, Research Policy, 18, 1989, pp. 19-33.

NELSON R.R. (1989), What Is Private and What Is Public About Technology?, Science, Technology & Human Values 14(3), 1989, pp. 229-241.

NELSON, R. R. (1993), National Innovation Systems: A Comparative Analysis. Oxford University Press: New York, 1993.

NELSON, R. R. and S. G. WINTER (1982), An Evolutionary Theory of Economic Change. Belknap Press/Harvard University Press: Cambridge, 2000.

NOOTEBOOM, B. (2000), Learning by interaction: Absorptive capacity, cognitive distance and governance, Journal of Management and Governance 4, 69-92, 2000.

OECD (2000), Enhancing the Competitiveness of SMEs through Innovation, paper presented at Business Symposium Roundtable on SMEs and Innovation, Bologna, 2000.

PAGANO, P. and SCHIVARDI, F. (2001), Firm size distribution and growth, Banca d'Italia Working Paper 394, 2001.

POLANYI, M. (1967), The tacit dimension. Doubledary Anchor: Garden City, New York, 1967.

PORTER, M. (1990), The Competitive Advantage of Nations. Free Press: New York, 1990.

PUTNAM, R. (1993), Making Democracy Work: Civic Tradition in Modern Italy. Princeton University Press: Princeton, 1993.

RODRIGUEZ-POSE, A. (1999), Innovation prone and innovation averse societies: economic performance in Europe', Growth and Change, 30, 1999, pp. 75-105.

RODRIGUEZ-POSE, A. and STORPER, M. (2006), Better rules or stronger communities? On the social foundations of institutional change and its economic effects, Economic Geography, 82, 2006, pp. 1-25.

ROMER, P. (1986), Increasing returns and long-run growth, The Journal of Political Economy, 94, 1986, pp.1002-1037.

RONDE', P. and HUSSLER, C. (2005), Innovation in regions: What does really matter?, Research Policy, 34, 2005, pp.1150–1172.

SALTER, A, and LAURSEN, K. (2006), Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms, Strategic Management Journal, 27, 2006, pp. 131-150.

SCHMOOKLER (1962), Economic Sources of Inventive Activity, The Journal of Economic History, 22, 1962, pp. 1-20.

SCHUMPETER, J. A. (1942), Capitalism, Socialism, and Democracy. New York: Harper and Brothers, 1942.

SMITH, K. (2005), Measuring innovation, in Fagerberg, J., Mowery, D.C. and R. Nelson, The Oxford Handbook of Innovation. Oxford University Press: New York, 2005.

STORPER, M. (1995), The resurgence of regional economics, ten years later: the region as a nexus of untraded interdependencies, European Urban and Regional Studies, 2, 1995, pp. 191–221.

STORPER, M. (1997), The Regional World: Territorial Development in a Global Economy. New York: Guilford Press, 1997.