THE ROLE OF INTER-ORGANIZATIONAL COLLABORATION WITHIN INNOVATION STRATEGIES: TOWARDS A PORTFOLIO APPROACH.

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ABSTRACT

Within the innovation literature, inter-organizational cooperation is being advanced as instrumental for improving the innovative performance of firms. In addition, it has been suggested more recently, that inter-organizational cooperation can be instrumental for addressing the paradoxical requirements innovation strategies entail. At the same time - large scale - empirical evidence for such a relation is scarce. Within this paper we examine whether evidence can be found for the idea that inter-organizational collaboration supports the effectiveness of innovation strategies. A multivariate analysis of data on Belgian manufacturing firms, collected by means of the CIS survey (n=246), reveals a positive relationship between inter-organizational collaboration and innovative performance. Moreover the findings reported here indeed suggest the relevancy of adopting a portfolio approach towards inter-organizational collaboration.

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INTRODUCTION: ORGANIZING FOR INNOVATION.

Innovation has long been acknowledged as crucial for the long term survival and growth of the firm; at the same time technological innovation can be seen as one of the critical driving forces behind elevating the economic well-being of people and nations (Schumpeter, 1934; Tushman & Anderson, 1997). However, managing innovation does not present itself as a straightforward exercise (Van de Ven, et al. 1983, 1999, Tushman & Anderson, 1997). The complexities entailed within designing and implementing a sound innovation strategy can be related directly to the multitude of objectives such a strategy comprises. In this respect relevant distinctions have been advanced and outlined by, amongst others, Abernathy (1978), Dosi (1982), Tushman and Romanelli (1985), Anderson and Tushman (1991), March (1991), Ghemawat (1991), Utterback (1994), Christensen and Bower (1996), Brown and Eisenhardt (1998), Garud and Karnoe (2002). The notions of incremental versus radical innovation, flexibility versus commitment, divergent versus convergent behavior, exploitation versus exploration or path creation versus path dependence form the core of the dualities being outlined. Whereas exploitation refers to activities such as refinement, efficiency, selection and implementation, exploration is best captured by notions like search, variation, experimentation and discovery (March, 1991.,p.102). As such, organizations trying to achieve both types of activities are being confronted with multiple, often contradictory demands confronting organizations with challenge of reconciling paradoxical requirements (Leonard-Barton, 1990, Dougherty, 1996, Benner & Tushman, 2003).

Recently, several scholars have advanced the notions of semi- or quasi-structures (Schoonhoven and Jellinek, 1990; Brown and Eisenhardt, 1997) and ambidextrous organizations (Tushman, Anderson and O'Reilly, 1997; Benner and Tushman, 2003) to handle the paradoxical requirements encountered. Within such configurations, conflicting ingredients can co-exist by adopting organizational designs of a hybrid nature; an issue explicitly addressed as well by authors like Cooper and Kleinschmidt (1995), and Christensen and Overdorf (2000). As a consequence, innovation strategies entail the deployment of multiple organizational arrangements of a heterogeneous nature, whereby balancing over time and between different units

becomes a crucial point of managerial attention (Van Looy, Debackere, Bouwen, 2003).

Within the work of several of the authors mentioned, inter-organizational collaborative arrangements are advanced as highly relevant for dealing with the aforementioned tensions. For instance, Brown and Eisenhardt (1997) pointed out the relevancy of strategic alliances for probing into the future and hence to overcome tensions related to combining short and long term developments. Christensen and Overdorf (2000) advocate the idea of complementing 'traditional' organizational practices, with creating new organizational structures, spinouts and acquisitions to achieve the exploration oriented objectives of an innovation strategy.

Within this contribution we want to examine whether empirical evidence can be found for such a supportive role of inter-organizational collaboration. Stated otherwise, are firms that deploy a multitude – or portfolio – of inter-organizational collaborations within the framework of their innovation strategy, better able to achieve innovations of both a more incremental and radical nature. This empirical examination will be done by analyzing data on Belgian firms collected by means of the CIS survey. However, before describing in more detail the data sample and the methods involved, we first discuss in more detail empirical findings on the role and impact of inter-organizational collaboration, as this will allow us to define our research questions more precisely.

THE ROLE OF INTER-ORGANIZATIONAL COLLABORATION WHEN INNOVATING: TOWARDS SPECIFIC PROPOSITIONS.

Inter-organizational collaboration has been recognized as important to supplement the internal innovative activities of organizations (Dodgson, 1993; Hagedoorn, 2002). From the present literature, it becomes clear that organizations can develop inter-organizational collaborations to improve their innovative capabilities by involving a variety of partners. Collaborations with existing suppliers and customers (Shaw, 1994; Von Hippel, 1988), potential lead users (Quinn, 1985; Von Hippel et al., 1999), universities and research centres (Gerwin et al., 1992; Santoro, 2000; Tidd et

al., 2002) and even potential or existing industry competitors (Dodgson, 1993; Hamel, 1991) have all been advanced as relevant in this respect.

The reasons why inter-organizational collaboration can contribute to the effectiveness and efficiency of an innovation strategy are numerous. First of all, inter-organizational collaboration can imply access to complementary assets needed to make innovation projects commercially successful (Teece, 1986; Hagedoorn, 1993). Second, working together with other organizations might bring along the transfer of codified and tacit knowledge (Ahuja, 2000; Eisenhardt & Schoonhoven, 1996). Organizations can become familiar with new competencies that are emerging within or outside the industry in a stepwise way (Roberts & Berry, 1985). Such phased acquisition processes might result over time in the creation and development of resources that are otherwise difficult to mobilize, imitate and substitute (Das & Teng, 2000). Finally, inter-organizational collaboration also allows spreading the costs of R&D over different parties (Hagedoorn, 2002; Veugelers, 1998), reducing the risks that are associated with R&D intensive innovation projects significantly.

The fact that inter-organizational collaboration has considerable potential to contribute to the innovation strategies of organizations does not mean that all collaborations are successful though; on the contrary, estimates suggest that as many as 60 per cent of all alliances fail (Bleeke & Ernst, 1993; Harrigan, 1988). The occurrence of unintended knowledge spillovers (Veugelers, 1998; Teece, 2002), the manifestation of learning races between the partners (Hamel, 1991; Larsson et al., 1998) and lack of flexibility and adaptability (Doz, 1996; Ring & Van de Ven, 1994) are frequently cited reasons for alliance failure.

Despite the occurrence of such drawbacks, empirical results seem to confirm that, by forming strategic alliances, organizations can potentially access social, technical, and commercial competitive resources that otherwise would require years of operating experience (Ahuja, 2000; Eisenhardt & Schoonhoven, 1996; Gulati, 1998; Nohria & Garcia-Pont, 1991; Teece, 1986). Moreover, if managed successfully, such alliances seem to contribute to the innovation effectiveness of the firms involved. By studying the start-ups' performance in Canadian biotechnology, Baum et al. (2000) came to the conclusion that alliance networks form a locus of innovation in

high-technology fields. Similarly, Shan et al. (1994) found out that the number of agreements with commercial firms has a positive significant influence on the amount of patents issued by biopharmaceutical start-ups. Tether (2002) observed that organizations which introduced at least one innovation that was new to the market cooperated significantly more with suppliers, customers and competitors than organizations which had not introduced such an innovation.

From such findings, we tend to conclude that organizations that engage extensively in inter-organizational collaboration are better equipped to create new or improved products and processes. Hence we hypothesize that:

H1: The more firms engage in cooperative arrangements, the more effective their innovative strategies.

Towards a more fine-grained approach

Several studies examining the reasons why organizations engage in inter-organizational collaboration have stressed the idea that different kinds of collaboration can serve different strategic and innovation objectives. Hagedoorn (1993) for example, illustrates that organizations will use technological oriented collaborations such as joint ventures, research corporations and joint R&D agreements to support long-term positioning strategies. Technology exchange agreements and customer-supplier relationships, on the other hand, can be seen as cost-economizing agreements which are associated with control of either transaction costs or operating costs of organizations (Hagedoorn, 1993). Cairnarca et al. (1992) point into a similar direction by arguing that the reasons for and hence the role of inter-organizational collaboration will differ depending on the different technological life-cycle stages of an industry. Before technological maturity is achieved, organizations deploy technology watching activities in order to get rapid access to specialized know-how. Scanning activities resulting in joint R&D agreements including initiatives for developing standards are frequently observed during such episodes. In this way, organizations are able to deal with the flux and rapid change that characterizes such ‘pre dominant design’ episodes (Anderson & Tushman, 1986; Utterback & Abernathy, 1975). On the other hand, when technological maturity is

setting in, organizations will tend to favor commercial and manufacturing agreements with customers and clients mainly to optimize existing technology, to exploit the existing technology in peripheral markets or to improve the commercial and manufacturing possibilities of the involved technology (Cairnarca et al., 1992).

More recently, researchers also started to make a distinction between different kinds of inter-organizational collaboration by looking at the learning objectives of these collaborations. Following March's (1991) dichotomy of exploration and exploitation, a distinction has been made between explorative and exploitative alliances (Koza & Lewin, 1998; Rothaermel, 2001). Using this distinction Rothaermel (2001) came to the conclusion that industry incumbents that focus on a network of exploitative alliances outperform industry incumbents that have a more explorative alliance network.

Within exploitative alliances, the main purpose is the enhancing of existing organizational competencies. More specifically, exploitative alliances will focus on leveraging existing skills (Holmqvist, 2003). This means that exploitation alliances focus on tangible complementarities among the allied partners as they exchange explicit knowledge (Teece, 1992). To achieve these objectives, exploitative alliances will benefit from clear performance objectives that are translated into measurable output controls which will be monitored by formalized coordinating and control mechanisms (Koza & Lewin, 1998; Van De Ven & Walker, 1984). These collaborative agreements will be characterized by clear job responsibilities, centralized procedures and highly engineered work processes. We can expect that such a 'mechanistic' structuring of the collaboration can bring along significant improvements of efficiency, time-to-market and cost-characteristics of existing products (Burns & Stalker, 1961; Tushman et al., 1997). Because these outcomes are the main objectives of incremental oriented innovation projects we hypothesize that:

> H2: The larger the number of exploitative collaborations, the more effective the development of innovations of an incremental or path reinforcing nature will be.

Explorative alliances, on the other hand, are used to create new organizational competencies. In these collaborations explorative learning processes and joint experimenting will be the main issue (Homqvist, 2003). Hence, a differential emphasis towards the exchange of intangible or tacit knowledge can be observed. To achieve such learning objectives, alliance partners will rely more on personal and informal modes of coordination and control (Koza & Lewin, 1998; Van De Ven & Walker, 1984, Ring & Van De Ven, 1994). Such 'organic' structures in which job responsibilities are less explicit and more flexible working procedures are established at the beginning seem to suit innovation projects of a more radical nature that focus on newness instead of efficiency (Burgelman, 1983; Burns & Stalker, 1961; Christensen & Overdorf, 2000; Tushman et al. 1997, Wheelwright & Clark, 1992). Therefore we hypothesize that:

> H3: The larger the number of explorative collaborations, the more effective the development of innovations of a path creating nature will be.

So, on the one hand explorative oriented alliances can be used to accelerate the development of new business ideas and to engage in experimentation and piloting. Exploitative oriented alliances, on the other hand, can leverage existing skills and provide the necessary complementary assets that allow optimizing existing products and processes (Doz & Williamson, 2002). The distinction between exploitative and explorative alliances is not only useful to illustrate that different kinds of inter-organizational collaboration might be relevant for different kinds of innovation objectives, it can also help to clarify how a diversified portfolio of collaborations can help to create a balanced innovation portfolio in which both incremental and radical projects are embedded. Following the arguments outlined so far, we hypothesize that when an organization engages in both exploitative and explorative alliances, it creates possibilities to achieve both incremental and radical innovation objectives. This means that the more balanced the collaboration portfolio of an organization, the more balanced the effects of the innovation strategy will be. Therefore we hypothesize:

> H4: Organizations with a collaboration portfolio which implies both exploitative and explorative alliances will be more likely to achieve results both in terms of incremental and novel innovations.

METHODOLOGY

Data

The data used for this study are drawn from the second version of the Community Innovation Survey (CIS II) conducted in several member states of the European Union in 1997[1]. The survey intended to develop insights into the innovative behavior of private organizations in the manufacturing industry[2]. In this study, the analysis is restricted to the Belgian manufacturing industry. These firms are distinguished from those who do not innovate based on their answers to the questions about whether they innovated between 1994 and 1996[3]. Innovation is defined by introducing new or improved products, or, new or improved processes. In total, the sample used consisted of 246 actively innovating firms[4].

Description of variables

Indicators of the effectiveness of innovation strategies

In several studies that examine the link between inter-organizational collaboration and innovative performance, patent intensity has been used as a measure of innovative outcome (e.g. Ahuja, 2000; Baum et al., 2000; Shan et al., 1994). However, the use of patent activity as a measure of innovativeness brings along some specific concerns. It can be observed that such an indicator is only useful within industries in which patents are an important outcome of innovative projects. Therefore, it is not surprising that studies using this indicator limit themselves to so-

[1] For more detailed information about the survey we refer to http://www.belspo.be. For the CIS II survey a representative sample of 2164 Belgian manufacturing firms was selected and an 11-page questionnaire sent out to them. The response rate was 64 % (1377)

[2] The authors are grateful to DWTC for granting access to the data.

[3] Only the innovating firms needed to fill out all questions in the survey. Restricting the sample to innovating firms might lead to sample selection cooperation is an important way to innovate for firms that would otherwise not be innovative. This assumption however is unlikely, given that all firms that cooperate do have some other innovation strategies, such as own R&D or some form of external knowledge acquisition (Veugelers & Cassiman (1999))

[4] The amount of missing values was particularly high on the question of 'total number of R&D personnel in 1996'. 62 of the innovating organizations did not report a specific amount on this question.

called technology intensive industries[5]. Second, the patent intensity gives only an indication of the successfulness of one type of innovative activity, namely innovative efforts that bring along an output that can be codified into an appropriable asset. However, a lot of incremental and radical innovations will not be appropriable to that extent (Teece, 2002). Hence it can be argued that organizations that have limited or even no patents at all, at the same time create a lot of new or improved products or processes. Finally using only the amount of patent activity does not allow making a distinction between incremental and radical innovation outcomes; more refined patent oriented indicators are needed in this respect and are not feasible anyhow within the scope of the current study as CIS data are treated confidentially on the company level.

Given these concerns, we have chosen to use the composition of turnover as a measure of the effectiveness of innovation strategies. More specifically, we have looked at the turnover realized in 1996; this turnover can be the result of 1) technological *new* products brought onto the market between 1994 and 1996, 2) technological *improved* products brought onto the market between 1994 and 1996 and 3) unchanged or marginal changed products between 1994 and 1996[6]. The proportion of the turnover attributed to new products is treated within this study as an indication of the effectiveness of the innovation strategy in terms of achieving its more path creating objectives. Likewise, the percentage of the turnover attributed to improved products is seen as an indicator of the effectiveness of the innovation strategy in terms of its more incremental or path reinforcing objectives. Finally, to measure the total effectiveness of an organization's innovation strategy, the sum of the two former variables is being used.

[5] For some exceptions that have focused on multiple industries, see: Keinknecht & Reijnen (1992); Fritsch & Lukas (2001) and Tether (2002)

[6] A technologically improved product is an existing product whose performance has been significantly enhanced or upgraded. A simple product may be improved (in terms of better performance or lower cost) through use of higher-performance components or materials, or a complex product which consists of a number of integrated technical sub-systems may be improved by partial changes to one of the sub-systems (The measurement of scientific and technological activities, Oslo Manual - OECD/Eurostat, 1997, p. 49). A technologically new product is a product whose technological characteristics or intended uses differ significantly from those of previously produced products. Such innovations can involve radically new technologies, can be based on combining existing technologies in new uses, or can be derived from the use of new knowledge. (The measurement of scientific and technological activities, Oslo Manual - OECD/Eurostat, 1997, p. 48)

Indicators of inter-organizational collaboration

Within the CIS II survey, organizations indicate whether or not they engage in inter-organizational agreements within the context of innovation. Respondents had to indicate whether or not they collaborated with 1) other organizations within the same group, 2) competitors, 3) customers, 4) consultants, 5) suppliers, 6) universities and 7) research institutes. For each of these different types of partners, further refinements relate to the location of the partner by using the following distinctions: Belgium, EU, USA, Japan and other countries. In this way, 35 binary variables become available each representing a combination of one specific type of partner with one specific geographic location. A score of 1 indicates that the organization indeed did engage in such collaboration, while 0 stands for the opposite. By adding these 35 variables, one obtains a variable with a score interval between 0 and 35, indicating the range and amount of the organization's innovation oriented collaboration portfolio. In our analyses, this variable has been labeled '#Alliances'.

In order to analyze the relationships advanced within hypotheses 2 and 3, additional indicators reflecting the difference between alliances of an exploitative and explorative nature are needed. Based on previous research, collaborations with customers and suppliers are assumed to be more exploitative oriented as such development efforts remain predominantly situated within a given value chain (Tripsas 1997). Collaboration with these partners has been described as instrumental for optimizing continuously existing core competencies (Brown & Eisenhardt, 1995, 1997; Schoonhoven & Jelinek, 1997). Where collaboration with suppliers can improve significantly the operational efficiency of existing production processes (Dittrich, 2001), collaboration with customers puts needs of existing customers high on the innovation agenda (Shaw, 1994; Von Hippel, 1988). In line, Christensen and Overdorf (2000) have convincingly argued that collaborations with partners and customers will not be helpful to support innovation projects of a more radical or path creating nature. These authors emphasize that collaboration with customers and suppliers will reinforce existing resources, procedures and values, while the creation

of innovations of a more path creating nature more often than not imply processes of 'creative destruction' (Schumpeter, 1939, 1959).

Therefore, by adding all the binary variables representing combinations that include collaborations with customers or suppliers, we created the variable '#Exploitation' that has a range between 0 and 10 and that represents the extent to which an organization makes use of exploitative oriented collaborations.

Collaborations with universities and research institutes, on the other hand, might be seen as more explorative oriented. These kinds of collaboration will be focused on the creation of know-how and know-why of new materials and technologies that eventually can be translated into commercial development (Wheelwright & Clark, 1992) The main focus will be on the generation of new knowledge instead of the exploitation of existing knowledge. Again, by adding all the binary variables, representing combinations that include collaborations with universities or research institutes, the variable 'EXPLOR' was created that has a score range between 0 and 10, indicating the extent to which an organization makes use of explorative oriented collaborations[7].

Moderating variables

Besides the intensity and nature of inter-organizational collaboration one might expect that variables like the size of the organization, the R&D intensity of the organization, the industry in which the organization is located, and whether or not the organization is part of a multinational/divisional entity will have an impact on the nature and the outcomes of the organization's innovation strategy.

Differences between small, entrepreneurial business entrants and large, mature industry incumbents with regard to their innovative capabilities have been

[7] For the other types of partners (within the group, competitors), no straightforward diagnosis in terms of exploration of exploitation seems plausible (e.g. working within the boundaries of the group, might imply pursuing synergies with other Business Units (path reinforcing) as well as cooperation with corporate R&D which might include projects aimed at path creating innovations. Likewise collaboration with competitors might both be more path creating (e.g. standard development within emergent technologies/applications) or more path reinforcing (e.g. bundling of products/services).

documented (e.g. Ahuja & Lampert, 2001; Christensen & Overdorf, 2000; Quinn, 1985). Therefore, the variable size measured by the natural logarithm of the number of employees, is included within the different models as a control variable. Likewise, it seems reasonable to expect that the internal innovation efforts of the organization will have an impact on the successfulness of the innovation strategy of the organization. Therefore we included the variable 'R&D Intensity' in the analysis that represents the ratio of the number of R&D employees divided by total number of employees. In addition, whether or not one belongs to a larger, multinational, entity (0/1) has been used a control variable, labeled 'Foreign Subsidiary'. Finally, we included the variable ''Industry' to control for industry effects in the different analyses. Following the industry dynamics outlined by Utterback & Abernathy (1975) one can expect that, within mature industries in which a dominant design is established the focus will be on incremental innovation projects, while within emerging industries radical innovation projects will be the main focus. Following Veugelers & Cassiman (1999), we distinguished five types of industries[8] and made one supplementary category, representing organizations that did not belong to one of these industries. Table 1 provides an overview in this respect.

Table 1 Overview of Sample Composition by industry.

'INDUSTRY'	Textile, Wood, Paper	Electrical Equipment Industry	Food	Chemical Industry	Metals and Manufacturing	Other	Total
N	27	39	17	62	94	7	246
%	11%	16%	7%	25%	38%	3%	100%

Because we only included innovating organizations in our analyses (see above), it is not surprising that the number of organizations belonging to more technological intensive industries (Electrical Equipment, Chemicals and Metals and Manufacturing) is larger than the number of organizations belonging to less technological intensive industries (Textile, Wood and Paper and Food).

[8] The five types of industries distinguished are: 1) Textile, wood or paper industry; NACE Codes: 17, 18, 19, 20, 21, 22); 2) Electrical equipment industry; NACE Codes: 30, 31, 32, 33; 3) Food; NACE Codes: 15, 16); 4) Chemical Industry; NACE Codes: 24, 25); 5) Metals and Manufacturing (NACE Codes: 26, 27, 28, 29, 34, 35) (Veugelers & Cassiman, 1999, p.78)

RESULTS

Descriptive Statistics.

In Table 2 an overview of the descriptive statistics can be found. On average the respondents attributed 10 % of their turnover to technological new products and 18 % to technological improved products. From table 1 it becomes apparent that he number of inter-organizational collaborations reported was rather limited. On average, the innovating firms used less than 3 out of the 35 collaboration possibilities that were indicated in the survey. Moreover, with regard to exploitative and explorative kinds of collaboration, innovating firms engage in less than 1 out of the 10 combinations proposed.

Table 2: Descriptive statistics

Variable	Mean	S	Correlations					
			Turn Over New Products	Turn over Improved Products	Size	R&D Intensity	# Alliances	# Exploitation oriented alliances
Turn Over New Products	0,10	0,13	1					
Turn Over Improved Products	0,18	0,20	-,016	1				
Turn Over Improved Products	0,18	0,20	-,016	1				
Size	5,19	1,42	,041	-,013	1			
Size	5,19	1,42	,041	-,013	1			
R&D Intensity	0,05	0,06	,192**	,039	,017	1		
R&D Intensity	0,05	0,06	,192**	,039	,017	1		
#Alliances	2,37	3,58	,209**	,060	,474**	,136*	1	
#Alliances	2,37	3,58	,209**	,060	,474**	,136*	1	
#Exploitation oriented alliances	0,47	0,50	,161*	,097	,359**	,101	,874**	1
#Exploitation oriented alliances	0,47	0,50	,161*	,097	,359**	,101	,874**	1
#Exploration oriented alliances	0,39	0,49	,184**	,014	,480**	,230**	,834**	,588**
#Exploration oriented alliances	0,39	0,49	,184**	,014	,480**	,230**	,834**	,588**

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

As table 2 includes as well the correlations, one can notice that the amount of turnover attributed to technological new products is not only positively correlated with R&D intensity, but also with the different collaboration variables included in our analysis. This provides already a first indication that the collaborative behavior of organizations might be related to innovative performance.

The relationship between inter-organizational collaboration and innovative effectiveness

Within the first hypothesis the effectiveness of innovation strategies has been related to the presence of a multitude of inter-organizational co-operative arrangements. A straightforward analysis in this respect consists of relating the total amount of alliances (#Alliances) with the proportion of turnover generated by improved or new products while at the same time including other control variables like size, industry, R&D intensity and whether one is a foreign subsidiary or not. Table 3 summarizes the findings of such an ANCOVA analysis whereby the sum of the turnover resulting from new or improved products acts as the dependent variable, while R&D intensity and size acts as covariates. As becomes clear from table 3 the total number of alliances is positively related to the effectiveness indicator used, supporting our first hypothesis. In addition, it can be observed that that R&D intensity also has a positive impact on the extent to which an organization realizes turnover from new and/or improved products, although significance levels are lower ($p<0,10$). Size, industry and whether or not one is a foreign subsidiary do not make a difference in this respect.

Table 3: Results of ANCOVA –
Dependent Variable: Proportion of turnover generated by new/improved products.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1,279	14	9,136E-02	3,492	,000
Intercept	,741	1	,741	28,324	,000
Intercept	,741	1	,741	28,324	,000
Size	2,382E-02	1	2,382E-02	,910	,341
Size	2,382E-02	1	2,382E-02	,910	,341
# Alliances	,621	1	,621	23,718	,000
# Alliances	,621	1	,621	23,718	,000
R&D Intensity	8,382E-02	1	8,382E-02	3,203	,075
R&D Intensity	8,382E-02	1	8,382E-02	3,203	,075
Foreign Subsidiary	5,202E-02	1	5,202E-02	1,988	,160
Foreign Subsidiary	5,202E-02	1	5,202E-02	1,988	,160
Industry	,184	5	3,671E-02	1,403	,225

Foreign Subsidiary * Industry	7,766E-02	5	1,553E-02	,594	,705
Error	5,390	206	2,617E-02		
Total	19,266	221			
Corrected Total	6,670	220			

R Squared =, 192 (Adjusted R Squared = ,137)

The following three hypotheses include the introduction of a distinction between the effectiveness of innovation in terms of new versus improved products as well as a characterization of the nature of the inter-organizational alliances (explorative versus exploitative). In order to examine the relationship between both effectiveness and the nature of the alliances, a tobit regression has been conducted (McDonald and Muffit, 1980, Greene, 2000) as this allows to include and analyze at the same time the occurrence and the extent of having turnover related to new or improved products[9].

Results of Tobit Analysis

In our second hypothesis we stated that the use of exploitative collaborations will be beneficial for the successful development of incremental oriented innovation projects. The Tobit analysis, in which the alliance variables (# Exploration alliances, # Exploitation alliances) are related to the amount of turnover resulting from improved products, provides evidence in this respect. As table 4 makes clear the amount of exploitation oriented alliances relates significantly to the presence and amount of turnover resulting from improved products ($p<0,0005$) while exploration oriented alliances do not. The latter applies as well for size, R&D intensity and industry. Finally, whether or not one is part of a multinational organization does affect the presence of turn over derived from improved products, albeit in a negative way ($p<0,05$).

[9] According to the decomposition logic of McDonald and Moffitt (1980), within the different models, 59% of the total change in innovation (improved or new) resulting from a change in the independent variables would be generated by marginal changes in the value of innovation (improved or new), whereas 41% would be generated by changes in the probability of innovating anything at all.

Table 4: Results of Tobit Analysis – Dependent variable: Presence/Proportion of turnover resulting from improved products.

Model Information

Data Set	
Dependent Variable	Presence of Turn Over Improved
Dependent Variable	Amount of Turn Over Improved
Number of Observations	221
Noncensored Values	179
Right Censored Values	0
Left Censored Values	42
Interval Censored Values	0
Missing Values	6
Name of Distribution	NORMAL
Log Likelihood	84.83643598

Analysis of Parameter Estimates

Variable	DF	Estimate	St Error	Chi-Square	Pr > ChiSq Label
Intercept	1	0.09859	0.04666	4.4642	0.0346
Foreign Subsidiary	1	-0.04138	0.02037	4.1266	0.0422
Size	1	-0.00005	0.007254	0.0001	0.9938
Food	1	0.06245	0.04835	1.6682	0.1965
Wood, Paper, Textile	1	-0.00798	0.05034	0.0251	0.8740
Chemical Industry	1	-0.01350	0.03633	0.1381	0.7102
Metals and Machinery	1	0.03104	0.03833	0.6560	0.4180
Electrical Equipment	1	0.04418	0.03917	1.2726	0.2593
R&D Intensity	1	0.16951	0.15827	1.1471	0.2841
# Exploitative alliances	1	0.02577	0.007212	12.767	0.0004
# Explorative alliances	1	-0.006762	0.008590	0.6198	0.4311

We also hypothesized that the use of explorative collaborations would be beneficial for the commercial success of a more path creating nature (H3). The results of the Tobit model in which the presence and the amount of turnover stemming from new products is used as a dependent variable, provides evidence for the hypothesis outlined, as Table 5 makes clear. Whereas the presence and amount of exploitation oriented alliances does not relate significantly to the proportion of turnover generated by new products, this is clearly the case for exploration oriented alliances ($p<0,01$). At the same time it can be noted that size is significantly negatively related to introducing new products, while R&D intensity is beneficial for introducing new

products (although only significant at the 10 % level). As in the case of turn over of improved products, no industry differences have been observed.

Table 5: Results of Tobit Analysis – Dependent variable: Presence/Proportion of turnover resulting from new products.

Model Information

Dependent Variable	Presence of Turn Over New
Dependent Variable	Amount of Turn Over New
Number of Observations	221
Noncensored Values	178
Right Censored Values	0
Left Censored Values	43
Interval Censored Values	0
Missing Values	6
Name of Distribution	NORMAL
Log Likelihood	133.34352977

Analysis of Parameter Estimates

Variable	DF	Estimate	St Error	Chi-Square	Pr > ChiSq Label
Intercept	1	0.08184	0.03589	5.1997	0.0226
Foreign Subsidiary	1	0.00425	0.01578	0.0726	0.7876
Size	1	-0.01150	0.005518	4.3396	0.0372
Food	1	0.05820	0.03764	2.3908	0.1220
Textile, Wood and Paper	1	0.06017	0.03823	2.4777	0.1155
Chemical Industry	1	0.01581	0.02825	0.3131	0.5758
Metals and Manufacturing	1	-0.00042	0.02991	0.0002	0.9886
Electrical Equipment	1	0.01380	0.03029	0.2074	0.6488
R&D Intensity	1	0.20817	0.12084	2.9677	0.0849
# Exploitative alliances	1	0.008928	0.005455	2.6786	0.1017
# Explorative alliances	1	0.01718	0.006409	7.1821	0.0074

Our final hypothesis stated that organizations with a more balanced collaboration portfolio would also achieve results of a more balanced nature, i.e. considerable levels of effectiveness both in terms of improved and new products. In order to assess the effects on both dependent variables simultaneously, a Manova has been conducted. As the findings in table 6 make clear, also hypothesis 4 is being confirmed. Both the number of exploitative and explorative alliances is associated significantly and positively with the proportion of turnover generated by new and improved products. This positive effect stems from significant partial associations between exploitative alliances and turnover stemming from improved products on the

one hand, and between explorative alliances and turnover stemming from new products on the other hand.

Table 6: Results of MANOVA
Dependent Variable: Centroid of turnover generated by new/improved products.

Source	Value	F	Sig.
Intercept	0,84	15,28	,000
Size	0,969	3,133	,046
Size	0,969	3,133	,046
R&D Intensity	0,976	2,41	,096
R&D Intensity	0,976	2,41	,096
Foreign Subsidiary	0,978	2,157	,118
Foreign Subsidiary	0,978	2,157	,118
Industry	0,905	1,245	,225
Industry	0,905	1,245	,225
# Exploitative Alliances	0,836	2,604	,001
# Exploitative Alliances	0,836	2,604	,001
# Explorative Alliances	0,886	2,012	,022
# Explorative Alliances	0,886	2,012	,022

It is also interesting to take a closer look at the other influencing variables that we have included within the different models. Although we expected that the size of the organization would influence the success of the organization's innovation strategy, significant results were found for this variable, but in a negative way. This negative relationship is to be situated in relation to the presence of turnover from new products (see also the findings of the Tobit analysis). Regarding R&D intensity, we observed a positive relationship with the proportion of turn over derived from new products, while no such relationship manifests itself with improved products, resulting in an overall relationship with a lower level of significance ($p<0,10$). Table 7 contains in this respect the disentangled data. Size does not affect the combination of new and improved turnover; size does however relates significantly with the amount of turnover stemming from new products. In line with the Tobit analysis reported above, this relationship is a negative one. Finally, no industry effects have been observed within this analysis, while at the same time being part of a multinational group does

relate to turnover from improved products, results again in line with the Tobit analysis outlined above.

Table 7: Breakdown of Manova analysis by type of Turn Over
New versus Improved

Source	Dependent Variable	Type III Sum of Squares	F	Sig.
Corrected Model	Turn over New	,345	2,262	,001
Corrected Model	Turn over New	,345	2,262	,001
	Turn over Improved	,562	2,183	,002
	Turn over Improved	,562	2,183	,002
Intercept	Turn over New	,169	27,642	,000
Intercept	Turn over New	,169	27,642	,000
	Turn over Improved	6,343E-02	6,158	,014
	Turn over Improved	6,343E-02	6,158	,014
Foreign Subsidiary	Turn over New	6,656E-04	,109	,742
Foreign Subsidiary	Turn over New	6,656E-04	,109	,742
	Turn over Improved	4,073E-02	3,954	,048
	Turn over Improved	4,073E-02	3,954	,048
Industry	Turn over New	6,996E-02	1,432	,185
Industry	Turn over New	6,996E-02	1,432	,185
	Turn over Improved	8,836E-02	1,072	,384
	Turn over Improved	8,836E-02	1,072	,384
# Exploitative alliances	Turn over New	5,942E-02	1,390	,211
# Exploitative alliances	Turn over New	5,942E-02	1,390	,211
	Turn over Improved	,273	3,784	,001
	Turn over Improved	,273	3,784	,001
# Explorative alliances	Turn over New	8,559E-02	2,337	,033
# Explorative alliances	Turn over New	8,559E-02	2,337	,033
	Turn over Improved	8,226E-02	1,331	,245
	Turn over Improved	8,226E-02	1,331	,245
Size	Turn over New	3,504E-02	5,739	,018
Size	Turn over New	3,504E-02	5,739	,018
	Turn over Improved	1,657E-03	,161	,689
	Turn over Improved	1,657E-03	,161	,689
R&D Intensity	Turn over New	2,318E-02	3,796	,053
R&D Intensity	Turn over New	2,318E-02	3,796	,053
	Turn over Improved	1,700E-02	1,650	,200
	Turn over Improved	1,700E-02	1,650	,200

Error	Turn over New	1,190
	Turn over Improved	2,009
	Turn over Improved	2,009
Total	Turn over New	3,155
Total	Turn over New	3,155
	Turn over Improved	6,295
	Turn over Improved	6,295
Corrected Total	Turn over New	1,536
Corrected Total	Turn over New	1,536
	Turn over Improved	2,571
	Turn over Improved	2,571

R Squared = ,225 (Adjusted R Squared = ,125) – Turn Over New Products
R Squared = ,219 (Adjusted R Squared = ,119) – Turn Over Improved Products

DISCUSSION

In this study we have tried to find some empirical evidence for the idea that the amount and variety of inter-organizational collaboration relates to the effectiveness of innovation strategies. The multivariate analyses conducted within this study confirm all hypotheses outlined. Firms that engage more in inter-organisational cooperation within the framework of their innovation strategies perform better in terms of the proportion of turn over realized by means of new or improved products. In addition, the difference between exploitative and explorative collaborations has been introduced to examine whether different kinds of collaboration relate to different types of innovation outcomes. More specifically, we hypothesized that exploitative oriented collaborations could support path reinforcing innovation projects, while explorative oriented collaborations would be beneficial for innovation objectives of a more path creating nature. Also these hypotheses have been confirmed. On the one hand, alliances with customers and suppliers, labeled as 'exploitative' are associated positively with higher levels of turnover stemming from improved products, while alliances with universities and research organizations, labeled as explorative, are associated in a similar way with turnover levels related to new products. In addition, both types of alliances are positively associated with higher levels of turnover stemming from both new and improved products. This latter finding demonstrates empirically the relevancy of adopting a portfolio approach towards alliances and networking when innovating.

As indicated before, our models did only explain a modest amount of the total variation present in the data. An explanation for this large amount of unexplained variance is that some important variables, which can influence substantially how and to what extent organizations innovate, were not included in the analyses. Burns & Stalker (1961), for example, proved already that the organizational structure will have a major influence on the innovative capabilities of an organization. More specifically, they found out that, while mechanistic organizations would excel in improving efficiency of existing core competencies (i.e. creating incremental innovations), organic organizations would be most suited to engage in the creative destruction of these same competencies (i.e. creating radical innovations). As became clear in the

introduction, several scholars have stressed that the organizational structure will determine largely the innovative behavior of organizations (Schoonhoven & Jelinek, 1997; Brown & Eisenhardt, 1997; Tushman et al., 1997). However, because the CIS II survey did not provide data of the organizational structure of the respondents, we could not include this type of variables in the present analyses.

The fact that we used the data from a survey that was not designed for our specific research questions has implications for the accuracy of the different indicators used. In the CIS survey, for example, organizations are asked whether of not they use different collaboration possibilities. However, organizations are not asked to give an indication of the extent to which they use these possibilities. In this way, an organization that collaborated with one national customer, one European supplier, and one American research institute, received the same score on the relevant variables as an organization that collaborated with 5 national customers, 5 European suppliers and 3 American research institutes. Although past research has shown that the diversity of the collaboration portfolio might be a more important predictor for innovative performance than the number of collaborations in which an organization engages (Baum et al., 2000), we believe that including the extent to which organizations use the different collaboration possibilities would contribute significantly to better insights in how collaboration can contribute to the innovation strategies of organizations.

It can be observed as well the used distinction between explorative and exploitative collaborations can be refined considerably. Following recent contributions (e.g. Koza & Lewin, 1998, Rothaermel, 2001), we based our conceptual distinction between exploitative and explorative collaboration on the type of partner that was involved in the collaboration. More specifically, we assumed that collaborations with suppliers and customers will be more exploitative oriented, while collaborations with universities and research institutes will be more explorative oriented. However, a more reliable way to make a distinction between exploitative and explorative collaborations would be to assess explicitly the learning objectives of the different collaborations in which an organization engages. This would not only allow to assess if collaborations with suppliers and customers are indeed more exploitative oriented and collaborations with universities and research institutes have

a more explorative nature, it would also allow to integrate other kinds of collaboration, such as collaboration with competitors, into the exploitation/exploration dichotomy.

Finally, also our measurement of innovation output warrant comment. More specifically, it is important to notice that our measurement of innovation output has to be categorized as a subjective one. After all, to measure innovation output, we rely on the assessment of the commercial successfulness of new and improved products by the respondents themselves. The use of self-report measures of innovativeness brings along a great risk of percept-percept bias (Anderson et al., In Press). However, finding objective measures that capture the innovativeness of organizations, especially within non-patenting-intensive industries, is not a straightforward task. Therefore, for future analysis we propose to optimize the validity of subjective performance measures, by using multiple respondents and assessing inter-rater reliabilities. (Fryxell et al., 2002).

Despite these limitations, our findings revealed results in line with the hypotheses outlined. The purpose of this study was to assess how the collaborative behavior of organizations can influence the innovative output of these organizations. Based on our results we can conclude that the more organizations use different collaboration possibilities, the more likely they create new or improved products that are commercially successful. Moreover, we also showed that different kinds of collaboration will be useful for different kinds of innovation outcomes. Because of these results we believe that senior management will not only have to pay attention to how internally incremental and radical innovation projects are balanced, but also will need to consider how a portfolio of exploitative and explorative inter-organizational collaborations can be created that supports these different innovation projects.

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