ECONSTOR

WWW.ECONSTOR.EU

Der Open-Access-Publikationsserver der ZBW – Leibniz-Informationszentrum Wirtschaft
The Open Access Publication Server of the ZBW – Leibniz Information Centre for Economics

Behncke, Nadine

Working Paper

Networks and product innovation across European SMEs

Discussion Papers, Center for European Governance and Economic Development Research, No. 229

Provided in Cooperation with:
cege - Center for European, Governance and Economic Development Research, University of Goettingen

Suggested Citation: Behncke, Nadine (2015) : Networks and product innovation across European SMEs, Discussion Papers, Center for European Governance and Economic Development Research, No. 229

This Version is available at:
http://hdl.handle.net/10419/106776

Nutzungsbedingungen:
Die ZBW räumt Ihnen als Nutzerin/Nutzer das unentgeltliche, räumlich unbeschränkte und zeitlich auf die Dauer des Schutzrechts beschränkte einfache Recht ein, das ausgewählte Werk im Rahmen der unter
→ http://www.econstor.eu/dspace/Nutzungsbedingungen
nachzulesenden vollständigen Nutzungsbedingungen zu vervielfältigen, mit denen die Nutzerin/der Nutzer sich durch die erste Nutzung einverstanden erklärt.

Terms of use:
The ZBW grants you, the user, the non-exclusive right to use the selected work free of charge, territorially unrestricted and within the time limit of the term of the property rights according to the terms specified at
→ http://www.econstor.eu/dspace/Nutzungsbedingungen
By the first use of the selected work the user agrees and declares to comply with these terms of use.

ZBW Leibniz-Informationszentrum Wirtschaft
Leibniz Information Centre for Economics

Mitglied der Leibniz-Gemeinschaft

Center for European, Governance and Economic Development Research
cege

Discussion Papers

Number 229 – January 2015

NETWORKS AND PRODUCT INNOVATION ACROSS EUROPEAN SMES

Nadine Behncke

GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

ISSN: 1439-2305

Networks and Product Innovation across European SMEs

Nadine Behncke*

Abstract

This paper analyzes the effect of different cooperation forms on innovation in small and medium enterprises in Belgium, Germany, Portugal and Spain using Community Innovation Survey data from 2008. We find that vertical cooperation and knowledge cooperation increases the probability to introduce product innovations in all countries. The positive effect is driven by cooperation in the home country in Germany and Spain while it comes from cooperations with foreign countries in Belgium and Portugal. However, our results suggest that SME are not able to capitalize from these cooperations. We find a significant and positive effect of horizontal cooperation on sales due to product innovation only in Germany.

Key words: Networks, SMEs, Innovation

JEL-Code: L14, L25, L2

*University of Göttingen, Department of Economics, Platz der Göttinger Sieben 3, D-37073 Göttingen, Germany. E-mail: Nadine.Behncke@wiwi.uni-goettingen.de

1. Introduction

Innovation is one of the most important processes for economic growth. Especially innovation in firms has been one important theme in the economics and management literature. While innovation was originally understood as research and development (R&D) undertaken mostly in large firms since the seminal contributions of Schumpeter (1934, 1942) it is nowadays associated with the knowledge used in the process of generating ideas. In this regard, the use of external relationships, i.e. networks, has been recognized as an important driver of a firm's innovativeness. An increasing literature demonstrates in single country-studies that networks are valuable tools to foster the innovation performance of firms because they allow firms easier access to new ideas and can improve the knowledge transfer from research institutions to business activities.[1] Of particular interest is the role of networks for small and medium enterprises (SMEs) since public policy has shifted its focus to the innovative behaviour of those firms. They are especially for SMEs a great chance because those firms seem not so innovative with regard to R&D investments due to their relatively limited internal resources as compared with large firms. Engaging in external collaboration thus provides chances for them to overcome the limits of their smallness and improve their internal technological absorption capacity and engage more in innovation activities.

The current paper contributes to the literature about the impact of external collaboration on a firms innovativeness in at least three different ways: First, the focus of this paper is on the effects of R&D collaboration on product innovation performance in SMEs. Studies focusing on the effects of external collaboration on SMEs are relatively scarce. We enrich the literature by analysing the outcome of cooperation with competitors, along the value chain and with knowledge generating institutions. Here, we distinguish between cooperation within the country and with partners from other countries.

In particular, we address two principal research questions: First, the paper asks whether SMEs that engage in networks are more likely to achieve positive results in producing product innovation and which cooperation partner matters for product innovations. Second, the paper analyses whether cooperation positively influences the sales due to new innovative products, meaning that SMEs are able to turn innovative potential into (innovative) economic value.

Second, we use comparative data across four EU countries at the firm level from the harmonized Community Innovation Survey (CIS). This allows studying differences in the cooperation behaviour of SMEs across countries that are different regarding their innovation

[1] see e.g. Rogers 2004; Zeng, Zie and Tam 2010.

policy or at a different technological position. Although there exists a limited literature conducting country comparisons theses studies do not focus on SMEs or they compare northern EU countries. We address this gap by focusing on Germany, Belgium and southern EU countries.

Finally, we contribute to the literature empirically by accounting not only for selection bias but also test for simultaneity bias of the cooperation variable, which is rarely done. Although it is now common to account for self-selection bias that is necessary when working with censored data, controlling for simultaneity bias of the cooperation variable remains often unaddressed. In addition, the few studies that address this problem do not test for the relevance of the chosen instruments when applying instrumental variable methods. Here, we enrich the literature focusing on the effects of cooperation in SMEs by not only accounting for self- selection but also for simultaneity bias and testing for the validity of the chosen method.

Our results suggest that cooperation along the value chain and knowledge cooperation increase the probability to introduce product innovations in all considered countries. The positive effect is driven by cooperation in the home country in Germany and Spain while it comes from cooperation with foreign countries in Belgium and Portugal. However, our results suggest that SMEs are not able to capitalize from that cooperation. We find a significant and positive effect of cooperation with competitors on sales due to product innovation only in Germany.

The remainder of the paper is structured as follows: the next section provides the theoretical background and reviews the literature on innovation, networking and external relationships with a particular focus on SMEs. Section 3 describes the data and the empirical methodology while section 4 shows differences and similarities across countries regarding firms innovative behaviour. Section 5 presents and discusses the results. The final section concludes.

2. Theoretical Background and literature review

It is widely acknowledged that firms access knowledge through in house R&D as well as though external relationships, namely with competitors, suppliers and costumers or with knowledge generating institutions. The advantages for firms and especially SME engaging in networks or research partnerships are manifold: Since the seminal work of Romer (1990) it is shown that it improves the learning effectiveness in absorbing external knowledge. Thus it

increases the impact on a firms innovative performance of incoming spillovers and it is also a mechanism to reduce outgoing spillovers.

The market failure literature argues that investments in technological assets, whose future value is low or uncertain, there is often the danger of opportunistic market behaviour which can undermine innovative behaviour. Here, especially horizontal networks between firms may act as a governance mechanism, which can sanction such behaviour by promoting social norms and legitimacy for implicit codes of conduct among the members (Tomlinson and Fai, 2013). A large theoretical literature analyses the link between horizontal cooperation and its welfare enhancing effects. As one main result can be stated that the positive effects of these cooperation depend on the amount of spillover effects. However, one limitation of these models is that they do not include cooperation costs (Czarnitzki, Ebersberger and Fier, 2007).

Horizontal cooperation, also known as co-opetition (Brandenburger and Nalebuff, 1996), is a construct where competing firms work together in certain stages of a product cycle or in certain technological areas. The building of trust and reciprocity through repeated interaction and the mutual interdependence is one of the core features in horizontal networks where collective learning and the sharing of risks and innovations costs foster innovative incentives. It has become accepted that horizontal cooperation among firms and also among SMEs can generate benefits that allow them to compete with larger firms. However, especially horizontal networks come with the risk of technology leakage to rivals and a loss of control of the innovative process (Tomlinson and Fai, 2013).

Empirical evidence does not give a clear picture on the effect of horizontal networks on product innovation in SMEs. While Quintana-Garcia and Benavides-Velasco (2004) found that coopetition had a positive effect on firms innovative capacity in a panel study of European bio-technology firms, both De Propis (2002) and Freel and Harrison (2006) did not find any evidence for a positive effect of horizontal cooperation that was significant among UK SMEs. Comparing Austria, Belgium, Denmark and Norway, Ebersberger et al (2012) find only a weak positive effect of domestic horizontal cooperation in Denmark and of international horizontal cooperation on the introduction of product innovation in Belgium.

Risks of free riding behaviour and knowledge diffusion along the value chain may also discourage firms to engage in innovative investment when they may be unable to seize the full return of their innovative activities. Strong vertical networks between firms and their suppliers and customers can help to overcome these problems in a similar manner like

horizontal collaborations. It can be shown that firms engaging in vertical networks are more likely to engage in resource pooling which ultimately improves the appropriability of innovations along the value chain (Martin, 2002). For example, Nieto and Santamaria (2010) found that vertical networks are the most important kind of network for Spanish SMEs to improve their probability of introducing product innovations and to close the "innovation gap" with larger firms. Recently, Lasagni (2012) supports this result by analysing data from SMEs across six European countries although not highlighting country-specific differences. He finds evidence that vertical networks improve the probability of a SME to introduce a product innovation and to generate turnover from an innovation. However, they do not focus on country differences in their analysis although their sample consists of SMEs from different countries. Furthermore, Gronum (2012) found for Australian SMEs that not only cooperation activities but also the number of vertical network ties and the frequency of interaction have a significant positive influence on the probability of introducing product innovation. Distinguishing between cooperation within the same country and with foreign countries Ebersberger et al (2012) show that especially international vertical cooperation is important for the probability of a firm to introduce a product innovation in Austria, Belgium and Denmark while domestic cooperation is of importance in Norway. However, they did not focus on SMEs in their analysis.

This result suggests that country characteristics may have an impact on the effect of networks on innovative results. While Austria and Belgium are relatively small countries that should be more open, Norway is a large country, which can offer a larger base for potential cooperation partners.

A common advantage of a network is that it provides access to complementary knowledge residing partners and grants access to intangible knowledge, which does not spill over and cannot easily contracted. In addition it allows for the exploitation of economies of scale and scope in R&D, hereby reducing innovation costs.

This is especially for SMEs a great chance because they are found not to be much innovative with regard to R&D investments due to their limited internal capacities. Engaging in networks thus provides chances for them to overcome the limits of their smallness and both improve their internal technological absorption capacity and engage more in innovation activities. But networks entail not only benefits and chances but also costs, which mostly derive from transaction cost theory. Among them are high coordination costs to distinct organizational

routines or costs of combining complementary assets, fixing transfer prices of intangible goods and finally the costs of regulating the exploitation of the rates of return of the joint innovative activities (Becker and Dietz, 2004).

Due to the uncertainty of the success of the joint innovative activities it may be the case that the actual costs outweigh the potential benefits of the cooperative agreements. Although a chance, the liability of smallness may increase the probability of realizing the potential negative effects of cooperation. It is questionable if the average SME can stem the high monitoring costs needed in these kinds of activities. For example, Spithoven et al (2013) compare the open innovation practices in Belgian SMEs and large enterprises. They find no significant effect of the average cooperation agreement on a firms turnover generated through introduced product innovation. In his early influential study, Rogers (2004) analyses the relationship between firm size, networks and innovation. While he finds a weakly significant effect of cooperation on the average firm, this effect can only be observed in firms with 5-19 employees or that have more than 100 employees.

Furthermore, engaging in networks also bears the potential danger of core knowledge being leaked. Besides these problems deriving from engaging in cooperation activities SMEs may have a lower probability of finding cooperation partners than large firms. There is the danger that they are not of interest for most technological cooperation partners like universities or research institutes because of their insufficient absorptive abilities. However, engaging in such knowledge sourcing networks seems to be important for generating innovation in the long term.[2]

Belderbos et al (2004) show that cooperation with universities increases the sales of new products from Dutch firms. Nieto and Santamaria (2007) provide evidence for Spanish SMEs that knowledge-sourcing networks are important determinants to introducing new products. In a recent study, Robin and Schubert (2013) compare the influence of cooperation with public research institutions on the development and rate of return of product innovations across French and German firms. Taking both potential selection and simultaneity bias of the cooperation variable into account they find in their careful conducted analysis that

[2] Vivas and Barge-Gil (2014) provide an extensive survey on the effects of knowledge external sources, e.g. cooperation with universities, on firms innovative behaviour. See also Debackere and Veugelers (2005) and Veugelers and Cassiman (2005) for early evidence on university-firm cooperation on innovative activity. For a review on research joint ventures see Caloghirou, Ioannides and Vonortas (2003).

cooperation with universities has a positive effect on product innovation but this effect is higher in Germany that in France.

The above literature can be summarized as follows: First, while the market failure theory explains the rationale for horizontal networks, the empirical literature mostly focuses on vertical networks along the value chain and/or knowledge cooperation. Moreover, as most studies focus on the influence of cooperation on the probability to introduce innovation, the insights from transaction cost theory are neglected, that cooperation entails benefits and costs. Third, most papers analysing these questions using data from different countries do not focus on SMEs or compare the effects between large and small firms. Finally, although most papers control for selection bias they do not control for simultaneity bias. One exception are Nieto and Santamaria (2007) who use a bivariate probit model with IV correction. However, they do not test for the instruments validity. In contrast, Robin and Schubert (2013) both account for selection and simultaneity bias and also test for the instruments validity but they do not focus on SMEs and analyse only the effects of knowledge generating cooperation.

Our study addresses these gaps by analysing the importance of different cooperation partners for the probability of SMEs to introduce product innovation and whether this generates turnover. Thus, bearing in mind that cooperation also entails costs that may be higher than the potential benefits. In addition, we control for selection bias and test for endogeneity of the cooperation variable.

3. Empirical Strategy

a. Data

The empirical analysis uses data from the recent wave of the CIS, which covers the years 2006-2008. The CIS is a harmonised survey conducted in every EU state under the supervision of Eurostat. The questionnaire gives firm-level information about their innovative activities, like product and process innovation, R&D and abandoned information. In addition it entails information on the innovation environment like public funding and firm specific details as firm-size and turnover.

The CIS follows mainly a “subjective innovation measurement approach”, meaning that most variables are binary variables. One of the major strengths of the CIS is its meaningful utilization to international comparisons. Although CIS 2008 is less informative, due to a change in the questionnaire, our analysis will use this wave, since it provides the latest data and reflects the most current developments. In contrast to earlier waves, CIS 2008 does not

contain variables that describe the means of innovation protection or that describe the consequences of process innovation. These variables will only be collected from now on every four years.

The survey provides a representative sample of firms with 10 employees or more in each EU state. However, in spite of the harmonised nature of the questionnaire difficulties remain in comparing the different EU countries.

The surveys contain very different sample sizes due to different response rates. For example, in Germany the response rate is typically very low. Although an extensive non-responsive survey indicates that there is little evidence for response-selection bias thus allowing the sample to be representative of the population of German firms, it provides difficulties in comparing different industries.

We account for this inter-industry heterogeneity by including industry-fixed effects in the regression.[3]

b. Dependent variables

We use two indicators of innovative performance as the dependent variables. The first one measures firm performance in terms of the introduction of new or significantly improved products or services to the market. The binary variable NEWMKT takes the value of 1 if the firm introduced an innovation to the market during the period 2006-2008, and the value of 0 otherwise. [4]

The second dependent variable measures the share of turnover resulting from innovative product/service development. In particular, the variable TURN equals the share of turnover that a firm generated in 2008 stemming from the market launch of product/service innovations developed during the period 2006-2008. Combing these two different measures of innovation performance allows in the following empirical analysis to distinguish between the probability of introducing an innovation due to different determinants and the actual innovative outcome.

c. Explanatory variables

[3] Please note that the CIS 2008 is a cross-sectional dataset despite covering the time period 2006-2008. Thus, it is not possible to include time effects or lagged effects which is also the reason for the limitations to properly account for possible endogeneity problems.

[4] To be precise, a firm answers the following question in the CIS:„Your enterprise introduced a new or significantly improved good or service onto your market before your competitors (it may have already been available in other markets).“

In this subsection we introduce the construction concepts underlying some of our explanatory variables. In particular, we elaborate on the search for external sources of innovation and the use of collaborative innovation partners.

Openness

To capture technological opportunities we follow Robin and Schubert (2013) in building an indicator of openness. We consider the eight main sources of knowledge or information provided in the CIS2008.[5] Each information source is coded as a binary variable taking the value of 1 if the source is used and 0 otherwise. Please note the difference to the cooperation variables. Here, the variable only indicates that an external source of knowledge is used, but it does not imply any formal cooperation. The eight indicators of knowledge sourcing are then added together. The indicator varies between a minimum of 0 (no external source is used) and a maximum of 8 (all available external sources used). A higher value of the indicator indicates a greater "openness" of a firm to external sources of information. In particular, the higher the importance of external knowledge sources the better firms´ in-house capabilities for developing new products are (Becker and Dietz, 2004, p. 215).

Cooperation

In the empirical analysis we use different indicators for cooperation. At a first glance, we use the binary variable *co*, which takes the value of 1 if the firm cooperates with a partner and 0 otherwise to analyse if cooperation in general has an effect.

Furthermore, we introduce the variable *coopnumber*, which measures the number of partners a firm cooperates with. The construction of this variable is similar to the indicator of openness. We consider the seven different cooperation partner available in the CIS, where each one is coded as a binary variable when a firm cooperates with the partner and zero otherwise.[6] Again, the indicator varies between a minimum 0 (no cooperation partner) and 8 (all available partner are used for cooperation). A higher value of *coopnumber* indicates a greater diversity of a firm to cooperation strategies/partners.

[5] The information sources are Market sources (Suppliers of equipment, materials, components, or software; Clients or customers; Competitioners or other enterprises in the same sector; Consultants, commercial labs or private R&D institutes), Institutional sources (Government or publicresearch institutes); Other sources (Conferences, trade fairs, exhibitions; Scientific journals and trade/technical publication; Professional and industry associations).

[6] The CIS allows to distinguish between seven cooperation partners: A) Other enterprises within your enterprise group; B) Suppliers of equipment, materials, components or software; C) Clients or customers; D) Competitiors or other enterprises in your sector; E) Consultants, commercial labs or private R&D institutes; F) Universitites or other higher education institutions; G) Government or public reseearch insitutes.

In a second step, we distinguish between cooperation partners. We construct three binary variables that reflect a firms cooperation with suppliers or customers (vertical cooperation), with competitors (horizontal cooperation), or with universities, consultants and public R&D labs (knowledge cooperation).

Finally, we distinguish these three variables between domestic cooperation and international cooperation. The CIS allows seeing whether the firm has cooperation with a partner from the home country or an international partner.

Other Control Variables

Nearly all of our explanatory variables are binary variables. The only exception is the R&D intensity, which is measured as the share of a firms internal R&D investment over turnover (*R&DInt*).

Next, we control for group membership. We include the binary variable *gp*, which takes the value 1 if the firm belongs to a group, and zero otherwise.

Competitive market forces are captured by the variable degree of internationalization (*INTMARKT*). The variable takes the value 1 if the firm sells its products on international markets and zero otherwise. Firm size is assumed to have an effect on a firms innovativeness. We measure firm size by a binary variable that takes the value 1 if the firm has more than 50 employees (*Size*). [7]

To capture shocks that are common to all industries we include in all specifications a set of industry binary variables.

d. Statistical Methodology

In this paper we estimate a knowledge production function to analyse whether cooperation activities affect the propensity to innovate. Most previous studies recognize the obvious sample selection problem and implement a latent probit selection model based on a firms decision to engage in cooperation activities or not or being innovative or not (e.g. de Faria et al, 2010).

The knowledge production function expresses the relationship between investment in R&D and innovation output (Fritsch and Franke, 2004, p.247).

Following the literature, we implement a latent Heckman-type model:

[7] We use the CIS 2008 anonymised CD-Rom release for our analysis. Here, information on firm size is provided by a count variable which distinguishes between three size classes: 10-49; 50-249; 250+. Since we restrict our sample to SME firm size is measured by a binary variable.

$$\begin{cases} y_1 = x_1\beta_1 + u_1 \\ y_2 = 1(x_2\beta_2 + u_2 > 0) \end{cases}$$

where x1 and x2 are vectors of explanatory variables, β_1 and β_2 are the associated vectors of parameters and u1 and u2 are the bivariate normal random errors.

The first equation is the intensity equation while the second one is the selection equation. Y_2 is a selection indicator equal to 1 if a firm introduced a product innovation that is new to the market and zero otherwise. Thus, the selection equation measures the probability of a firm becoming a product innovator. The outcome equation measures how factors affect the innovativeness of firms, with Y1 measuring the share of revenue, which is due to the introduced product innovation on the subsample of innovative firms.

For the model to be identified it is necessary that the x vector in the selection equation includes variables that are not included in the outcome equation. Otherwise the model would just be identified on structural form. Following the literature we include the variable "firm size" as the exclusion variable. Controlling for the mills ratio based on the selection equation in the outcome equation accounts for potential selection bias.

However, in addition to selection bias there is a potential problem of endogeneity due to simultaneity bias between our variable of interest -the cooperation variable- and the innovation measure.

According to Becker and Dietz (2004) two main reasons explain the occurring simultaneity bias: On the one hand the use of external sources affects the commitment of a firm to innovate while on the other hand innovative firms are more likely to have the internal capacities that are necessary to engage in cooperation.

Testing and solving for endogeneity bias is challenging using only cross-sectional CIS data because of the problem of finding suitable instruments to use instrumental variable methods. To instrumentalize collaborations the literature suggests one or more of the following instruments: search for public finance, technological forcasting activities, participation in international innovation programs and market expansion goals (Nieto and Santamaria, 2013).

We use an instrumental variable approach for probit regressions to test whether collaboration is endogenous using the variable *support* from the CIS data set as an instrument, which should be similar to the proposed instrument "search for public finance". While this approach allows testing for endogeneity in the selection equation, the disadvantage is that it is not possible to check the validity of the proposed instrument. This is one problem of the few studies in the innovation and networks literature, which test for simultaneity bias. A discussion of the instruments validity seldom takes place. However, one way to check the instruments validity

is to use an IV approach in the outcome equation since linear IV gives consistent estimates while bivariate probit gives efficient estimates. It is recommended to present results from both models (Chiburis, Das and Lokshin, 2012).

To preclude the results, we highlight the importance of testing the relevance of instruments despite the difficulties when the endogenous variable is a binary regressor. We find no evidence for endogeneity when a first stage F-statistic >10 indicates the instruments relevance but when the instruments explanatory power is not high enough both, the Smith-Blundell Test statistic in the IV probit model and the Durbin-Wu-Hausman Test in the linear IV model reject the Nullhypothsis of exogeneity of collaboration.

4. Differences and Similarities across countries

The following analysis is based on the results from the Eight Community Innovation Survey (CIS 8) for Germany, Belgium, Spain and Portugal. The survey covers the period 2006 to 2008.

We restrict the samples to SMEs in the manufacturing sector leaving us with 2347 (Germany), 8598 (Belgium), 15020 (Spain) and 3439 (Portugal) observations, respectively. Table 1 gives the summary statistics of the independent variables used in the empirical analysis and a first impression of similarities and differences between the four countries with regard to firm characteristics and the innovation environment.

With regard to investment in R&D Germany and Spain are similar. SME in these countries invest around 2% of the turnover in inhouse R&D while this type of investment is almost negligible in Belgian and Portuguese SMEs. The internationalization process of SME is most pronounced in Germany and Portugal where on average over 60 % sell their products in international markets. In contrast, only around 28 % of the Belgium SMEs are internationally active.

Table 1: Summary statistics of the independent variables

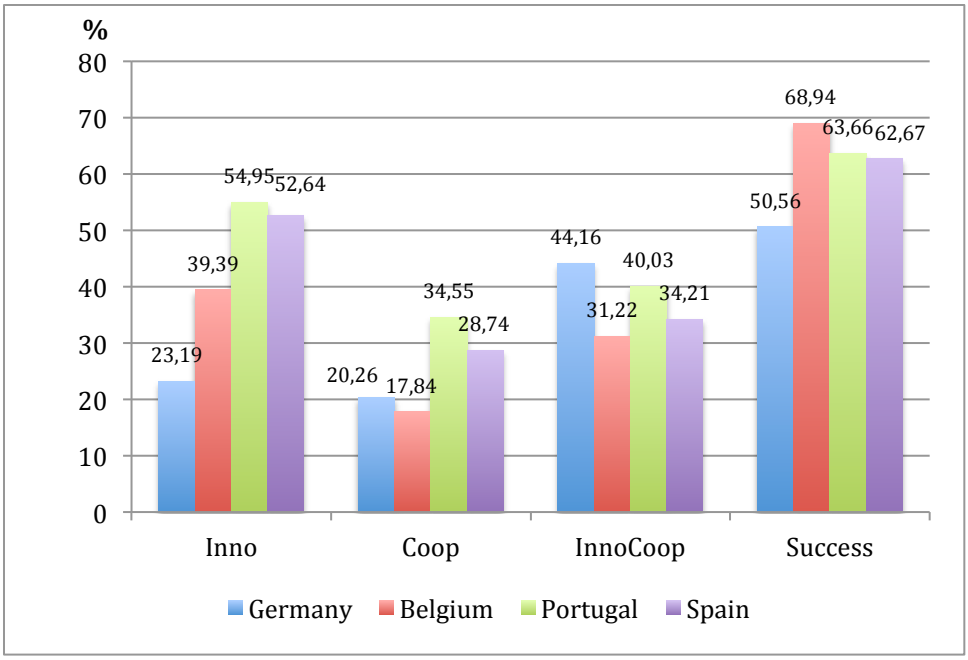
		Ger	Bel	Esp	Prt
GP	Obs	2347	8598	15020	3439
	Mean	0.282	0.057	0.212	0.145
	Med	0.450	0.231	0.409	0.352
RuDInt	Obs	2139	2436	15015	3439
	Mean	0.018	0.003	0.017	0.006
	Med	0.104	0.029	0.211	0.064
IntComp	Obs	2378	8598	15020	3439
	Mean	0.646	0.265	0.556	0.623
	Med	0.478	0.441	0.497	0.485
Support	Obs	2378	8598	15020	3439
	Mean	0.180	0.028	0.184	0.084
	Med	0.384	0.166	0.388	0.277
Openness	Obs	2378	8598	15020	3439
	Mean	5.119	7.867	7.028	7.352
	Med	3.192	2,216	2.746	2.246
Size	Obs	2378	8598	15020	3439
	Mean	0.478	0.249	0.312	0.311
	Med	0.500	0.433	0.463	0.463
Co	Obs	2264	2436	7950	1883
	Mean	0.206	0.133	0.230	0.296
	Med	0.404	0.339	0.421	0.457
Conumber	Obs	2378	8598	15020	3439
	Mean	0.405	0.088	0.225	0.296
	Med	0.989	0.569	0.421	0.457
networkHorz	Obs	2378	8598	15020	3439
	Mean	0.399	0.013	0.017	0.0512
	Med	0.196	0.114	0.129	0.220
networkHorzIN	Obs	2378	8598	15020	3439
	Mean	0.0362	0.100	0.013	0.040
	Med	0.187	0.099	0.112	0.196
networkHorzFor	Obs	2378	8598	15020	3439
	Mean	0.101	0.004	0.006	0.020
	Med	0.099	0.063	0.076	0.139
networkVer	Obs	2378	8598	15020	3439
	Mean	0.117	0.030	0.067	0.143
	Med	0.321	0.063	0.250	0.350
networkVerIn	Obs	2378	8598	15020	3439
	Mean	0.105	0.026	0.059	0.129
	Med	0.307	0.158	0.236	0.335
networkVerFor	Obs	2378	8598	15020	3439
	Mean	0.0383	0.012	0.021	0.079
	Med	0.192	0.110	0.144	0.269
networkKnow	Obs	2378	8598	15020	3439
	Mean	0.143	0.016	0.082	0.086
	Med	0.350	0.126	0.275	0.280
networkKnowIn	Obs	2378	8598	15020	3439
	Mean	0.140	0.014	0.082	0.081
	Med	0.347	0.119	0.275	0.274
networkKnowFor	Obs	2348	8598	15020	3439
	Mean	0.019	0.003	0.008	0.019
	Med	0.135	0.053	0.091	0.138

Policy efforts on different levels are inclined to help fostering the innovativeness of SMEs. However, the number of SMEs participating in such programs differs considerably across the

four countries. For example, in Germany and Portugal around 18 % of SMEs receive some kind of support while it is only around 3 % in Belgium and 8 % in Portugal.

Figure 1 presents differences regarding the introduction of product innovation in SME across the four countries. The first two columns show the share of SME who introduced a product innovation or who engaged in cooperation. In Portugal and Belgium over 50 % of SMEs introduced products that were new to the market and not only new to the firm. In contrast, the share of innovative SME is relatively low in Germany, which is around 23 %.

Figure 1: Product Innovation and Cooperation in SME

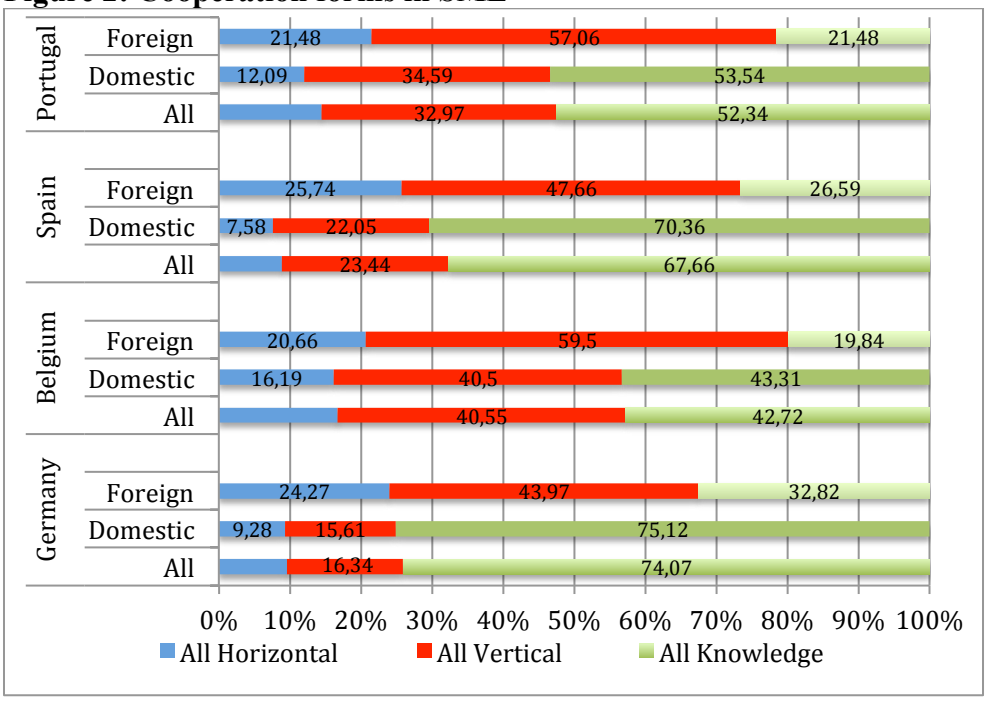


The share of SMEs who are engaged in cooperation reflects this pattern, as can be seen in column 2. The highest share of SMEs that have cooperation partner is in Portugal with 35 % while Belgium has the lowest share with around 18 %.

However, innovative SMEs seem to be more inclined to cooperate as is shown in column 3. Here, Germany stands out with a share of 44 % of innovative SMEs that have cooperation partners. Belgium stands out with only a share of 31 % of innovative SMEs pursuing cooperation strategies. The last column can be interpreted as the success of the cooperation activities. It shows the share of cooperating firms that introduced a product innovation. With the exception of Germany the share of cooperating SMEs that introduce a new or significantly improved product is over 60 %. However, in Germany the success rate seems to be relatively low with a share of about 50 %.

To better explain these differences we look if there are differences with regard to the cooperation partners SMEs choose. Figure 2 distinguishes between the different cooperation forms.

Figure 2: Cooperation forms in SME



With the exception of Belgium in all countries "knowledge sourcing" networks are by far the most important ones, followed by vertical networks. In Belgium the share of knowledge cooperation is remarkably lower than in the other countries and nearly as high as the share of vertical networks. Horizontal networks seem not to be very important in all countries. Distinguishing between domestic and foreign cooperation reveals that SME have mostly knowledge sourcing cooperation partners in the same country and engage in vertical networks in foreign countries. In addition, horizontal networks also become more important. One reason for the observed overall pattern –despite some differences in the share- across countries may be that most policy measures and initiatives focus on domestic collaboration and do not encourage international collaboration, as Ebersberger et al (2012) assume.

The empirical analysis examines the impact of those different cooperation forms on innovation probability and innovation performance of SME. It will also be distinguished between domestic and international collaboration.

5. Results

This section presents the results from our econometric analysis. Following our estimation strategy table 2 presents results from the Heckman model correcting for selection bias and treating collaboration (*co*) as exogenous. For each country, the first column presents the results from the selection equation while the second one displays results from the outcome equation. Since the focus of our analysis is of a comparative nature we focus on analysing similarities and differences between the four countries with regard to cooperation.

As can be seen in table 1 (column I), the estimated effect of cooperation on the probability of introducing a product innovation is positive in all countries with the exception of Portugal but statistically significant only in Belgium. However, the number of cooperation partners has a significant positive effect in all four considered countries, implying that not only engaging in cooperation activities is important for increasing the probability of introducing product innovation but also with whom and how many partners a firm cooperates. In common with the literature, international competition and openness have a (highly significant) positive effect of the probability of becoming an innovator. Support is only statically significant in Belgium and Spain.

Table 2: Heckman model: co = exogenous

	DEU		BEL		ESP		PRT	
	I (select)	II (outc)	I	II	I	II	I	II
Co	0.174	-0.033	0.502***	-0.024	0.107	0.010	-0.031	-0.004
Conumber	0.154**	0.07	0.130**	0.007	0.057**	0.021	0.115***	0.013
RDInt	3.224***	0.160**	1.918	0.443	0.040	0.095	3.059**	0.142**
Gp	-0.004	-0.034**	0.029	0.021	0.030	0.001	0.094	-0.009
Intcomp	0.470***	-0.048**	0.385***	-0.018	0.111**	0.097	0.089	0.028
Support	-0.089	0.029	0.518***	0.007	0.166***	0.146	0.105	-0.020
Openness	0.153***	-0.015**	0.049***	-0.011*	0.046***	0.030	-0.004	-0.017***
Size	-0.031		0.130		0.006		0.098	
Mills Lambda	9.48***		0.02		1.37		0.068	
Obs	2021	1583	1480	897	4463	2113	1314	592

Turning now to the results of the outcome equation displayed in column II, reveals some interesting results. Here, it is analysed if certain determinants have a real effect on the innovation success of SME, measured as the share of turnover from product innovations. Thus, while the results of the selection equation can be interpreted as the potential, the outcome equation shows if the potential can be realized.

As main result can be stated, that SME in all four European countries are not able to realize gains from engaging in cooperation activities or from cooperating with many partners. Both variables are always statistically not significant.

In addition, while international competition and openness may increase the probability of SME introducing product innovation, these determinants have a statistically significant

negative effect in Germany. In Belgium and Portugal openness has a statistically negative effect, too. Instead, investments in R&D do not only positively affect the probability of introducing innovation but also have a highly statistically significant effect on innovation intensity in Germany and Portugal while we find no such effects for Belgium and Spain.

The next step in our analysis consists in determining whether our results are biased with endogeneity.

Table 3 displays the results of the probit model with endogeneity in column I and a linear IV approach in column II, where we instrumentalize the cooperation variable and conduct standard endogeneity tests. While a limited number of papers recognize the need to correct for possible endogeneity they seldom check the validity of the chosen instruments that can be attributed to difficulties when the endogenous variable is a binary variable.

Our results suggest that our estimate of cooperation is likely to be biased in Belgium and Spain but not in Germany and Portugal in both the probit IV and the linear IV regression. However, we also conduct tests for the validity of the instrument in the IV regression. The F-statistic of the first stage reveals that our chosen instrument is only valid for Germany and Portugal but not for Belgium and Spain with a value higher that 10.

Table 3: endogenous Probit and IV: co = endogenous

	DEU		BEL		ESP		PRT	
	I (probit)	II (IV)	I	II	I	II	I	II
Co	-0.854	0.148	3.858***	-21.527	2.303***	-18.961	-2.880*	-0.071
Conumber	0.485*	-0.060	-0.781***	4.660	-0.627***	5.320	0.757**	0.032
RDInt	2.921***	0.083	-0.478	2.645	-0.013	0.206	1.780	0.201**
Gp	-0.001	-0.011**	-0.191**	1.701	-0.086*	0.880	0.237**	-0.003
Intcomp	0.486***	-0.087	0.095	-1.045	0.068	-0.761	0.150**	0.029
Openness	0.159***	-0.028	0.015	-0.141	0.025**	-0.264	-0.005	-0.004**
Size	0.033		0.085		0.040		0.080	
Wald-Exogeneity-Test	1.49		16.30		15.88		1.00	
F-Test Instrument		76.65		0.44		0.99		23.77
Durbin-WU-Test		1.25		9.157***		11.55***		0.001
Obs	2035	2021	1480	1480	4463	7946	1314	1883

Instrument: Support; industry-dummies included, dep. Variable(1): newmkt; (II) turnmar.

Qualitatively, the results in the outcome equation remain the same after correcting for endogeneity. Cooperation remains in all four countries statistically insignificant although the magnitude of the coefficient drastically increases and changing its sign in Germany and Spain. However, there are some changes in the selection equation: The cooperation variable changes its sign in Germany but remains non significant and the negative coefficient is now weakly statistically significant in Portugal. However, the quantitative interpretation of the coefficients in both estimations gives rise to concern since the magnitude of the coefficients has increased although the estimates should be biased downwards. More innovative firms

should be more likely to cooperate thus endogeneity corrected estimates should be lower. According to Robin and Schubert (2013) this parameter inflation problem is often observed with IV methods in finite samples and can occur even when the instruments pass the instruments validity tests.

Since the estimations where our instruments seem to have enough explanatory power, do not reject the null hypothesis of exogeneity of cooperation we do not control for endogneity in the last part of our analysis.

Here, we depart from the assumption that all cooperation partners are of the same nature. In the following estimation, we first distinguish between horizontal, vertical and knowledge source cooperation, and in a second step further distinguish whether the cooperation is with partners in the same or from a foreign country.

The results of the selection equation are displayed in table 4 while the results of the outcome estimation are presented in table 5.

Table 4: Dependent Variable: newmkt; selection equation

	DEU		BEL		ESP		PRT	
	I	II	I	II	I	II	I	II
networkHorz	-0.091		0.399**		0.104		0.142	
networkVer	0.363***		0.533***		0.156***		0.256**	
networkKnow	0.381***		0.334*		0.098*		0.109	
networkHorzIN		0.020		0.605***		0.150		0.263*
networkVerIN		0.358***		0.441***		0.143**		0.092
networkKnowIN		0.337***		0.283		0.122**		0.091
networkHorzFOR		-0.323		-0.362		0.065		-0.133
networkVerFOR		0.065		0.472***		0.057		0.269**
networkKnowFOR		0.350		0.454		-0.175		0.022
RDInt	3.290***	3.204***	1.945	1.800	0.046	0.053	3.106***	3.196***
Gp	-0.009	-0.004	0.054	0.049	0.038	0.041	0.104	0.102
Intcomp	0.478***	0.474***	0.389***	0.401***	0.111**	0.113**	0.082	0.069
Support	-0.070	-0.067	0.539***	0.556***	0.177***	0.175***	0.116	0.110
Openness	0.149***	0.149***	0.050***	0.050***	0.048***	0.048***	-0.002	-0.002
Size	-0.024	-0.016	0.126	0.106	0.006	0.007	0.100	0.101
Mills Lambda	8.19***	7.69***	0.01	0.61	1.341	1.105	0.053	0.048
Obs	2053		1480		4463			1314

Industry-dummies included. Standarderrors are available upon request and are omitted to save space. Robust standard errors.

There are two main results obtained from the estimation: First, vertical networks, meaning cooperation with suppliers and customers, have in all considered countries a positive highly statistically significant effect on the probability of SMEs introducing product innovation. Second, the influence of horizontal networks and knowledge sourcing networks differs across countries.

Cooperation with competitors positively affects firms innovative probability only in Belgium. Knowledge sourcing networks are highly significant in Germany and weakly statistically significant in Belgium and Spain while having no influence in Portugal.

Distinguishing between home and foreign country networks shows that mostly cooperation with partners from the same country affects the probability of introducing a product innovation. However, there are some noteworthy exceptions: In Belgium both the coefficients of home and foreign country vertical networks are statistically highly significant. In Portugal, the positive effect for vertical networks seems to come mainly from foreign vertical cooperation's since the estimated coefficient is highly significant. In addition, distinguishing between home and foreign networks increases the statistically significance of the coefficient of domestic horizontal cooperation which is now significant at the 10% level while the coefficient of foreign horizontal cooperation is negative albeit statistically not significant.

We turn now to the question whether SMEs can capitalize from the chances and be in fact innovators. The results from the outcome equation are displayed in table 5. Here, we can observe some remarkable differences when distinguishing between different kinds of networks.

Table 5: Dependent Variable: turnmar; outcome equation

	DEU		BEL		ESP		PRT	
	I	II	I	II	I	II	I	II
networkHorz	0.085*		0.046		0.021		0.021	
networkVer	0.003		-0.026		0.078		0.030	
networkKnow	-0.057**		0.013		0.068		-0.002	
networkHorzIN		0.046		0.064		0.049		0.017
networkVerIN		-0.010		-0.037		0.036		0.019
networkKnowIN		-0.052**		0.033		0.075		-0.006
networkHorzFOR		0.010		-0.055		-0.021		0.017
networkVerFOR		0.005		0.036		0.053		0.017
networkKnowFOR		-0.007		-0.124*		-0.164		0.034
RDInt	0.169**	0.170**	0.418	0.331	0.100	0.098	0.138*	0.136*
Gp	-0.030*	-0.032**	0.021	0.017	0.007	0.003	-0.007	-0.011
Intcomp	-0.045**	-0.044**	-0.014	-0.018	0.097	0.082	0.027	0.026
Support	0.037*	0.040*	0.005	-0.007	0.149	0.123	-0.017	-0.023
Openness	-0.012**	-0.012**	-0.011*	-0.126**	0.030	0.023	-0.016***	-0.017***
Obs	1610		897		2113		592	

Industry-dummies included. Standarderrors are available upon request and are omitted to save space. Robust standard errors.

While the results in table 2 seemed to suggest that cooperation in general or the number of cooperation had no statically effect on innovative sales, now, a different picture emerges.

For Portugal, the results don´t change where we can´t observe any statically significant effect of any kind of cooperation. In contrast, we observe a significant positive effect of the average horizontal network but also a negative significant effect from knowledge sourcing networks in

Germany, which seems to derive mainly from home country networks. While we can´t observe any effect for the average kind of network we find a weak negative significant effect for foreign knowledge sourcing cooperation in Belgium.

Although mostly not discussed, negative coefficients of networks –especially for outcome regressions- are not uncommon. They show whether a SME can translate its innovative probabilities in an actual economic turnover. Since especially SME face more constraints than large firms due to their "liability of smallness" the occurred costs of monitoring and coordinating the cooperation activities may be higher than the expected gains, thus leading to inefficient results. In contrast, the highly statistically significant coefficient for R&D expenditures in Germany and Portugal demonstrates that those two countries main gain more from internal R&D spending than from external cooperation where there is always the danger that core knowledge is leaked.

6. Conclusion

The purpose of the current paper was to analyse whether and which forms of cooperation have an effect on the probability as well as on the sales of product innovations of SMEs in Belgium, Germany, Spain and Portugal.

Empirically we contribute to the literature by accounting not only for selection bias but also test for simultaneity bias of the cooperation variable, which is rarely done.

Our results imply first, that that not only engaging in cooperation activities is important for increasing the probability of introducing product innovation but also with whom and how many partners a firm cooperates since the number of cooperation partners has a significant positive effect in all four considered countries but not the cooperation variable.

However, we find that SME in all four European countries are not able to generate innovative turnover from engaging in cooperation activities or from cooperating with many partners. Implying, that the actual costs associated with cooperation partners may be higher than the expected gains.

Correcting for endogeneity does not change these results. But we want to highlight the importance of testing for the relevance of the chosen instrument in the IV approach. Our conducted tests reveal that suitable instruments do not reject endogeneity while unsuitable ones do this.

Distinguishing between the different cooperation forms leads to three main results: First, vertical networks have in all considered countries a positive highly statistically significant effect on the probability of SME introducing product innovation. Second, the influence of

horizontal and knowledge sourcing network differs across countries. Cooperation with competitors positively affects firms innovative probability only in Belgium. Knowledge sourcing networks are highly significant in Germany and weakly statistically significant in Belgium and Spain while having no influence in Portugal. Distinguishing between home and foreign country networks shows that mostly cooperation with partners from the same country affects the probability of introducing a product innovation. However, the positive effect is driven by cooperation in the home country in Germany and Spain while it comes from cooperation with foreign countries in Belgium and Portugal.

Third, our results suggest again that SME are not able to capitalize from those cooperation's in the considered countries. We find a significant and positive effect of horizontal cooperation on sales due to product innovation only in Germany.

As far as policy implications are concerned, our results demonstrate the importance of country characteristics and the different institutional set-ups among the considered four countries. Further research is needed, how policy interventions affect and which environment is needed that SME not only have a high probability to introduce product innovation but also can generate sales due to it. Here, comparisons between SMEs and large firms may be useful.

As SME are heterogeneous another empirical approach like quantile regressions, may also be fruitful to analyze which kind of firm is able to economically gain from cooperation in order to arrive at more precise policy recommendations.

References

Becker, W. and J. Dietz (2004): "R&D cooperation and innovation activities of firms—evidence for the German manufacturing industry", Research Policy 33, pp. 209-223.

Belderbos, R., M. Carree, B. Diederen, B. Lokshin and R. Veugelers (2004): "Heterogeneity in R&D cooperation strategies", International Journal of Industrial Organization 22, pp. 1237-1263.

Brandenburger, A.M & Nalebuff, B.J (1996) *Co-opetition*. New York: Currency/Doubleday

Caloghirou, Y., Ioannides, S. and Vonortas, N. S. (2003): "Research Joint Ventures", Journal of Economic Surveys, 17, pp. 541–570.

Chiburis, R., J. Das and M. Lokshin (2012): „A practical comparison of the bivariate probit and linear IV estimators" Economics Letters, 117 (3), pp. 762–766.

Czarnitzki, Dirk; Ebersberger, Bernd; Fier, Andreas (2007): „The relationship between R&D collaboration, subsidies and R&D performance: Empirical evidence from Finland and Germany", *Journal of Applied Econometrics* 22 (7), pp. 1347–1366.

Debackere, K. and R. Veugelers (2005): "The role of academic technology transfer organizations in improving industry science links", Research Policy 34, pp. 321-342.

De Marchi, V. (2012): "Environmental innovation and R&D cooperation: Empirical evidence from Spanish manufacturing firms", Research Policy 41, pp. 614-623.

Ebersberger, B., C. Bloch, S. Herstad, and E. Van de Velde (2012). "Open Innovation Practices and Their Effect on Innovation Performance," *International Journal of Innovation and Technology Management*, (forthcoming).

de Faria, P., Lima, F., & Santos, R. (2010): "Cooperation in innovation activities: The importance of partners", *Research Policy*, *39*(8), pp. 1082-1092.

Faems, D., B. van Looy and K. Debackere (2005): "Interorganizational Collaboration and Innovation: Toward a Portfolio Approach", Journal of Product Innovation Management 22, pp. 238-250.

Freel, M.S & Harrison, R, T (2006): "Innovation and Cooperation in the Small Firm Sector: Evidence from Northern Britain", *Regional Studies*, 40, 289-305

Fritsch, M. and F. Grit, (2004): "Innovation, regional knowledge spillovers and R&D cooperation," Research Policy Vol. 33(2), pp. 245-255.

Griffith, R.,E. Huergo, J. Mairesse, B. Peters (2004): "Innovation and Productivity across four European Countries", Oxford Review of Economic Policy 22(4), pp. 483-498.

Gronum, S., M.-L- Verreynne and T. Kastelle (2012): "The Role of Networks in Small and Medium-Sized Enterprise Innovation and Firm Performance", Journal of Small Business Management 50(2), pp. 257-282.

Lasagni, A. (2012): “How can External Relationships enhance Innovation in SMEs? New Evidence for Europe”, Journal of Small Business Management 50(2), pp. 310-339.

Liu, W.-H. (2008): “Do Active Innovation Policies Matter? – Findings from a Survey on the Hong Kong Electronics SMEs“, Kiel Working Paper No. 1445, September.

Mairesse, J., and P. Mohnen (2010): “Using Innovation Survey for Econometric Analysis,” in *Handbook of the Economics of Innovation Volume 2*. Eds. B. H. Hall and N. Rosenberg. Amsterdam; Boston: North Holland, 1130–1155.

Martin, S., 2002. Spillovers, appropriability, and R&D. Journal of Economics 75 (1), pp. 1–32.

Nieto, M. J. and L. Santamaria (2010): “Technological Collaboration: Bridging the Innovation Gap between Small and Large Firms”, Journal of Small Business Management 48(1), pp. 44-69.

Quintana-Garcia, C & Benavides-Velasco, C.A. (2004) Co-operation, competition and innovative behaviour: a panel data of European dedicated biotechnology firms’, *Technovation*, 24, 927-938

Robin, S., Schubert, T. (2013): “Cooperation with Public Research Institutions and Success in Innovation: Evidence from France and Germany, Research Policy”, Vol. 42, pp. 149-166.

Rogers, M. (2004): “Networks, Firm Size and Innovation”, Small Business Economics 22, pp. 141-153.

Romer, P. M. (1990): “Endogenous technological change”, Journal of Political Economy, 98, S71–S102.

Schumpeter, J.A. (1934): “*The Theory of Economic Development*.” Cambridge, MA: Harvard University Press.

Schumpeter, J.A. (1942): “*Capitalism, Socialism and Democracy*.” New York: Harper and Row.

Segarra-Blasco, A. and J.-M. Arauzo-Carod (2008): ”Sources of innovation and industry–university interaction: Evidence from Spanish firms“, Research Policy 37, pp. 1283-1295.

Spithoven, A., Vanhaverbeke, W., Roijakkers, N., (2013): “Open innovation practices in SMEs and large enterprises”, Small Business Economics 41 (3), 537–562.

Tomlinson, P. R. and Fai, F. M. (2013): “The nature of SME co- operation and innovation: a multi-scalar and multi-dimensional analysis”, International Journal of Production Economics, 141 (1). pp. 316-326.

Veugelers, B. and B. Cassiman (2005): “R&D cooperation between firms and universities. Some empirical evidence from Belgian manufacturing“, International Journal of Industrial Organization 23, pp. 355-379.

Vivas, C. and Barge-Gil, A. (2014), IMPACT ON FIRMS OF THE USE OF KNOWLEDGE EXTERNAL SOURCES: A SYSTEMATIC REVIEW OF THE LITERATURE. Journal of Economic Surveys. doi: 10.1111/joes.12089

Zeng, S. X., X.M. Xie and C.M. Tam (2010): „Relationship between cooperation network and innovation performance of SMEs“, *Technovation* 30, pp. 181-194.