Markets and innovativeness: Does structure influence innovation performance?*

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Summary
This empirical analysis of a microeconomic dataset for the year 1992 and 833 Dutch industrial firms finds that innovativeness (i.e. the share of "radically or completely new products" in turnover) is related to the length of the product life cycle, R&D intensity and technological opportunities at firm level. The Schumpeterian notion that entree barriers, market power and market concentration are important for innovativeness is contested by our findings as firm size, the concentration ratio, persistence of profit parameters, and entry and exit rates turn out to be insignificant. On average, knowledge protection by patenting reduces the firms' innovation performance whereas market-induced knowledge protection created by first mover advantages increases innovativeness at the firm level. Our investigation supports the notion of modern innovation theory that co-operation between suppliers, main producers and users improves firms' innovation performance.

1 Introduction

Innovation and Schumpeter are almost synonymous in many economic discussions. Indeed, ever since the introduction of the notion of creative destruction (Schumpeter 1942) this particular vision of how, on the one hand, innovativeness and, on the other hand, market structure (firm size and concentration) interact has dominated empirical research that seeks to relate R&D expenditures to market power. Empirical evidence, however, for the Schumpeterian hypothesis is scant, both at the level of firms and industries (Symeonides, 1996) and at the macroeconomic level (Van Bergeijk and Haffner, 1996).

One reason why empirical studies may have been unable to detect the Schumpeterian notion of a positive correlation between innovativeness and market power may be that the research design is concentrating on the input of the innovation process (i.e., R&D) rather than the output of that process (i.e., the new products that arrive and survive on the market). Another reason may be that most studies only investigate a single specific aspect of market structure, whereas structure is an intrinsically complex and endogenous concept with many dimensions. In this paper we will try to achieve a more comprehensive picture of the forces that determine innovation, using insights of modern innovation theory.

Our interest in this topic derives from two perspectives:

- the lagging of Dutch innovativeness behind other European countries; and
- the area of tension between on the one hand competition policy (that aims at improving the efficient and dynamic functioning of markets) and on the other hand technology and industrial policy (that stimulates technological co-operation between firms and research institutes).

Dutch innovativeness is lagging behind other European countries. Figure 1 compares the proportion of sales in new product areas in the 12 countries as reported by the European Community Innovation Survey (Calvart et al, 1996). The figure shows a wide variation in innovation performance among countries. Due to methodological complications and because the CIS data contain some country specific biases (for France, Spain and Portugal) in the way firms responded to the questionnaire, caution is recommended when interpreting the results of international comparisons. Nevertheless, the innovation performance of Dutch firms is among the lowest; around 35% of sales in new products for Dutch firms compared to around 60% in Germany (the average is 41%).

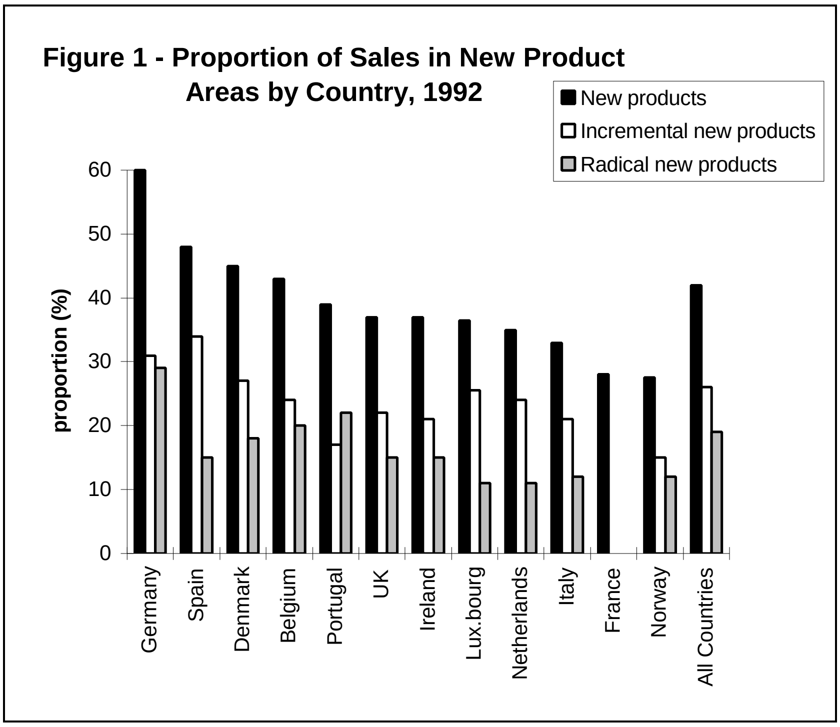

Figure 1 - Proportion of Sales in New Product Areas by Country, 1992

Our second motivation is the substantial change in the Dutch policy environment that now features competition and deregulation, whereas the Netherlands used to be the ‘cartel paradise of Europe’ (Asbeek-Brusse and Griffiths, 1995). Discussion of this structural policy change focusses on the possible trade-off between, on the one hand, the stimulus from more vigorous competition policy creating economic dynamism and, on the other hand, the negative influence on “excess” or “monopoly” profits that are assumed to be the major source for financing R&D and “thus” for innovation. At the same time Dutch innovation policy aims at increasing innovativeness by stimulating technology co-operation between firms and research institutes. Thus the research question that we address in this paper is at the heart of Dutch economic policy as it deals with an important topic on the interface of competition policy, innovation policy and economic growth.

The plan of the paper is as follows. Section 2 briefly restates the literature on the determinants of innovation. On the basis of this literature Section 3 develops a short hand description (“core model”) of innovativeness (i.e. the share of ‘radically or completely new products' in turnover) that is related to the length of the product life cycle, R&D intensity and technological opportunities at branch level. Next we discuss extensions of this "empirical core model" considering market structure variables (such as concentration, entree- and exit-ratios) and performance indicators (such as persistence of profits parameters) that operationalize important ingredients of the Schumpeterian analysis. Next we add variables that reflect the possibility of effective knowledge protection (patenting and first mover advantages). Finally, we introduce some indicators referring to the impact of inter-firm co-operation on innovativeness. So in a sense our model investigates the Schumpeterian hypotheses as well as the hypothesis of modern innovation theory that inter-firm co-operation improves the innovation performance of firms. Section 4 then presents and discusses the empirical results (an appendix discusses the data sources in more detail). In the final section we discuss our findings in the light of recent market developments.

2 The determinants of innovation

One of the central issues in the industrial organisation literature focuses on the link between market structure and firms' innovativeness. A common argument in this part of the literature, mostly using the economic analysis of Schumpeter (1942) as a starting point, is that a concentrated market structure and a large firm size may improve firms' innovativeness and hence their competitiveness. This view contradicts the classical observation, based on the "ideal" model of perfect competition that monopoly power results in static allocative inefficiency. Schumpeter did not explicitly explain why large enterprises should perform better as innovators, but his successors formulated several hypotheses explaining why innovation would increase with firm size and market power (for an overview, see: Cohen and Levin, 1989; Geroski, 1990; Symeonidis, 1996). According to this literature large firms with market power have:

- superior access to external capital;
- a better ability to pool and spread risks and to gain monopoly profits;
- scale and scope economics in the production of innovations; and
- more possibilities to finance R&D from own profits and to appropriate the returns on innovation.

Symeonidis (1996) surveys the empirical literature on the relationship between innovation, market structure and firm size and found little evidence in support of the Schumpeterian hypothesis:

> "The main characteristic of the empirical literature on innovation-market-structure hypothesis is its inconclusiveness. However, three main results seem to have emerged. First, there is little evidence of a positive relationship between R&D intensity and concentration in general, although there may be circumstances where such a relationship exists. Second, there is even less evidence of a positive relationship between innovative output and market structure. Third, industry characteristics such as technological opportunity explain much more of the variance in R&D intensity or innovation than market structure."

In addition, Symeonidis (1996) points out serious limitations such as measurement problems, econometric problems relating to the endogeneity of market structure and methodological problems such as the use of concentration ratios as a proxy of market power.

A fundamental shortcoming of this part of the literature on firms' innovation performance is that it focuses on the individual firm as a solo performer in innovation processes (the Schumpeterian "heroic entrepeneur"). Indeed, innovations are strongly motivated by the horizontal struggle between competitors, but vertical relations between suppliers, main producers and users are also of great importance for the creation of innovations (Edquist, 1997). Following Schumpeter, innovations can be characterised as new combinations of (existing) knowledge and competencies, originating from different actors in the value chain. It has already for a long time been recognised in modern innovation theory that firms almost never innovate in isolation. Close interaction and knowledge exchange with customers, competitors and suppliers of machinery and inputs is needed to innovate. And according to the insights of modern interactionistic innovation theories innovations cluster in industries that have a variety of forward and backward economic and technological linkages in the value chain (for a review, see: Debresson, 1996 and Edquist, 1997). However, so far vertical relations have not been systematically analysed in innovation theory and there is a lack of an adequate theoretical approach as well as little empirical evidence that support the hypothesis of interdependence between economic linkages and innovation performance (Roelandt, Gerbrands, Van Dalen and Van Sinderen, 1996).

One exception is the pioneering work of DeBresson (1996), who developed a stochastic theory for the prediction of innovation performance (DeBresson, 1996). In his view economic conditions do not determine innovations but only increase the probability that an innovation occurs. The economic conditions act both as constraints and incentives that make innovative activity more probable in one area than in another. Accordingly innovative competition is not made by individual firms, but by networks (DeBresson and Amesse, 1991). In this line of reasoning firms do not compete on their own. Paradoxically, they compete through co-operation, within a network of other firms. In this view the probability of innovation strongly depends on the number and variety of supplier an users linkages between firms and industries. A domestic producer has more incentives to innovate when it serves a variety of user industries and when it uses inputs from a variety of domestic supplier industries. The underlying rationale of this hypothesis is that the variety of information and competences by dense suppliers and users networks will produce more possibilities to recombine factors. As all innovative outputs need new combinations, it follows that innovative outputs would be more likely when the number of user and producer linkages increase. Figure 2 illustrates this "interdependency hypothesis", assuming that the level of innovation performance increases more than proportionately with the number of economic linkages. DeBresson and his associates found significant empirical support for this hypothesis in such diverse countries as Italy, France and China.

Figure 2 - The vertical interdependency hypothesis on innovation

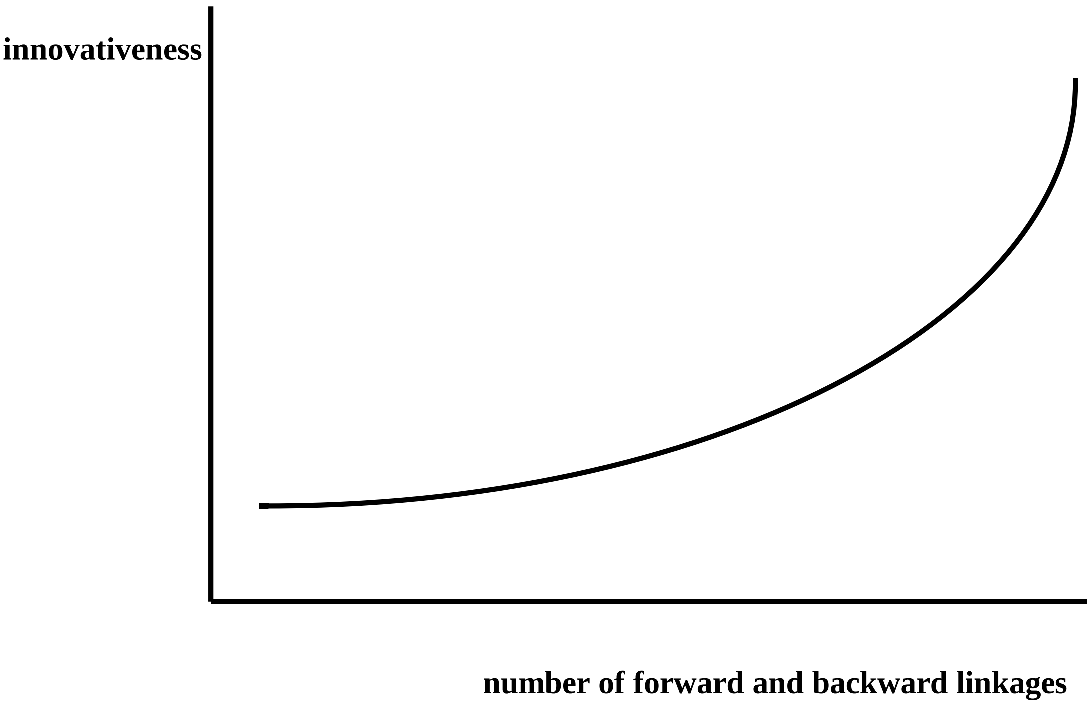

Figure based on DeBresson and Amesse (1991)

To conclude, the literature suggests that there seems to be little empirical support for the hypothesis that market power, a large firm size and market concentration will increase the level of innovative activity. This implies that there may be no trade-off between static and dynamic efficiency and between competition policy and innovation performance. Modern innovation theory suggests that a dense suppliers-users network and co-operation and knowledge exchange between suppliers and users in a value chain (vertical interdependency) improves the firms' innovation performance. This implies that the combination of a vigorous competition policy creating economic dynamism and at the same time a technology policy that stimulates vertical co-operation between firms would increase the probability of innovative behaviour.

In the next section of this paper we will focus on this issue, analysing empirically the link between innovative activity, market structure and inter-firm co-operation. Does the suggested relationships between on the one hand the smooth functioning of markets and vertical inter-firm co-operation and on the other hand the level of innovativeness hold for the Netherlands?

3 The core model

The research strategy adopted in this paper is a two stage procedure consisting of, firstly, developing a "core" model that explains actual innovativeness at the firm level on the basis of conditional factors (R&D-intensity, the length of the product life cycle and technological opportunities) and, secondly, adding to this "core" model a number of variables that reflect market structure and/or market conduct and public innovation policy instruments.

The various indicators of innovative behaviour used in the literature can be characterised by measuring either innovative inputs or outputs (Research & Development, patents, number of significant innovations, share of new products in turnover). These measures have both advantages and disadvantages (Cohen and Levin, 1989; Symeonides, 1996). The problem with patent counts is that the "propensity to patent" strongly depends on industry structure and market conditions. Moreover not all patents will finally result in successful innovations. It has also been argued that the economic impact of radical and major innovations is initially low (Symeonidis, 1996). Radical innovations subsequently undergo a series of small and gradual improvements that finally result in a broad diffusion and adoption of the new developed knowledge in a variety of new products. In our analysis we would like to focus on this broad interpretation of innovativeness using "the proportion of radical or completely new products in firm's turnover" as a proxy. We have used the firm's research and development activities (measured by R&D-intensity, that is: full time equivalents engaged in research and development as a share of total employment) as a proxy for the innovative inputs. All in all, we expect that R&D-intensity correlates positively with innovativeness.

One difficulty, however, in measuring the relationship between innovation performance and market structure is that opportunities to innovate can structurally differ between industries and sectors due to the specific market characteristics and the available possibilities of actually using new technologies for product and process renewal. In the literature most studies have controlled for technological opportunity, appropriability conditions, or both. The literature suggests that this kind of industry characteristics explain more of the variance in innovation performance than market structure variables (Symeonidis, 1996). To handle this issue we have used two different measures:

- LIFECY: the length of the product life cycle at firm level, and
- TECHOP: technological opportunities at industry level (3 digit), by ranking the average industries' unit values in low and high technological opportunities (De Graaf and Noordman, 1995).

We expect a negative correlation between the length of the product life cycle and the level of innovativeness as a long length of the product life cycle may reduce the incentive to innovate in the short run. We expect a positive correlation between the technological opportunity proxy at industry level and the firm's innovativeness.

Subsequently, we have extended this core model considering market structure and market conduct variables . Having the Schumpeterian approach in mind, we focus on variables that indicate the level of competition in a market. The intensity of competition is difficult to measure with any precision. To get a more comprehensive picture of the different factors that might determine the level of rivalry or market power we have used seven measures:

- SIZE: firm size (number of employees at firm level);
- PROFIT: the persistence of profits (at industry level, 3 digit). The estimated values of PROFIT indicate how fast short run excess profits return to normal profits in the long run. A high PROFIT level indicates a low level of rivalry;
- C4_90: the C4 concentration ratio (market share of the four largest companies in the industry, 3-digit-level);
- ENTRY: the share of new entrants at industry level (3-digit);
- EXIT: the share of exiting firms at industry level (3-digit);
- PATENT: the possibility of effective knowledge protection by patenting (dummy-variable); and
- TIME: the possibility of effective knowledge protection by first mover advantages.

Following the Schumpeterian line of reasoning we expect a positive correlation between on the one hand SIZE, PROFIT, C4_90, EXIT, PATENT and TIME and on the other hand innovativeness. Furthermore we a priori expect a negative correlation between innovativeness and ENTRY.

Next to this we extended the model with vertical interdependency variables following the interactionistic innovation theory. The theory suggests that co-operation between users and suppliers in a network might improve the innovation performance of firms. We operationalized this hypothesis by using two proxies:

- LINKS: the total number of forward and backward linkages at industry level (3 digit), and
- COOP: the existence of co-operation with suppliers and users at firm level (dummy variable).

We consider the first variable to indicate the variety of the network structure in the industry in which a firm operates (following Roelandt, Den Hertog and Jacobs, 1997). The second variable refers to the actual existence of co-operative agreements directed towards innovation between a firm and his suppliers and users. We expect a positive correlation between on the one hand LINKS and COOP and on the other hand the probability of innovative behaviour.

Finally we extended the model with a policy variable (POLICY), referring to the use of one of the Dutch policy measures, aiming at improving firms´ innovative behaviour by granting a loan to research and development activities. This facility, called the "Technologisch Ontwikkelingskrediet (TOK)" (Technological Development Credit) originated in the 1950s and can be characterised as a "revolving fund" as firms have to reimburse the loan after having successfully innovated. Naturally, we expect that TOK affects innovativeness in a positive way.

4 Empirical results

Table 1 summarizes the results of our OLS regressions.
The estimations of the core model in column 1 show significant correlations consistent with a priori theoretical expectations. Research & Development activities positively contribute to innovativeness, and so do technological opportunities at the industry level. Our estimations support the hypothesis that a long product life cycle discourages innovative behaviour in the short run. The coefficients of the core model appear to be rather stable (see specifications 2 to 10).
From the regressions market concentration, firm size and entry barriers do not appear to contribute significantly to innovativeness. All market structure variables turn out significant and signs often contradict with the Schumpeterian line of reasoning.

The estimates for knowledge protection parameters (PATENT and TIME) at first sight contradict common sense. On average, knowledge protection by patenting appears to decrease the firms´ innovativeness. This result, however, is consistent with the literature on the impact of knowledge diffusion on innovativeness (OECD, 1996). Knowledge protection by one firm simply hinders other firms to imitate and adopt the new knowledge. On the other hand, market-induced types of knowledge protection, like first mover advantages, stimulates the innovative behaviour of firms. In that case not only the first innovating firm can benefit from running ahead of his competitors, but at the same time this stimulates its competitors to improve their own innovation performance.

The findings offer empirical support for modern interactionistic innovation theories which state that an extended network of users and suppliers as well as actually co-operating with suppliers and users will increase innovativeness (Roelandt, Gerbrands, Van Dalen and Van Sinderen, 1996, DeBresson, 1996). It is interesting to note that this is not the case for co-operative agreements with other actors than users and suppliers. We did not find any significant evidence that co-operating with public and private research institutes and universities or using intermediate broker institutions (like the Dutch Innovation Centres) significantly improve the innovation behaviour of firms.

Table 1 – Regression Results, firms in industry, 1992, OLS.

Dependent variable: share of radical or complete new products in turnover (INNO)

Restriction: RDI<100

Model	1	2	3	4	5	6	7
RDI	0,83*	0,84*	1,02*	0,84*	0,82*	0,85*	0,7
Techop	3,11*	3,06*	3,08*	2,90*	3,24*	3,66*	3,3
Lifecy	-0,15*	-0,14*	-0,14*	-0,15*	-0,15*	-0,15*	-0,
Size_200		-1.11					
Profit			-7,10				
C4_90				-0,02			
Entry					0,01		
Exit					-0,10		
Patent						-2,43**	
Time						3,33**	
LinkS							0,(
Coop							4,1
Policy							
Turnover							

Const	12,7*	13,0*	15,2*	13,4*	13,2*	10,9*	9,8
R^2_{adj}	0,10	0,10	0,12	0,10	0,10	0,12	0,1
F-value	33,6*	25,4*	24,1*	24,6*	20,1*	21,9*	22
No. Obs.	873	873	701	870	867	835	87

Sources: Dutch Innovation Survey 1993 , EIM, CBS and CPB. For more details see Appendix.

* p < .01   ** p < .05 *** p < .10

Finally, the estimates for public innovation policy instruments suggest a significant positive relationship between the TOK facility and innovativeness. Other policy measures (the "PBTS" aiming at facilitating co-operation between firms, universities and research institutes and participating the EC technology programmes) do not significantly improve firms´ innovative behaviour.

To conclude, the final model (F = 15,5) shows that:

- research and development activities and technological opportunities at industry level improves the innovation performance of firms;
- a long product life cycle discourages to innovate in the short run;
- market concentration, firm size and market power does not show any significant correlation with innovativeness and thus we did not find support for the Schumpeterian hypotheses;
- overall, effectively patenting discourages innovativeness and "first mover advantages" encourages innovation performance. This implies that market-induced types of knowledge protection benefits the first innovator and at the same time stimulates its competitors to imitate and adopt the newly developed knowledge in their products;
- a dense user-supplier network as well as co-operating with users and suppliers when innovating will increase firms´ innovativeness.

Obviously, our findings should be interpreted with caution as we have faced serious data and measurement problems. Our model, while significant in what it explains, only accounts for 12 per cent of the variance in innovation performance. First of all we could not account for other variables that, according to the modern innovation theory, also might explain the level of innovativeness. For instance, we have used the level of research and development activities as the main and only input into the firm´s innovation process. Modern innovation theory suggests that several other types of knowledge (and more in particular the combination of a variety of knowledge inputs, like education and training, marketing and design, organisational renewal) also contribute significantly to the firms´ level of innovativeness. Moreover, in the Netherlands research and development activities are highly concentrated within a few large companies. The five most R&D-intensive companies in the Netherlands account for almost 50 per cent of the total R&D expenditures and about 50 Dutch firms account for 90 per cent of the total private research and development expenditures. In combination with the relative low level of innovativeness of Dutch firms (see section 1) our data set contains a lot of different firms that combine low levels of R&D with low shares of new products in their turnover. Besides, due to lack of data, we had to leave firms operating in the service sectors and in the farming sector outside our analysis (most of the variables in the extended model are missing for the service sectors and the survey does not contain any firm in the agricultural sector).

Indeed, measuring the degree of rivalry in a market with any precision is very difficult. We have used broad indicators and found no significant correlations. And we could not specify more precisely the various mechanisms that might explain the relationship between market structure and innovativeness. This is a more general limitation that has also been recognised in the literature in this field. The fact that we have not found support for the Schumpeterian hypothesis does not simply mean that we have found evidence for the competing hypothesis that a smooth market functioning improves innovativeness. However, the findings offer support for the "interdependency hypothesis" and in addition suggest that market-induced forms of knowledge protection increase the propensity to innovate.

5 Discussion

How can we interpret our findings in the light of recent market developments? Due to the changing nature of competition, the competitiveness and innovativeness of firms is increasingly dependent upon entering strategic alliances with other companies and knowledge institutions which have complementary knowledge and technology (Oerlemans, 1996, and Reger, 1997). As a result of the increasing globalisation of world trade (Van Bergeijk and Mensink, 1997) and the opening of sheltered markets, competition is getting a more international dimension and is intensifying. A firm's competitiveness is increasingly dependent upon the ability to apply new knowledge and technology in products and production processes. Companies have to adapt themselves to rapidly changing market conditions or take the lead by innovating its products and production processes. Technological developments are taking place at an ever higher speed and the rate of specialisation is increasing (Yoshitimo, 1997). It is increasingly difficult for individual companies to produce all the relevant knowledge in house and to translate new knowledge into innovative products or production processes. To reduce risk, companies are specialising around their core competencies. Consequently, for their success in the innovation process, companies are becoming more dependent upon complementary competences outside the own company. Innovation is not so much a sole activity of a single company (like the "heroic Schumpeterian entrepreneur"); it requires an active search process to tap new sources of knowledge and technology and to apply them to products and production processes. This places great demands on the ability of companies to organise new combinations of complementary competences in a flexible way (Vickery and Wurzburg, 1996). By a more flexible organisation and integration of different links in the production chain through entering strategic alliances, joint ventures and consortia, companies are developing strategies to cope with the increasing dependency on their environment. The synergy stemming from the combination of complementary and dissimilar competences and the necessity to cope the dependency on the environment are the driving forces behind the development of such co-operative relationships, which are meant to increase the innovativeness and competitiveness of all participating parties.

Establishing such co-operative relationships makes it easier for companies to respond to changing competitive relations and to the ever higher quality demands of their customers. Products and services have to be dedicated to the individual needs of the customers. This "customisation" is not only a trend in the market for capital goods but also, and to an increasing extent, in the market for consumer products and services. As a result, the innovation process extends over the full production chain. Strategic formation of networks aimed at innovation requires therefore a flexible integration of activities of different companies in the full value chain.

In this way, rivalry between companies for the favour of the high demanding customers is stimulating the formation of networks of innovative actors and an increase in the quality of products, services and production processes in the whole production chain. This need for integration of several parts of the production chain has the result that in many cases the most innovative networks cross the traditional borders of companies and sectors. New combinations of markets and technologies require new forms of division of labour, as is exemplified by the developments in the mecha-tronic (1970s), the opti-tronic (1980s), the bio-chemical industry and multi-media (1990s).

Our findings seems to reflect these market developments, challenging the traditional line of reasoning in economic research that primarily analyses horizontal relations between competing firms with similar activities and focuses on price competition, entry barriers and the individual firm. Due to changing market conditions, nowadays competition is not about individual firms, but about networks of dissimilar firms in the same value chain. And the firms' competitiveness strongly depend on its capability to absorb and use new knowledge and to participate in strategic production networks.
So, inter-firm co-operation and competition coincide. According to Enright (1995) the appropriate question is not whether to compete or co-operate, but rather on what dimensions to compete and on what dimensions to co-operate. This issue is at the very heart of economic policy making as it deals with an important topic at the interface of competition policy, innovation policy and economic growth. Our findings suggest that a combination of a vigorous competition policy creating economic dynamism and at the same time a technology policy that stimulates (vertical) co-operation between firms, can increase the probability of innovative behaviour.

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Appendix: Summary of database and descriptive statistics

The data set contains microeconomic data of 833 industrial firms in the Netherlands for the year 1992. This data set consists of survey data gathered and kindly provided by the Stichting voor Economisch Onderzoek (SEO), University of Amsterdam. We extended the data set with some variables at the sectoral level (3 digit), using these indicators as a proxy of industry characteristics.

(1) The variables

Dependent variable

INNO: This variable represents at firm level the proportion of radically changed or completely new products in turnover (1992). Data source: SEO, Dutch Innovation Survey, 1992.

Independend variables

"Core model"

RDI: This variable measures the R&D intensity, based on the volume of labour years (full time equivalents). More precisely RDI is defined as the volume of R&D activities within a company (in labour years, full time equivalents) as a percentage of the total number of personel (in full time equivalents). Data source: SEO, Dutch Innovation Survey, 1992.

TECHOP: De Graaf and Noordman (1995) constructed 5-digit product groups, using unit values as proxy for technological content. This classification is an alternative for the OECD-classification of sectors on account of R&D-intensity. The CPB classification is used in this study to construct a 3-digit 0/1 dummy variable "TECHOP". When a sector produces low-tech or medium-low-tech products, the value is 0, otherwise the dummy has the value 1.

LIFECY: This variable measures at firm level the length of the life cycle of the most important products (in years) of the firm. Data source: SEO, Dutch Innovation Survey, 1992.

Competition

Size_200: We constructed a 0/1 dummy variable to control for the employment at the firm level in 1992 (in full time equivalents). Value 0 means less than 200 employees (FTE's), value 1 means 200 employees (FTE's) or more. Data source: SEO, Dutch Innovation-Survey, 1993.

PROFIT: Kleijweg and Nieuwenhuijsen (1995) estimated for the Dutch industry (3-digit level) how fast excess profits, made in the short run, disappear in the long run. When profits in a sector exceed the average profit level of all industries together, excess profits are made. With the help of regression analysis, whereby actual excess profits are confronted with excess profits in the past, the relative speed in which profits adjust to the calculated industry average is defined. A high value of the variable "PROFIT" means that short term excess profits disappear relatively slowely. This indicates a low level of rivalry. For an extensive description of the research method en results, see Kleijweg and Nieuwenhuijsen (1995).

C4_90: Employment in 1990 of the 4 most labour intensive companies in a sector divided by the total employment in the 3-digit sector for that year. Data source: CBS.

ENTRY: Percentage of new entrants in a sector at 3 digit level ("starters en overige oprichtingen") in 1992. Data source: Chamber of Commerce, "Mutatiebalansgegevens 1992".

EXIT: Percentage of exiting firms ("opheffingen en faillisementen") in 1992 at 3 digit level. Data source: Chamber of Commerce, "Mutatiebalansgegevens 1992".

PATENT: Trying to protect the competition advantage of innovations, firms have different opportunities. One of them is patenting the innovation. In the SEO survey, firms were asked to judge, on a scale from 1 to 5, how effective this instrument is for protecting their competitive advantage. Based on these results, we constructed a 0/1 dummy variable, whereby 0 means "not important" and 1 means "important".

TIME: To protect the competition advantage of innovations, firms can benefit of "first mover advantages". In the SEO survey, firms were asked to judge, on a scale from 1 to 5, how important the time benefit for the first innovator' is for protecting their competitive advantage. Based on these results, we constructed a 0/1 dummy variable, whereby 0 means "not important" and 1 means "important".

Co-operation

LINKS: The variable LINKS represent the number of backward and forward linkages of a sector with suppliers and users, based on 3-digit input-output-tables. Source: CBS, National Accounts.

COOP: In the SEO survey, firms were asked whether they participated actively in

1992 in R&D-projects with other organisations (like suppliers, customers, universities, rival firms). Contracting R&D out, without active participation, is not meant in this definition. Based on these results, we constructed a 0/1 dummy variable. To firms that do not actively participate in a R&D project we assigned the value 0. Firms that co-operate with suppliers and custumers were marked with value 1. Firms actively involved in R&D projects in another way were also marked with 0.

Other

POLICY: In the SEO Innovation survey firms where asked whether they were credited in 1992 with Technical Development Credits ("Technologisch Ontwikkelingskrediet"). We constructed a 0/1 dummy variable with value 0 when a firm is not credited with this kind of government support and value 1 when a firm received such a credit.

TURNOVER: Based on indexdata (1985=100) of total sales for the year 1992, we constructed a 3-digit variabele representing the growth of turnover in the 1985-1992 period. Data Source: CBS, Maandstatistieken.

(2) Descriptive statistics

The models in this study have been tested, using OLS regression analysis. R&D-firms (RDI=100) were excluded (3 cases). The analysis is based on a microeconomic dataset for the year 1992, including 833 observations for each variable.

The following table represents the correlation coefficients (to measures the strength of the association between two variables). The matrix contains the dependent variable and the significant independent variables of table 1 (see section 4 of this paper).

Table A: Correlation matrix (Restrictions: RDI<100, SBI74>200 and SBI74<400)

	INNO	RDI	TECHOP	LIFECY	SIZE	PROFIT	C4_90	ENTRY	EXI
RDI	0,24*	1							
TECHOP	0,13*	0,07*	1						
LIFECY	-0,17*	-0,09*	-0,12*	1					
SIZE_200	-0,02	0,12*	-0,08*	0,04***	1				
PROFIT	-0,07**	0,08*	-0,28*	0,01	0,11*	1			
C4_90	0,04***	0,22*	-0,08*	0,01	0,18*	0,32*	1		
ENTRY	0,02	0,06*	0,06*	-0.03	0,03***	0,22*	0,03	1	
EXIT	0,00	-0,00	0,04**	-0,06**	0,00	0,15*	-0,00	0,80*	1
PATENT	-0,00	0,18*	0,08*	-0,00	0,11*	-0,02	0,03	0,03	-0,0
TIME	0,09	0,10	-0,02	-0,06	0,09	0,02	0,02	-0,03	-0,0

	*	*		**	*				
LINKS	0,04	0,02	-0,16	-0,08	0,01	0,14	-0,15	0,08	0,03
	***		*	*		*	*	*	
COOP	0,11	0,12	-0,03	-0,06	0,18	0,03	0,06	-0,01	-0,0
	*	*		**	*		**		
POLICY	0,10	0,21	0,06	-0,03	0,07	-0,02	0,06	-0,01	0,01
	*	*	*		*		*		
TURN OVER	-0,04	-0,05	0,20	0,00	-0,09	-0,08	-0,40	-0,06	-0,0
	***	*	*		*	*	*	*	

* : P<0.01 (1-tailed significance), ** : P<0.05 (1-tailed significance), *** : P<0.10 (1-tailed signif