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Why do Firms Co-operate for Innovation? A comparison of Austrian and Finnish CIS 3 results

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Why do Firms Co-operate for Innovation?

A comparison of Austrian and Finnish CIS 3 results

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January, 2004

Abstract: This paper analyzes co-operative behavior of innovative firms in Finland and Austria. We use data from the third wave of the Community Innovation Survey (CIS 3). Descriptive statistics indicate that the rate of innovators is quite similar in Austria and Finland, while the number of co-operating enterprises is considerably higher in Finland. Econometric analysis reveals that a number of factors that determine co-operative arrangements are only significant in the one or the other country. We conclude that co-operative behavior in the two countries is much more dependent on national factors and much deeper rooted in the underlying innovation systems than the existing literature may assume.

Key Words: co-operation, CIS 3, Austria, Finland
JEL Codes: O310, L240

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1 Introduction

This paper analyzes co-operative behavior of innovative firms in Austria and Finland with data from the third wave of the Community Innovation Survey (CIS 3). Successful innovation is increasingly recognized as requiring the convergence of many sources of knowledge and skills, usually linked in the form of a network. Various empirical evidence for the superior innovation performance of co-operating companies can be found among others in Freeman et al. (1972), Maidique and Zirger (1984), Gemunden et al. (1992), Palmberg et. al (1999), Czarnitzki and Fier (2003).

Today, few innovations can be assigned to a single specific technological field or even a specific firm (e.g. Klein, 1992). Accordingly, firms cannot expect to keep pace with the development of all relevant technologies without drawing on external knowledge sources. In this respect, innovation co-operations today are widely considered as an efficient mean of industrial organization of complex R&D processes. In most of the recent research on industrial economics and new innovation theory the increasing complexity of knowledge, the accelerating pace of the creation of knowledge and the shortening of product life cycles are considered to be responsible for the rising importance of innovation networks (Malerba 1992, Eliasson 1995). Mechanisms of learning and knowledge creation play a decisive role in the emergence of networks of R&D co-operations. In this light, co-operations are to be considered as a component of the emerging knowledge based society, in which knowledge is crucial for economic growth and competitiveness. In the knowledge based society not only the quantity of knowledge used is greater but also the mechanisms of knowledge creation and utilization are changing. Aside from the direct effect of collaboration for innovation for the participating partners there are indirect effects of knowledge diffusion that are increasingly recognized in the tailoring of innovation policy measures targeted to increase the collaboration propensity of companies. Evidence for the creation of large spillovers through publicly induced collaboration can be found in Lerner (1999) or Audretsch et al (2002).

The paper is structured as follows: Chapter 2 provides a brief theoretical background of the ongoing discussion on co-operative behavior. Chapter 3 gives some descriptive features of the dataset that is examined. An econometric analysis of the co-operative behavior is delivered in chapter 4. Chapter 5 summarizes the main findings and concludes with some directions for future research.

2 Theoretical background

In recent discussions of co-operative behaviour in the theoretical literature focusing on the theory of the firm, the knowledge-based view, as well as the resource-based view are increasingly criticised due to their emphasis of firm specific capabilities only. Although both views emphasize that firms do have dynamic capabilities in order to sustain their competitive advantage, a lack has to be ascertained with respect to the explanation how these sources of competitive advantage are built up. The reason for this can be seen in the neglect of the firms' network of external relationships. As a consequence of this critic the so-called relational-based view of the firm (Dyer and Sing 1998) has emerged which focuses on inter-firm relationships as a source of competitive advantage. According to this view competitive advantages cannot be generated by a firm in

isolation but only in collaborative relationships with other actors, namely other firms (including competitors) but also institutions which were created with the purpose of knowledge generation (i.e. universities and public research laboratories), as well as vertically linked actors (as suppliers and customers). These co-operations are characterized by intensive knowledge exchange and learning processes basically by the combination of complementary assets as well as the realisation of synergies.

Empirical investigations of R&D collaborations (see e.g. Hagedoorn and Schakenraad (1989) and Vonortas, Caloghirou and Ioannides (2003) for an excellent survey) have identified a number of motives for firms joining these collaborations. Furthermore, the empirical investigations also show that R&D collaborations are not uniquely distributed among firms with respect to different industries, regions and countries but show rather specific patterns. With respect to the motives of firms to enter into collaborations, the aim of our paper is to compare two different economies and to explore country specificities. This finally should also allow us to shed some light on the functioning and organisation of the particular national innovation system.

In order to reduce the large number of different motives and reasons for firms collaborating in R&D the different motives and characteristics explaining collaborative behaviour can be grouped into sectoral, company, strategic and political characteristics. Furthermore, a firm's propensity to collaborate is also determined by the firm's management of appropriability as well as its intentions and targets pursued while joining a collaboration.

On the sectoral level, the propensity to collaborate is influenced by the technology intensity of the sector. Due to the higher degree of complexity (Malerba and Orsenigo 1993) as well as a faster speed of knowledge generation and utilisation processes (Pyka and Saviotti 2002) collaborative behaviour is more likely in industries which can be characterized as high technology industries (Dodgson 1994). In order to introduce novelties to the market firms are compelled to focus on their core competencies and collaborate with other actors who are offering the necessary complementary assets. The industrial organization of the sector also influences the collaboration behaviour of its firms. The most relevant category in this respect is the intensity of competition within the industry. It is argued that industries characterized by a high degree of intensity in competition are less likely to show cooperative behaviour (Von Hippel 1989) as leaking knowledge leading to minor innovations could give rise to decisive competitive advantages. Moreover, the identification of appropriate collaboration partners is easier in sectors with only a few large firms. High competitive intensity may be associated with reduced search costs and higher propensity to collaborate. Finally, also the appropriability conditions on the industry level are considered relevant. In industries characterized by low appropriability conditions technological spillover effects can be seen as the decisive source of external knowledge. In the case of higher degrees of appropriability, however, the firms do get access to external knowledge only via collaboration (Pyka 2002). Here, successful knowledge transfer is crucially linked to communication and mutual learning processes; simple imitation is not possible (Winter 1987).

Beside the industry characteristics, firm specific characteristics such as size and export orientation, also determine firms' collaborative behaviour. Larger firms having their own R&D departments are supposed to be engaged more actively in R&D collaboration as they can devote

the necessary resources for partner search etc. Furthermore, firms who sell large parts of their production abroad are also more likely to be engaged in R&D collaboration. Thereby, it is implicitly assumed that in highly industrialized countries export activities are strongly influenced by the international technological competitiveness (Kang and Sakai 2000).

Closely related to firm characteristics is the third group of influences relating to the strategic design of a firm's R&D activities. Of course, the absolute amounts of R&D expenditures as well as their persistence are supposed to be positively correlated with the willingness of firms to join a R&D partnership. Additionally, firms do follow different strategic orientations with respect to the design of their R&D activities. Some firms rely basically on their own R&D efforts without considering other knowledge sources seriously, whereas other firms choose a much broader R&D orientation considering also different external knowledge sources and the building up of absorptive capacities as relevant (Cantner and Pyka 1998).

Even though appropriability conditions are shaped by general features of the knowledge relevant for an industry and therefore can be considered as sectoral characteristics (Klevorick et al. 1995, Levin et al. 1987, Cohen et al 2000) a firm can influence the appropriability by employing measures to protect the generated knowledge. They can do so by making use of formal instruments such as patents and trademarks but they can also use more strategic and less formal instruments such as secrecy and lead time advantages. Those different means to ensure appropriability also influence the propensity of firms to join R&D collaborations e.g. in the biotechnology based industries there is an increasing trend in co-patenting (Pyka and Saviotti 2002) indicating that the possibility of joint and enforceable intellectual property rights is conducive to collaboration in these industries. On the more strategic side of appropriability management, increasing the complexity of design, secrecy, lead time advantages are among the most important means. In cases where these strategic means are considered to be effective in R&D co-operations also, they should have a positive influence on the collaboration decisions.

Increasing costs in R&D and an increasing innovation dynamics are among the most frequently mentioned reasons why firms join R&D collaborations (e.g. Hagedoorn and Schakenraad 1989). The different motives related to this discussion of overcoming knowledge and financial obstacles can be summarized under the group of targets and intentions for collaborative R&D. On the one hand firms are supposed to overcome economic hampering effects by sharing the costs of R&D in co-operations. On the other hand, cooperative R&D is supposed to give the actors access to larger spillover pools where knowledge is shared voluntarily (e.g. Nelson 1987) among the actors participating the cooperation. This is of particular importance if the knowledge is characterized as complex and/or tacit.

Finally, the decision of a firm to collaborate with other actors in R&D can also be influenced by policy measures. Meanwhile there exist on a national as well as on a European level a bunch of R&D subsidy programmes which are strongly connected to the prerequisite for the participants of performing collaborative R&D.

Besides these motives for collaboration from the viewpoint of industrial organization and industrial dynamics the literature on national innovation systems also highlights country

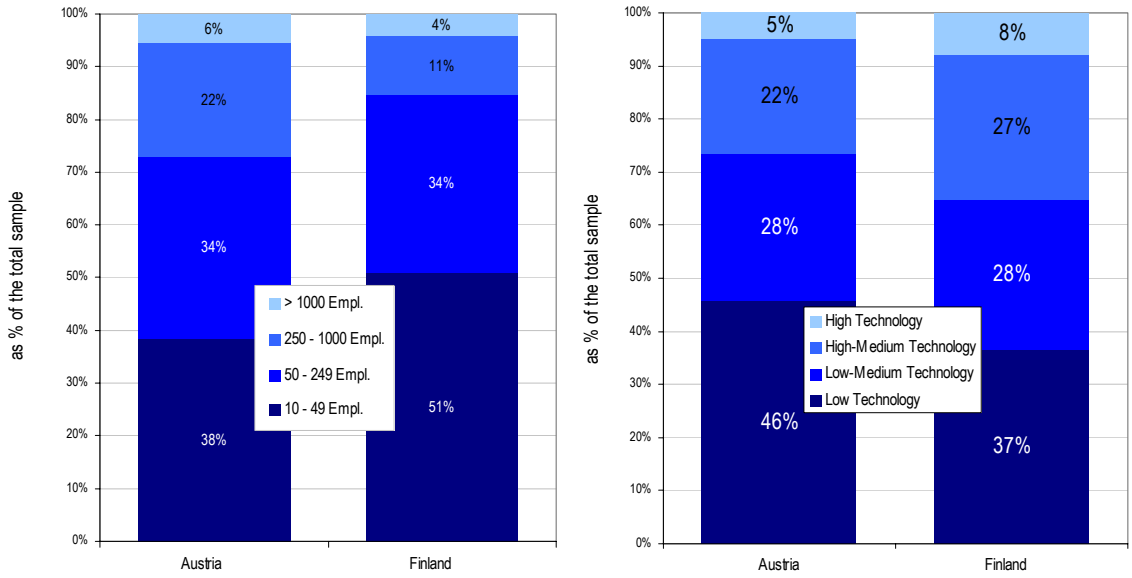
specificities for R&D collaboration (e.g. Lundval et al. 2002). Different national contexts are considered to be responsible for disparate possibilities for establishing organised markets and processes of interactive learning which might also be relevant for the differences to be observed between Austria and Finland.

3 Austria and Finland – Differences and similarities

The work is based on the first available results from the Third Community Innovation Survey (CIS 3) for Austria and Finland. The survey has been in 2001 and covers the period 1998 to 2000. In Austria and Finland, the survey has been and carried out by the two national statistical agencies, Statistics Austria and Statistics Finland organized who also provided the data for this study. We restrict our analysis to manufacturing enterprises (NACE 15-37).

The two samples[1] comprise of 453 (Austria) and 1,046 firms (Finland), respectively. The difference in sample size mainly originates form the number of small and medium firms (10 – 49, 50 – 248 employees, see Chart 1). In these two size classes the Finnish sample outnumbers the Austrian by more than 500 observations. On contrary, the sectoral composition of the two samples fits quite well. Classified by the OECD taxonomy of manufacturing industries based on technology (see OECD 2001), we just find a higher share of low technology firms in Austria and, vice versa, a higher share of high technology and high-medium technology enterprises in Finland.

Chart 1: Composition of the samples by size class and sector, Austria and Finland, 1998-2000



Source: Statistics Austria, Statistics Finland; own calculations

[1] Due to legal restrictions in the usage of the data, we were not allowed to pool all observations into a single sample.

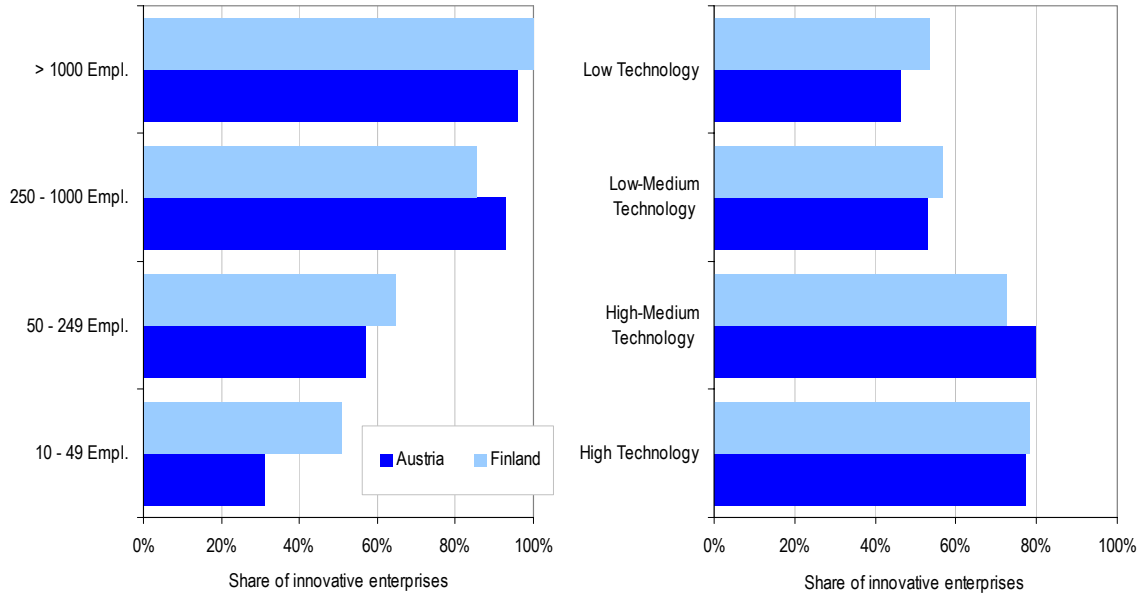
Innovative and co-operative behavior

The most basic indicator of innovative activity in the CIS survey is if the enterprise has "introduced any technologically new or significantly improved products or processes which were new to the firm", if such an introduction is still running of or if it has been abandoned. We treat all firms with successful product and process innovations and/or with running innovation processes as innovators.

Comparing the share of innovators, we find an approximately equal level of innovative activity in the two countries. The share of innovative enterprises is roughly the same (57% for Austrian enterprises vs. 61% for Finnish firms). We see only minor differences if we examine the share of innovators for different sectors and size classes (see .

Chart 2). The only exception is the scale of innovative activity in small enterprises (10 – 49 employees) which is considerably higher in Finland than in Austria.

Chart 2: Share of innovative enterprises in manufacturing by size class and sector, Austria and Finland, 1998-2000



Source: Statistics Austria, Statistics Finland; own calculations

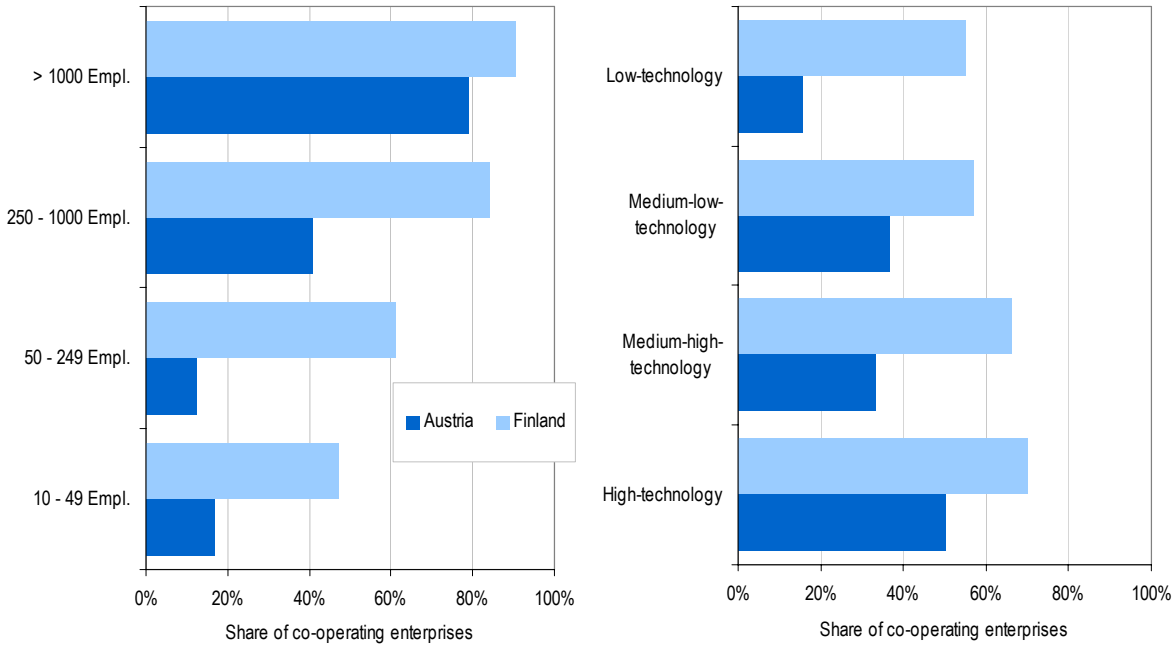
Austrian and Finnish enterprises, however, differ considerably if we turn to co-operative behavior. The CIS questionnaire asks for co-operative arrangements[2] only if the enterprise has reported innovative activity. In Finland, 61% of all innovators (37% of all enterprises) have entered in a co-operative arrangement. The rate drops to 29% (17% with regard to the total number of enterprises) in Austria. In other words, the probability to find a co-operating enterprise in the Finnish sample – given a comparable propensity to innovate - is two times higher than in the

[2] The exact wording is: 'Did your enterprise have any co-operation arrangements on innovation activities with other enterprises or institutions in 1998-2000?'

Austrian one. Especially, we find a considerable higher number of co-operators among small and medium-sized enterprises and a higher propensity of Finnish firms to co-operate in all sectors of the OECD classification (see Chart 3).

A first hint to the reasons for such big differences is given by the partner structure of co-operating firms in Austria and Finland (Chart 4). The largest differences between Finland and Austria can be found in the number of co-operations within the market. Finnish enterprises enter into co-operations with suppliers and customers more frequently than their Austrian counterparts. The only type of business co-operation that can be found more often in Austria than in Finland are co-operations with competitors. We also find differences in the propensity to co-operate with consultants and public labs[3]. Science-industry-relations, on the other hand, seem to be equally close in both countries.

Chart 3: Share of co-operating enterprises in manufacturing by size class and sector, Austria and Finland, 1998-2000

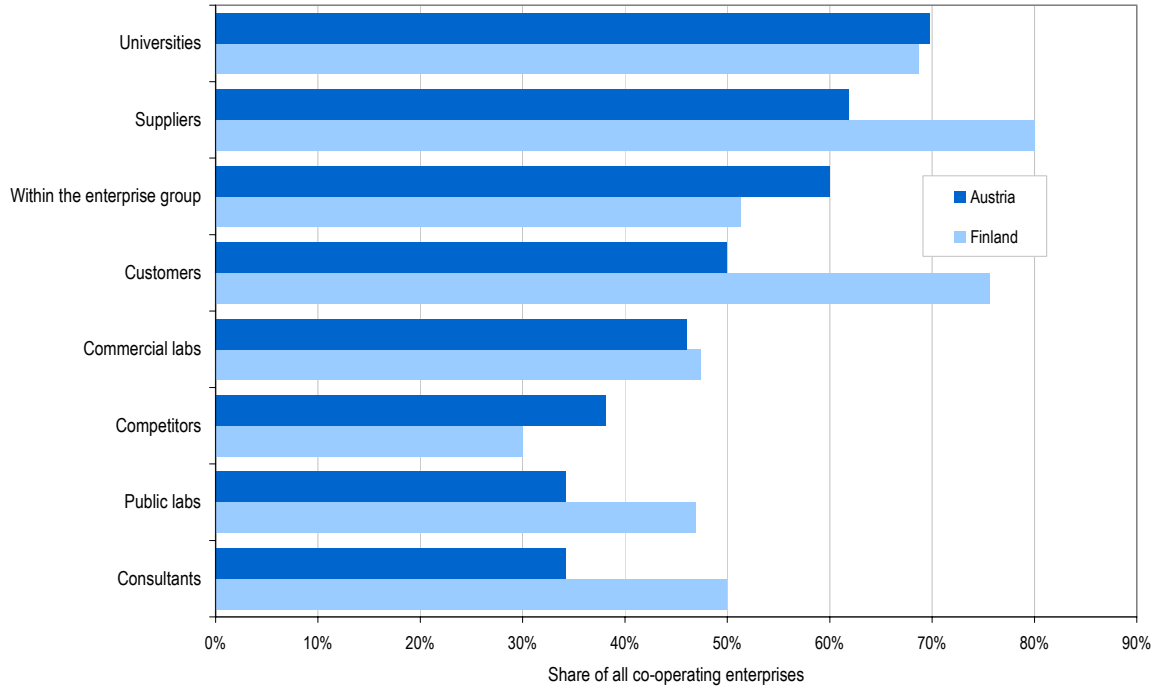


Base: Innovators

Source: Statistics Austria, Statistics Finland; own calculations

[3] An explanation may be that the public labs have a much higher significance and size in Finland than in Austria. VTT, the largest public lab in Finland, employs about 3,000 people, while Austrian Research Centers, only has 700 employees. Other public labs in Austria are even smaller.

Chart 4: Partners of co-operating enterprises, Austria and Finland, 1998-2000



Base: Innovators; co-operations with more than one partner possible

Source: Statistics Austria, Statistics Finland; own calculations

4 Econometric analysis

The differences in co-operative behavior between Finland and Austria presented in chapter 3 are confusing because the existing literature offers only little explanation for the vast differences observed. Therefore, we want to explore national patterns of collaboration for both the Finnish and the Austrian sample by econometric analysis in order to identify the main influences for the co-operative behavior in the two countries.

4.1 Variables in the analysis

In the following section we endeavor to find patterns in the collaboration behavior in Austria and Finland. We introduce the dependent variables for the analysis below. According to the previous discussion we group the independent variables in our analysis into six different groups that represent the underlying level of influence and focus of the variables.

4.1.1 Innovation and collaboration

The dependent variables represent both the innovation behavior as well as the collaboration behavior of the companies. The variable about innovation activity (INNOV) contains the information whether companies introduced a product innovation or a process innovation, conducted R&D or abandoned ongoing R&D projects. INPDT and INPCS indicate product and process innovators, respectively. The variables about collaboration behavior contain information

about the collaboration partner regardless of whether the partner is domestic or international. The variables used in the analysis below are summarized in Table 1.

Table 1: Independent variables

Variable	Description
INNOV	Dummy for innovation activity
INPDT	Dummy for product innovation
INPCS	Dummy for process innovation
COGEN	Dummy for collaboration with any partner
COSUP	Dummy for collaboration with a supplier
COCUS	Dummy for collaboration with customers
COCOM	Dummy for collaboration with competitors
COUNI	Dummy for collaboration with universities or research institutes

4.1.2 Sectoral characteristics

The independent variables describing characteristics of the sector of the firm's activity are the sector classification, the industry structure, the sectoral innovation dynamics and the sectoral level of outgoing spillovers. We characterize the sectors by their technology intensity (OECD 2001, Annex). The analysis below will assume low technology manufacturing as the basis sector. To capture the effects caused by the industry structure we include the average size of the enterprise in the industry (SIZEAV). The velocity of innovation dynamics is approximated by the number of market novelties as a fraction of the number of product innovations in the sector (SPEED). The construction of the innovation dynamics variable follows Belderbos et al (2003). We also construct a variable indicating the appropriability conditions in a sector. As the appropriability conditions cannot be directly observed as a proxy the companies appreciation of competitors as a knowledge source for innovation is used. Weak appropriability conditions coincide with a high appreciation of the competitor as an information source. APPCON is the average importance of competitors as an information source in a sector. We construct the variable on the basis of the 2-digit industries. The construction is in line with the indicator for outgoing spillovers in Belderbos et al. (2003).

4.1.3 Policy and funding

The national and international policy influence on collaboration is represented by the funding variables. The variables FUNGMT and FUNEU indicate funding from the national government and from the EU.

4.1.4 Company characteristics

The companies are characterized by the size, the export orientation and the affiliation to a group of enterprises. The size of the company is captured by the number of employees; according to the conventional practice we include the natural log of the size in the regressions. We include the share of exports on turnover of the companies to approximate the export orientation of the companies. This strikes us as particularly important as we compare two small open economies. Furthermore, an external orientation of an economy is likely to be accompanied by a potential

access to foreign external knowledge sources. Veugelers and Cassiman (2002) include the export share such as to proxy the competitiveness of the enterprises.

4.1.5 R&D strategy

The characterization of the R&D process, which collaboration is a part of, is achieved by the sheer magnitude of the R&D efforts, their diversity, their endurance, and the targeted innovations such as process innovations or new products to the markets.

To capture firm level heterogeneity concerning the intensity by which innovation activities are pursued we include the total sum of innovation expenditure as a fraction of turnover. We include the R&D intensity squared to account for a non linear impact on the probability to collaborate. Belderbos et. al (2003) argue that increasing R&D intensity and a positive impact on collaboration can be closely related to absorptive capacities (e.g. Cohen and Levinthal, 1990). From a certain point on increasing R&D intensity indicates to more basic research or to idiosyncratic internal R&D. We also include a dummy indicating the permanent engagement in R&D activities (cf. Cassiman and Veugelers 2002).

Furthermore, we include a measure to indicate the diversity of innovation activities pursued by the individual company. According to the Oslo manual (OECD 1997) the innovation activities are broken down into (i) *intramural research & experimental development*, (ii) *acquisition of R&D (extramural R&D)*, (iii) *acquisition of machinery and equipment*, (iv) *acquisition of other external knowledge*, (v) *training*,(vi) *market introduction of innovations* and (vii) *design & other preparations for production/deliveries*. Categories (v) to (vii) are covered in the innovation surveys in a composite category.

We use an entropy measure to summarize the diversity of the innovation activities of the companies:

$$RDDIV_i = \sum_{j \in \{1...5\}} p_{ji} \cdot \log(p_{ji}) \qquad (1)$$

where p_{ji} is the expenditure for the *j*th category of innovation activities as a fraction of the total sum of innovation activities of firm *i*.[4]

We include the innovation result in two variables. INMAR codes the introduction of a product innovation that is new to the market, whereas INPCSO indicates companies which introduced process innovations. Although product or process innovations are both the result of the innovation process and of the collaboration, it can be argued that it is the search for certain types of innovations that drove the companies to collaborate with one type of partner or the other. As such, INMAR and INPCSO reflect the desired innovation and the collaboration the means to achieve it. INMAR then indicates the companies' ambition to introduce novelties, where INPCSO reveals a strong cost awareness and the desire to reduce costs (cf. Frisch and Lukas 2001, Tether 2002).

[4] For computational ease log (0) has been defined to be 0.

4.1.6 Management of appropriability

The management of the collaboration is characterized by the utilization of strategic and formal protection mechanisms.

As firms are actively protecting their innovations in various ways the efforts to strategically protect the innovations are included in the variable PROTS. The more formal protection activities are captured in the variable PROTF. The strategic methods comprise of (i) secrecy (ii) complexity of design (iii) lead-time advantage. The more formal methods of protection include (i) patents, (ii) design patterns, (iii) trademarks, (iv) copyrights**.** The value of the protection variables indicates the fraction of methods used by the companies.

4.1.7 Targets and intentions

Collaboration is commonly associated with a knowledge sharing or a cost sharing motive. The targets and motives for collaboration can be derived from the perceived shortages in financing or knowledge or by the knowledge flows that informally spillover from or into the company and its utilization.

As also suggested by the Oslo manual (OECD 1997) the factors hampering the innovation activities in companies are summarized by *economic factors* and *internal (enterprise) factors*. For both categories we created a variable indicating the severity of the factors by summing up the companies assessment of the severity of the sub-categories (0 to 3) and dividing the sum by the number of sub-categories. Hence, the variables HAMPECO and HAMPINT are bound below by zero and bound above by 1. This procedure is justified by a factor analysis showing that indeed the categories bundled in the OSLO manual also showed a high correlation and constitute different factors.

Recent empirical research has increasingly tried to analyze the effects spillovers have on the companies propensity to collaborate (e.g. Kaiser 2002, Cassiman and Veugelers 2002, Hernan et. al. 2003). The literature follows two different approaches. The first approach establishes a spillover pool which defines the source of the spillovers. The magnitude of the spillover a company receives depends on the companies distance to the spillover pool. Various concepts exist to approximate the distance to the spillover pool (Kaiser 1999, Jaffe 1986 and Jaffe 1988). In studying the collaboration for R&D, Kaiser (2002) follows the first approach. The second approach is more subjective from the surveyed firms' point of view. It refers to the firms' assessment of the importance of different sources of information for the innovation. As the question does not target to formal relationships with the sources of information it also covers information that has been acquired through informal channels. Cassiman and Veugelers (2002) and Belderbos et. al. (2003) follow this approach. As it reflects the managerial decision for collaboration more closely we also follow the latter approach.[5]

[5] A third approach can be identified that bases on Mansfield (1985). It differs from the approaches above as it does not allow to compute firm specific spillovers. Depending on the industry it assigns sector specific spillovers on a 2- to 4-digit level. Henan et al. (2003) follow this approach.

We base our construction of incoming spillovers on the companies' assessment of the importance of certain information sources. These information sources are (i) *the enterprise itself*, (ii) *other enterprises within the same group*, (iii) *suppliers*, (iv) *customers*, (v) *competitors*, (vi) *universities*, (vii) *research institutes*, (viii) *professional conferences*, *journals* and (ix) *fairs and exhibitions*. The variables approximating the spillovers are constructed by summing up the importance of the sources (0 to 3) and dividing it by the number of sources involved. Hence the variables are bound below by zero and bound above by one.

SPILLVERT approximates the incoming vertical spillovers and refer to the sources (iii) suppliers and (iv) customers. The horizontal spillovers (SPILLHOR) are constructed on the basis of the source (v) competitors. Institutional spillovers (SPILLINST) capture the effects that originate from (vi) universities and (vii) research institutes. Belderbos et. al. (2003) use this construction of the incoming spillovers. We also include the spillover that originates from publicly available sources as suggested in Cassiman und Veugelers (2002). SPILLPUB is calculated on the basis of the companies' assessment of (viii) professional conferences & journals and (ix) fairs & exhibitions as information sources. All spillover variables give the difference between the industry mean (2-digit industries) and the company assessment of the spill over.

As far as collaboration is about knowledge sharing, the internal flow of knowledge within the enterprise should have an influence on the company's propensity to collaborate. The internal flow of knowledge is approximated by an indicator (INTKNO) constructed in the same way as the spillover variables above. It is based on the importance of internal knowledge sources for innovation.

With reference to Kamien and Zang (2000) and Cassiman and Veugelers (2002) we argue that companies which value sources associated with basic research and development more than sources of applied R&D benefit more from incoming spillovers. In this vein we include an indicator (UTILIZ) for the basicness of R&D in our analysis. It is the valuation of universities and research institutes as sources of information relative to the valuation of customers, suppliers and competitors as sources.

4.1.8 Summary of the independent variables used

Table 2 summarizes the independent variables in the analysis. It also gives the descriptive statistics for the variables for the Austrian and the Finnish sample.

Table 2: Summary of the independent variables

Variable	Description		AT	FI
GP	dummy for companies that belong to a group of companies	Mean	0.593	0.483
		Med.	1.000	0.000
		Max	1.000	1.000
		Min	0.000	0.000
EMPL	log employment of the company in the year 2000, in 1000 employees	Mean	5.159	4.136
		Med.	5.244	3.850
		Max	8.931	10.048
		Min	2.303	2.303
EXPSHR	export share of the company	Mean	0.483	0.389
		Med.	0.517	0.400
		Max	1.000	1.000
		Min	0.000	0.000
RDEXP	innovation expenditure as a fraction of the turnover	Mean	0.054	0.041
		Med.	0.023	0.006
		Max	1.000	1.000
		Min	0.000	0.000
RDDIV	index for diversification of the R&D efforts	Mean	0.599	0.321
		Med.	0.652	0.000
		Max	1.481	1.584
		Min	0.000	0.000
HAMPECO	index for the severity of economic hampering factors	Mean	0.525	0.223
		Med.	0.556	0.000
		Max	1.000	1.000
		Min	0.000	0.000
HAMPINT	index for the severity of internal hampering factors	Mean	0.378	0.217
		Med.	0.417	0.167
		Max	0.917	1.000
		Min	0.000	0.000
INTKNO	index for the internal knowledge flow	Mean	0.571	0.339
		Med.	0.500	0.333
		Max	1.000	1.000
		Min	0.000	0.000
UTILIZ	index for the basicness of R&D	Mean	0.729	1.108
		Med.	0.643	1.200
		Max	3.750	7.500
		Min	0.167	0.167
PROTF	index for the utilization of formal means of protection	Mean	0.347	0.199
		Med.	0.400	0.000
		Max	1.000	1.000
		Min	0.000	0.000
PROTS	index for the utilization of strategic means of protection	Mean	0.559	0.347
		Med.	0.667	0.333
		Max	1.000	1.000
		Min	0.000	0.000
FUNGMT	dummy for receiving public funding from governmental agencies	Mean	0.531	0.350
		Med.	1.000	0.000
		Max	1.000	1.000
		Min	0.000	0.000
FUNEU	dummy for receiving public funding from the EU	Mean	0.190	0.073
		Med.	0.000	0.000
		Max	1.000	1.000
		Min	0.000	0.000

Variable	Description		AT	FI
SPILLINST	index for incoming spill overs from universities and research institutes	Mean		0.000
		Med.		0.009
		Max		0.778
		Min		-0.410
SPILLVERT	index for vertical spillovers	Mean		0.000
		Med.		0.010
		Max		0.492
		Min		-0.611
SPILLHOR	index for horizontal spillovers	Mean		0.000
		Med.		-0.011
		Max		0.700
		Min		-0.542
SPILLPUB	index for spillovers from publicly available sources	Mean		0.000
		Med.		0.000
		Max		0.628
		Min		-0.486
APPCON	index for appropriability conditions in the industry	Mean	1.329	0.893
		Med.	1.385	0.923
		Max	2.500	1.625
		Min	0.000	0.000
TECHH	dummy for companies in a high technology manufacturing sector	Mean	0.066	0.078
		Med.	0.000	0.000
		Max	1.000	1.000
		Min	0.000	0.000
TECHMH	dummy for companies in a medium-high technology manufacturing sector	Mean	0.302	0.274
		Med.	0.000	0.000
		Max	1.000	1.000
		Min	0.000	0.000
TECHML	dummy for companies in a medium-low technology manufacturing sector	Mean	0.260	0.282
		Med.	0.000	0.000
		Max	1.000	1.000
		Min	0.000	0.000
RDENG	dummy for continuous engagement in R&D	Mean	0.558	0.393
		Med.	1.000	0.000
		Max	1.000	1.000
		Min	0.000	0.000
INMAR	dummy for product innovation new to the market	Mean	0.504	0.381
		Med.	1.000	0.000
		Max	1.000	1.000
		Min	0.000	0.000
INPCSO	dummy for process innovation only	Mean	0.143	0.066
		Med.	0.000	0.000
		Max	1.000	1.000
		Min	0.000	0.000
SIZEAV	average size of the company in the sector	Mean	69.115	68.398
		Med.	49.237	27.016
		Max	262.463	679.734
		Min	1.228	6.026
SPEED	speed of technological development in the sector or	Mean	0.574	0.745
		Med.	0.579	0.750
		Max	0.900	0.867
		Min	0.000	0.000

4.2 The econometric model

In the following multivariate analysis we use a quite straight forward econometric setup. We regress the probability of collaboration on the independent variables given in table 2.[6]

$$\Pr(y_i = 1 \mid x_i, \beta) = 1 - F(-x_i'\beta) \tag{2}$$

As the linking function F any function can be used which is continuous, strictly increasing function that takes a real value and returns a value in between zero and one. We use the cumulative distribution function for the logistic distribution and obtain the logit model:

$$\Pr(y_i = 1 \mid x_i, \beta) = 1 - \exp(-x_i\beta)/(1 + \exp(-x_i\beta)) = \exp(x_i\beta)/(1 + \exp(x_i\beta)) \tag{3}$$

where x_i is the vector of the independent variables for the *i*-th observation and β is the vector of coefficients.

We run the Logit regressions on the Austrian and the Finnish sample independently to obtain the parameters β_A and β_{FIN}. The parameter estimates can be compared according to their significance in both country regressions. However they do not give an estimate about the strength of an influence of the independent on the dependent variable as the linking function F is non linear. We compute the marginal effects of the independent variables and use those for the cross country comparison. The regression results in the following section report the marginal effects instead of the parameter estimates.

4.3 Results of the multivariate analysis

In this section we report the results of the multivariate analysis. In this setup we used the data as they are supplied. We do not employ a weighing scheme such as to make the sample representative for the companies in the given economies. We do not apply any correction here, as we recognize that the sample is only a small fraction of the whole population of businesses in Austria as well as in Finland, which makes any correction quite unreliable. Tether (2001, p. 7) argues that corrections may be misleading as due to the sampling methodology in the CIS firms the uncorrected distribution is closer to the real distribution in terms of economic significance.

4.3.1 Identifying innovators

The first step of the analysis is to identify the innovating firms from the total set of manufacturing firms.

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[6] As the collaboration question is posed only to companies that conduct some innovation activities i.e. product innovation, process innovation, abandoned or ongoing innovation projects see OECD (1997), we can only include firms with innov=1 in the collaboration regression. It cannot be reasonably assumed that the conducting innovation activities is a purely random event some selection bias may exist. To tackle the selection bias, we include the propensity score of the Logit regression identifying the innovators (as given in Table 3 below) in the set of independent variables (Olsen 1980). It is labeled INNOVPROB

Table 3: Identifying the innovators

	Innovators (INNOV)				Product Innovators (INPDT)				Process Innovators (INPCS)			
	Finland		Austria		Finland		Austria		Finland		Austria	
C	-0.438	***	-0.537	***	-0.508	***	-0.546	***	-0.536	***	-0.724	***
GP	-0.043		0.052		-0.022		0.035		-0.079	**	-0.022	
EMPL	0.110	***	0.111	***	0.101	***	0.080	***	0.100	***	0.120	***
LPROD	0.000	**	0.000		0.000		0.000		0.000		0.000	
EXPSHR	0.048		0.190	***	-0.012		0.198	***	0.003		0.154	**
TECHH	0.277	***	0.044		0.269	***	0.086		-0.034		0.038	
TECHMH	0.161	***	0.106	*	0.212	***	0.127	**	0.020		-0.006	
TECHML	0.044		-0.015		0.059		0.014		0.034		0.059	
SIZEAV	0.000		0.000		0.000		0.000		0.000		0.000	
Num of Obs	1046		453		1046		453		1046		453	
McFadden	0.0967		0.2503		0.0873		0.1964		0.0575		0.1932	
LR statistic	134.90		154.99		126.40		122.66		77.90		115.65	
Prob (LR stat)	0.0000		0.0000		0.0000		0.0000		0.0000		0.0000	

It turns out that the influence of firm size on the propensity to innovate is of comparable magnitude in both countries. In Finland we also experience that innovative behavior increases with technology intensity, a result that is in line with the theory. The propensity to engage in innovative activities and the propensity to launch a product innovation in Austria is ruled by an inverted u-shaped influence of the technology intensity. Innovative activities and product innovations are more likely in the medium high technology sectors than they are in the low technology and the high technology sectors. Moreover, the export share plays an important role for innovation in Austria. In neither of the countries the propensity to introduce process innovations is influenced by the technology intensity of the sector. In contrast to the Finnish experience the Austrian results reveal that the propensity to innovate increases with the export orientation of the companies.

4.3.2 Cooperation in general

From a theoretical point of view (see chapter 2), the decision to co-operate for innovation may be influenced by factors specific to a certain national innovation system as well as factors independently of the location of the firm.

Table 4: Results of the multivariate analysis

	Cooperation COGEN			
	Finland		Austria	
C	-0.517	***	-0.176	
INNOVPROB	0.007		0.224	
a.APPCON	-0.078		0.011	
a.TECHH	-0.019		-0.052	
a.TECHMH	0.018		-0.040	
a.TECHML	-0.010		0.231	***
b.FUNEU	0.174	**	0.111	*
b.FUNGMT	0.136	***	0.059	
c.EMPL	0.049	**	-0.102	
c.EXPSHR	-0.017		-0.046	
c.GP	0.017		-0.111	
c.RDENG	0.042		-0.036	
d.INMAR	0.090	**	0.026	
d.INPCSO	0.132	**	-0.014	
d.RDDIV	0.115	***	0.042	
d.RDEXP	0.643		1.134	*
d.RDEXP2	-1.106		-1.095	
d.SIZEAV	0.000		0.000	
d.SPEED	-0.144		-0.165	
e.PROTF	0.157	**	-0.030	
e.PROTS	0.090	*	0.058	
f.HAMPECO	0.150	**	0.098	
f.HAMPINT	0.016		-0.056	
f.INTKNO	0.105		0.146	
f.SPILLHOR	-0.211	***	0.238	**
f.SPILLINST	-0.108		0.129	
f.SPILLPUB	-0.011		0.131	
f.SPILLVERT	0.464	***	-0.104	
f.UTILIZ	0.135	***	0.162	*
Num of Obs	643		258	
McFadden	0.2791		0.3557	
LR statistic	240.57		109.35	
Prob (LR stat)	0.0000		0.0000	

We find only three factors that are significant for the co-operation in both countries. First, the **utilization of incoming spillovers** influences positively the propensity to cooperate in R&D. The associated variable UTILIZ is closely connected to the companies' assessment of basic research and development relative to applied research. The obtained result can also indicate that the more information companies exchange on basic issues rather than on issues concerning the immediate application of technologies, the more likely they are to collaborate. The further away the information exchange is from immediate application the more likely companies are to collaborate. This may also be an indicator for the companies' fear to exchange applied knowledge that may in turn leak to a competitor. Second, the results of the regression show that enterprises receiving **European Union funding** (FUNEU) tend to co-operate more frequently. As the framework programmes require joint research project, this result needs no further interpretation. Third, we see that **horizontal spillovers** (SPILLHOR) also matter significantly. However, the coefficients have opposite signs in Finland and Austria. Finnish companies receiving high spillovers from competitors are less likely to collaborate than companies that receive lower horizontal spillovers.

Yet, Austrian companies receiving high spillovers from competitors have a higher propensity to cooperate as compared to companies that receive less horizontal spillovers. This indicates that the informational gain through competitors substitutes for collaborative efforts in Finland. Whereas in Austria the information supplied by competitors is likely to be augmented by information and other resources from other collaboration partners.

A striking result is that the **sectoral affiliation** according to the OECD classification influences the propensity to collaborate differently in the two countries. Austrian firms in the medium-low technology manufacturing sectors have a higher propensity to collaborate for innovation than the all other sectors. Examples of these industries are coke and petroleum products, rubber and plastic products or basic metals and fabricated metal products. These industries still represent a higher-than-average share of manufacturing in Austria compared to other European countries, in particular compared to their weight within the Finnish industry. Their significance for co-operation may be explained by what the typical mode of innovation in Austria: A constant upgrading and improvement of products and processes in traditional industries, like the ones listed above. Steel producers, manufacturers of textiles or simple metal products increasingly have diversified downstream the value chain into semi-final products and became important suppliers for the electrical and electronics, consumer goods or the automotive industry. Evidence for this explanation has been delivered by the CIS 2 results (Leo 1999) and a number of case studies of innovative enterprises (Leitner 2003). Moreover, Dachs et al. (2003) have shown that Austrian enterprises in low and medium technology industries exhibit considerably higher R&D expenditures than their European competitors. This may have increased the need to cooperate for innovation.

Another factor which distinguishes Finland from Austria is the importance of **governmental funding** for co-operation. The corresponding variable is highly significant in Finland with a positive sign for the general model as well as for regression models of co-operation with suppliers, competitors, universities and research institutions. In Austria, however, the variable is insignificant for the general model as well as for co-operations with most partners. The only exceptions are co-operations with universities and research institutes and customers. Governmental funding is one of the variables, where national policy priorities and special features of the prevailing innovation system become most striking: Austria has done a lot in recent years to promote contacts between science and industry, but there is only little initiative at the national level to promote co-operative arrangements between innovating firms. Co-operation is not a requisite to receive grants from the promotion agencies for research and development, like the FFF or the ERP (see also Leo and Ziegler 2003). Activities to promote clustering of firms mainly exist at the level of provincial governments and the Austrian Economic Chamber, but have less financial means than national activities.

In Finland, on the other hand, strengthening of inter-firm networking and co-operation has been a priority of technology policy. The Trend Chart country report for Finland lists a number of measures towards this goal (see Kutinlahti and Oksanen 2003). The National Technology Agency (Tekes) is strongly committed towards fostering collaboration for R&D in Finland. Finland experiences a longer history with a collaboration targeted public funding policy than most of the other European countries, because since Tekes started its first technology program collaboration

has been a part of the financing principles. Tekes' notion of collaboration, however, is not focused on a special kind of collaboration; rather does it include a whole plethora of different types of networks covering the whole spectrum of activities from basic R&D up to marketing. It induces pre-competitive horizontal collaboration, vertical cooperation as well as networks of small and medium sized companies with larger companies or R&D institutions, where the latter cannot get funding unless they cooperate with SMEs or R&D institutes (Schienstock and Hämäläinen 2001).[7]

Both countries show a different picture concerning the **R&D efforts**. The magnitude of R&D efforts measured by the fraction of turnover spent for R&D influences the propensity to cooperate positively. The sheer magnitude has no significant influence in the sample of Finnish firms, though. Rather is it the diversity of efforts that has a positive bearing on the companies' tendency to collaborate. The more divers the innovation activities are the more likely the company engages in collaborative activities. Also the use of **protection mechanisms** plays an important role for Finnish firms to cooperate for R&D. Both the use of strategic and formal means of protection increases the likelihood of collaboration. In Austria the use of protection mechanism seems rather unrelated to the collaboration decision.

Our result also shows that Finnish companies that strive for products that are **new to the market** (INMAR) and companies which aspire **only process innovations** (INPCSO) tend to collaborate more often than companies that strive for product and process innovations, where the product innovations are not completely new to the market. Within the sample of Austrian firms the type of innovation the companies search for is not of any significance for their collaboration behavior.

Summary: The model depicts a rather complex picture of determinants explaining collaborative R&D in Finland. The explanations cover structural variables (firm size), strategic variables as well as policy variables. The situation in Austria instead is determined prominently by technology indicators (TECHML) and by the propensity to export.

[7] Another program that might have influenced the collaboration propensity in the years 1998 to 2000 is the National Workplace Development Programme of the Finnish Ministry of Labor. In the years 1996 to 1999 it aims at increasing productivity and quality of working life. The funding focused on the development and the utilization of knowledge and innovation in Finnish workplaces. The program includes 13 networking projects and circa 100 organizations be it companies or R&D institutes (Schienstock and Hämäläinen 2001).

Table 5: Detailed results for different collaboration partners

	Coop. with suppliers				Coop. with customers				Coop. with competitors				Coop. w. univ & res.inst.			
	COSUP				COCUS				COCOM				COUNI			
	Finland		Austria		Finland		Austria		Finland		Austria		Finland		Austria	
C	-0.331	*	-0.302		-0.559	***	-0.219		-0.458	***	0.585		-0.698	***	-0.037	
INNOVPROB	0.002		0.125		-0.019		0.109		0.015		0.326		0.023		0.343	
a.APPCON	-0.142		-0.016		-0.202	*	-0.035		-0.061		-0.132	*	-0.116		-0.007	
a.SIZEAV	0.000		0.000		0.000		0.001	**	0.000		0.001	*	0.000		0.000	
a.SPEED	-0.142		-0.128		0.019		-0.176		-0.034		-0.162		-0.025		-0.107	
a.TECHH	-0.055		0.031		0.181		0.132		-0.049		-0.023		0.095		-0.081	
a.TECHMH	-0.021		-0.025		0.099		0.047		-0.051		-0.087		-0.008		-0.056	
a.TECHML	-0.055		0.174	**	0.062		0.204	**	-0.016		0.199	**	0.011		0.184	**
b.FUNEU	0.131	**	0.080	*	0.067		0.134	***	0.052		0.152	***	0.109	*	0.076	
b.FUNGMT	0.116	***	-0.066		0.052		-0.081	*	0.068	**	0.009		0.138	***	0.103	**
c.EMPL	0.032		-0.056		0.051		-0.061		0.031	*	-0.208		0.052	***	-0.161	
c.EXPSHR	-0.024		0.008		-0.037		-0.017		-0.039		-0.393		-0.038		-0.283	
c.GP	-0.005		-0.029		0.013		-0.113		-0.010		-0.253		-0.023		-0.060	
d.INMAR	0.112	***	0.048		0.099	**	0.055		0.047		0.004		0.085	**	0.031	
d.INPCSO	0.119	**	0.090		0.116	*	0.051		0.131	**	-0.027		0.036		0.054	
d.INTKNO	0.236	**	0.020		0.160		0.222	**	0.061		0.287	**	0.172	*	0.074	
d.RDDIV	0.084	**	0.036		0.104	**	0.034		0.060		0.048		0.166	***	0.109	**
d.RDENG	-0.001		-0.017		0.020		-0.001		0.040		-0.018		0.076	**	-0.001	
d.RDEXP	0.203		1.479	**	0.722		0.901		0.653	*	1.109	**	0.307		0.526	
d.RDEXP2	-0.330		-1.990	*	-0.697		-1.294		-1.012		-1.476	*	-0.690		-0.419	
e.PROTF	0.117	*	0.061		0.122	*	0.034		0.002		-0.063		0.124	**	-0.062	
e.PROTS	0.089	*	0.086		0.098	**	0.031		0.052		0.052		0.099	**	0.028	
f.HAMPECO	-0.001		0.108		0.067		-0.040		0.078		0.178	**	0.078		0.183	**
f.HAMPINT	0.137		0.206	*	0.081		0.180	*	0.026		-0.052		0.028		0.073	
f.SPILLHOR	-0.377	***	-0.087		-0.281	***	0.040		0.191	***	0.233	***	-0.138	**	0.142	*
f.SPILLINST	-0.010		0.361	**	0.088		0.214		0.107		-0.188		0.074		0.050	
f.SPILLPUB	0.137		0.195	**	-0.013		0.160	*	-0.002		0.144	*	-0.018		0.084	
f.SPILLVERT	0.615	***	-0.089		0.600	***	-0.159		0.047		-0.103		0.323	***	0.016	
f.UTILIZ	-0.007		-0.063		0.019		0.011		-0.073		0.109	*	0.150	***	0.139	
Num of Obs	643		258		643		258		643		258		643		258	
McFadden	0.2772		0.4147		0.2739		0.4935		0.2155		0.3714		0.3970		0.5342	
LR statistic	246.96		97.75		242.98		104.70		131.48		65.81		353.85		144.21	
Prob (LR stat)	0.0000		0.0000		0.0000		0.0000		0.0000		0.0001		0.0000		0.0000	

4.3.3 Pattern of collaboration

In this section we discuss the results of the analysis of the determinants for collaboration for different partners as displayed in table 5. The discussion structured according to the blocks of influences discussed above.

4.3.3.1 Sectoral characteristics

The collaboration probability is higher in the Austrian medium low technology manufacturing **sectors** than in any other Austrian sectors. This higher collaboration probability can be found for vertical, horizontal and industry science collaborations. In Finland we find no significant differences across the sectors.

In Austria, our proxy for the **competitive structure** of the industry does have a significant influence on the cooperation with customers and competitors. The stronger the competition in the sector the more likely companies are to collaborate with customers and competitors. The latter can be caused by two effects. First, collaboration for innovation can be used as a mean to moderate product market competition. Second, this effect can also be caused by mere search effects. The larger the average company the easier a potential cooperation partner can be spotted. As this translates into reduced search costs it renders collaboration cheaper in those environments. In the case of fiercer competition the inclusion of customers in the development process can reduce the risk, secure customer loyalty and speed up the development process such as to increase the companies' competitiveness. The competitive situation within the sector of activity does not have an influence on the collaboration for innovation frequency of the companies in Finland. Beyond the measures for technological intensity and the firm level innovation activities the innovative pressure caused by the speed of the technological dynamic does not cause significant impacts on the companies' likelihood of collaboration.

Austrian companies in sectors with strong appropriability conditions tend to collaborate more frequently vertically such as to manage the appropriability problem. Weak appropriability conditions in the sector cause companies to collaborate less with their customers in Finland.

Summary: Sectoral differences help to explain the collaboration pattern in Austria, whereas the Finnish pattern of cooperation for innovation is less affected by characteristics related to the sector of the companies' activities.

4.3.3.2 Policy

The innovation policy variables in our analysis only cover the **public funding** of R&D. We cover it both on the national as well as on the EU level. The Finnish innovation policy succeeds in increasing the collaboration with suppliers, competitors and university and research institutes. We do not find an influence on the collaboration with customers. This is caused by the design of the public funding, which explicitly focuses on the creation of a network structure and to induce companies to collaborate with partners that they would have not collaborated with, had they not received funding. The rationale for the state intervention is the indirect beneficial effects that

derive from collaboration. The direct economic benefit of collaboration with customers is so obvious for the individual firms that there seems hardly any rationale for policy to foster it beyond the level that companies engage in customer collaborations anyway.

In Austria the innovation policy succeeds in attracting science industry collaboration. However, as an unintended side effect, it also succeeds in decreasing the collaboration with customers.

Both in Finland and in Austria we find a positive influence of the **EU funding**. Finnish companies receiving EU support collaborate more frequently with suppliers and universities. Although horizontal collaboration corresponds best to the EU's notion of pre-competitive research Finish firms are reluctant to engage in these types of networks even if EU funding is available. Companies tend to arrange their collaborative networks along the value chain in case of EU funding (Luukkonen and Niskanen 1998). In Austria, however, vertical and horizontal cooperation for innovation is positively affected by the availability of EU funding.

Summary: The national policy seems to be of greater relevance to collaboration in Finland than it is in Austria. The EU policy affects both countries to the same extent.

4.3.3.3 Company characteristics

The **affiliation** of a company to a group of companies (GP) plays no role in the determination of collaborative behavior in both countries. Although both Austria and Finland are small and open economies, the **export orientation** does not influence the propensity to collaborate for innovation.

The size of the company has the expected positive impact only on certain types of collaboration partners of the Finnish companies. Predominantly it influences the collaboration with competitors and universities & research institutes. This size effect is in excess of the size effect that is already included in the regression identifying the innovators. In Finland, collaboration for innovation with universities and research institutes and with competitors is positively size dependent. In Austria, no significant influence can be detected. If size is a proxy for the market power in a certain industry the collaboration with competitors can be of collusive nature. The size dependency of collaboration with universities and research institutes can be a self selection process of the Finnish companies. It is a common belief that research centers and academic research institutes are only willing to collaborate with larger firms. Also the collaboration with competitors requires resources for the management of the collaboration and translating the shared knowledge into a competitive advantage. The availability of the resources may be strongly size dependent and so is the propensity to collaborate with competitors, eventually. The collaboration with universities and research institutes is size dependent as with the size of the company and its internal functional diversification its capability to process the generated (scientific) knowledge increases.

Summary: In both countries the company characteristics have almost no influence on the frequency and the structure of the collaboration for innovation, once the selection bias of the innovators is controlled for.

4.3.3.4 R&D strategy

The **R&D intensity** has a different impact in Austria and in Finland. Except for the competitors as collaboration partners, the relative size of the R&D efforts does not have a significant impact on the collaboration probability of Finnish companies. The results for Austrian firms show a totally different picture. Both for co-operations with suppliers and with competitors we observe a significant inverted u-shaped relationship. For both cases the R&D intensity has a positive influence up to the level of about 0.37. Beyond the R&D intensity of 0.37 increasing R&D intensity results in a decreasing likelihood of collaboration. The sheer size of the R&D efforts does not determine the collaboration for innovation in Finland, rather is it the **diversity of the R&D** activities that has a positive impact on the propensity to collaborate vertically and with universities and research institutes. The more diversified the R&D efforts of a firm are, the more likely it is to collaborate with either one of those partners. This is caused by the comprehensive view Finnish companies maintain of R&D as a core part of their business activities. It also suggests that collaboration is seen as an integral part of successful R&D activities, whereas the findings for the Austrian companies suggest, that even if companies maintain a comprehensive approach to R&D this does not influence their propensity to collaborate significantly. Only science industry collaboration is determined by the diversity of the R&D activities.

Finnish companies also reveal that science industry collaboration patterns are closely linked not only to the comprehensiveness of the R&D approach, but also to its **endurance** suggesting that collaboration with universities is a strategic decision being beneficial in the long run.

Cost awareness as indicated by the search for **process innovation only** causes companies in Finland to cooperate vertically and horizontally. Yet, cost awareness does have no influence in Austria, though. The higher vertical collaboration frequency of pure process innovators can also be explained by the technical requirements and preconditions process innovations pose up and down the value chain. As the Finnish environment is not characterized by fierce price competition we suspect that process innovators' collaboration with competitors concerns the improvement of processes by way of mutual learning that does not directly affect the relevant dimensions of competition. The more relevant dimension of competition in the case of Finland is certainly **products that are new to the market**. In the case of new products to the market we do not see a significant parameter estimate for collaboration with competitors. With customers and suppliers involved in the shaping of new products we observe a positive influence of the high level innovation dummy.[8] Neither the pure process innovators nor the high level innovators reveal a higher collaboration propensity in Austria.

Summary: The various variables characterizing the design of the companies' R&D activities have a strong influence on the composition of the companies' portfolio of collaboration partners in Finland. In Austria, however, those variables exhibit only a limited influence on the collaboration pattern.

[8] Also other studies point to the relevance of vertical collaboration for successful innovation, see e.g. Palmberg, Leppälahti, Lemola, and Toivonen, (1999), Palmberg, Niininen, Toivanen, and Wahlberg, (2000).

4.3.3.5 Targets and intentions

As compared to Austria, the spillovers, be it **horizontal or vertical**, have a strong influence on the companies propensity to collaborate in Finland. Vertical spillovers have positive influence on the frequency of vertical collaboration and science industry collaboration, whereas horizontal spillovers have a negative influence. Horizontal cooperation, however, is positively influenced by horizontal spillovers. Vertical spillovers have negative impact on horizontal collaboration, not significantly, though.

Public spillovers do not exert any significant influence on any collaboration. In our analysis **shortages in economic resources** and **internal hampering factors** have also no influence in Finland.

In Austria **horizontal spillovers** influence the collaboration probability positively both in the case of competitors and in the case of universities and research institutes. The latter result contradicts the finding for the Finnish sample. Spillovers from public sources positively influence vertical and horizontal cooperation for innovation. In case of shortages in economic resources the companies tend to collaborate more frequently with competitors and universities or research institutes. The first effect points to a cost sharing motive and the latte underpins the common notion of universities and research institutes as cheap collaboration partners. In the case of internal hampering factors vertical collaboration seems mandated. As the internal hampering factors directly relate to shortages in knowledge there seems to be a knowledge sharing motive behind vertical collaboration. Spillovers from the science base increase the propensity to collaborate with suppliers.

The **utilization** of spillovers increases the collaboration probability with universities and research institutes in Finland supporting the importance of absorptive capacities in science industry collaboration. In Austria, however, it increases the propensity to collaborate with competitors.

Summary: In both countries the motives for cooperation as exemplified by the spill over variables and the hampering factor variables are of crucial influence on the amount of collaboration and structure of the collaboration pattern.

4.3.3.6 Management of appropriability

The more elaborate the management of appropriability is the more likely Finnish companies are to collaborate with customers, suppliers and universities and research institutes. Both **formal** and **strategic methods** are used to protect the knowledge and the intellectual property of the firms. Two interesting facts stand out here. First, the increasing probability to collaborate with universities and research institutes points to the use of protection mechanisms to protect the intellectual property generated during the projects, where as the increasing probability to collaborate with customers and suppliers may also point to already protected property that can only be used by the collaboration partners by way of formal cooperation. Second, the collaboration with competitors is not affected by the companies' attitude towards protection methods. Collaboration with competitors is not about issues that can be protected through those mechanisms.

Summary: The management of appropriability determines the collaboration pattern only in Finland. In Austria appropriability questions do not relate to collaboration issues.

5 Conclusion

In the sections above we have analyzed and compared the pattern of collaboration for innovation in Austria and in Finland. Although, both countries share some common characteristics such as being small open economies, being members of the euro-zone, having joined the EU in 1995 and showing some comparable innovation pattern, we find differences in the factors affecting the company's decision to collaborate for innovation. The different factors can be interpreted in terms of the overall influences on collaboration.

The results indicate that Austrian firms are strongly influenced in their decision to co-operate by their sectoral affiliation. However, opposed to conventional wisdom, not only high-technology but also enterprises from medium-low technology sectors are actively co-operating. R&D intensity is another influential factor that affects co-operational behavior. The results also show, not surprisingly, the influence of EU policies. On the other hand, national funding only influences co-operations with universities and research centers and has no effect on horizontal or vertical co-operations. Finally, we see that the existence of horizontal spillovers from competitors affects co-operations positively.

The analysis of the collaboration behavior reveals that it is strongly influenced by features of the R&D strategy and by the companies' appreciation of various types of spillovers. The collaboration of Finnish companies also seems to be guarded by the use of both formal and strategic protection instruments. Technology policy in terms of governmental funding shows to be highly successful in inducing companies to collaborate.

Our results show that the co-operative behavior of firms in Austria and Finland still seems to be the result of the underlying national innovation systems in many aspects. This is somehow surprising, given the tendency of firms to globalize their operations, including R&D. We neither find a strong tendency in the theoretical and empirical literature to explain co-operative behavior by country-specific variables. Instead, much of the determinants discussed in the literature (size, technology content) should be valid for all enterprises regardless of location. This indicates that a cross-country approach may be able to contribute more valuable insights of co-operative behavior than single-country studies.

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