Innovation Systems and Innovative Performance: Voice Systems

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Abstract

The literature on 'exit' and 'voice' countries (Anglo-American versus continental European economies and Japan) points to performance differences between these two generic systems of innovation. However, little has been done so far to study differences among voice countries. This paper suggests that four 'voice' countries, Austria, Finland, the Netherlands, and Germany, with stable long-term trust relations between economic actors and a relatively consensual style of decision making, show substantial differences in innovative performance. I argue that this is due to both sector specialization and the institutional environment. This is because the capacity to escape from historical patterns of industrial specialization depends in part on the set of institutions in a country. They provide important resources for innovation, such as capital and skilled personnel. Indirectly, innovations are affected by the system of economic governance, which is more or less corporatist in these four countries. However, a corporatist regime can be responsive or rigid, depending on the degree of exposure to external challenges and crises (regime effect). Furthermore, the same responsive or rigid regime can result in different types of innovation, depending on whether firms have to operate in a competitive, highly exposed sector or in a sheltered one (sector exposure effect). The first tentative empirical results show that the regime effect dominates over the sector exposure effect.

Descriptors: innovation performance, technology lock-in, varieties of capitalism, national systems of innovation, corporatism

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Introduction

Studies in the 'varieties of capitalism' literature have distinguished two kinds of 'generic' innovation systems: the 'exit' versus 'voice' model, or the 'type A' and 'type B' systems, (see, e.g., Nooteboom 2000), often exemplified by idealised models of the Anglo-American and the continental European–Japanese type (Dore 1986; Sako 1992). Relatively formal, distant and short-term relations between economic actors such as customers and suppliers, employers and employees, and between competing firms characterize type A systems. Actors operate individually on *markets*, business relations are formalized in *contracts*, and when dissatisfied, actors '*exit*' the relation and look for new partners on the market. Relations, there-

Organization Studies
2000, 21/5
941–969

0170–8406/00
0021–0037 $3.00

fore, are often short-lived. Actors do not invest much in them, but are also not subject to hold-up problems. Firms and workers have relatively short-term perspectives.

In type B systems, economic actors establish longer lasting and more exclusive relations with each other, do not easily change partners and *'voice'* dissatisfaction rather than exit the relationship and look for new partners. Actors invest in relation-specific assets — e.g. workers in skills useful only for one employer — and cooperate in finding new solutions to problems experienced by (one of) the partners. Such relations may develop into stable multiple *networks*, with organizations specialized in coordination at the nodes, such as trade *associations*. Economic actors in type B systems have more of a long-term orientation, again as regards the relations in which they are engaged.

These different types of relations between economic actors have consequences for the nature of innovations. Economic actors in 'exit' systems are more able to take risks by changing partners regularly — and this should be conducive to more radical innovations. Actors in 'voice' systems with long-term relationships, in contrast, can share knowledge more easily, and can invest in the further development of such knowledge. That should aid innovation. However, such new knowledge would be developed from the existing shared knowledge base. This would be more conducive to incremental innovations, the more so as the reliance of actors on long-term relations reflects their greater attachment to security, and their reluctance to take great risks. Empirical studies seem to confirm this view. Casper (2000) finds American biotechnological firms to be specialized in more risky subfields where more radical innovations can take place, while German biotechnology firms concentrate on less risky fields of research and product development.

This paper suggests that innovative performance not only differs between exit and voice countries but also among voice systems; and that these differences are partly due to sector specialization and historical patterns of industrial organization, and partly to the combined influence of the institutional setting and a sector's exposure to external economic pressure. Stability and long-term orientation alone do not necessarily enhance innovation. They need external pressure to do so. Otherwise, stability can result in rigidity and paralysis. What holds for stable relations between economic actors also holds for their institutional environment. An institutional regime can be either responsive or rigid, depending on whether it is challenged from the outside or not, and firms that have to do business in a more responsive or more rigid institutional environment will react differently when they face strong or weak competition. Firms highly exposed to domestic or international competition, for instance, will be more inclined to make radical innovations in a responsive institutional environment than in a rigid one.

In the following, four 'voice' economies, Germany, the Netherlands, Finland, and Austria will be analyzed. They are all heavily exposed to international trade and are governed by institutions that result in relatively sta-

ble intra- and inter-firm relations. Section 1 gives an overview of some major characteristics of the countries and argues that relationships between key economic actors are more interdependent than adversary. The second section measures innovative performance using input and output measures and survey studies. For the purpose of aggregation, data have been standardized by attributing 1 to the highest value reached by the United States or the 15 EU countries and 0 to the lowest value of the variable. The type of innovation — radical or incremental — is measured by means of survey studies, literature-based indicators and technology indicators. The puzzle of how stable relationships can nevertheless result in different performance patterns is investigated in the next two parts. The third section explains differences in performance by means of sector specialization. The next section gives some complementary institutional explanations for performance variations: the degree of adaptiveness of institutions and external pressure to which sectors are exposed. The fifth section gives some first rough empirical evidence on institutions, sector exposure and innovation. These relationships are of course highly tentative given the theoretical and empirical difficulties of analyzing systematic connections between institutions, industrial specialization and innovation patterns, but do, I suggest, highlight the need for more detailed studies of exactly how institutions and macro-economic environments structure innovative performance in different sectors and countries.

Four Countries with Stable Relationships Between Economic Actors versus the United States

Austria, Finland, Germany, and the Netherlands are four 'voice' countries. Firm–competitor, firm–supplier, firm–customer and firm–worker relations are generally stable (OECD 1998: 259). Workers stay a long time with the same firm, and firms keep their traditional suppliers. This is facilitated as firms are exposed to less intense domestic competitive pressure than in exit countries, although Germany faces more domestic pressure than the Netherlands, and the two other countries less so.

Many relationships between economic actors in these countries are channelled through business associations (Van Waarden 1995). These organize many aspects of inter-firm relationships, regulate sectoral markets, provide collective goods, and act as conflict resolvers. Many associations are voluntary, although Germany and Austria also have compulsory business associations which together form the Chamber system, a relic of the medieval guilds. It is the strongest form of business organization.

Such associations facilitate the survival of small and medium-sized firms. While the largest 1 percent of all firms in the United States produce 72 percent of the value added, in Finland the figure is 62 percent, in Germany 54 percent, and in the Netherlands 35 percent. In Austria, the largest 2 percent of all firms produce only 26 percent of the value added. There are a considerable number of small firms in Finland in addition to some very

large ones, such as Nokia. In Germany, there is a greater variety of firm sizes, but the small and medium-sized categories are important. In addition to some rather large firms, the Netherlands has many smaller ones, organized not only in trade associations but also in cartels. In Austria, very large privately owned firms are almost non-existent.

Firm–worker relations are organized by and between important and rather centralized employers' associations and trade unions. Union density is the highest in Finland (72 percent in the 1990s), followed by Austria (46 percent), Germany (33 percent), and the Netherlands (25 percent), compared with only 16 percent in the United States. (see Table 1).[1] Trade-union power in the four 'voice' countries is still larger, when measured as the percentage of workers covered by collective agreement. In Austria, trade unions bargain collective agreements for basically all workers, whether union members or not. The coverage rate is 98 percent in Austria, 95 percent in Finland, 82 percent in Germany and 71 percent in the Netherlands but only 18 percent in the United States, where unions only bargain for their members (see Table 1). In addition, firm–worker relations are also organized at the local level, through shop stewards in Finland (Lilja 1997) and works councils in Austria, Germany, and the Netherlands. They have been (though to various degrees over time) the extended arm of well organized and centralized trade unions. National or sectoral wage bargaining reduces the firm's influence on individual workers, and firing restriction clauses in collective agreements make hiring and firing strategies rather expensive, as does statutory regulation. OECD data confirm that mobility of workers is relatively low. Only 12 percent of workers stayed less than one year in a specific firm in Austria, 16 percent in Germany and the Netherlands and 17 percent in Finland, compared to 26 percent in the United States (see Table 1).

This high degree of organization of economic actors in associations that regulate markets either alone or through contracts with other associations is typical for 'associational economic governance' or 'neo-corporatism'. Relatively centralized wage bargaining and consensual styles of decision making typify such countries (Van Waarden 1999). Historically, this governance regime, emphasizing concertation, consultation, and compromise, if not consensus, has developed under circumstances of vulnerability, typically experienced by economies that are highly exposed to international trade (Katzenstein 1985). Therefore small economies figure prominently in the list of 'neo-corporatism'.[2] In 1995, the degree of openness — a measure steadily increasing since the 1960s in all countries — was 13 percent in the United States, as opposed to 25 percent in Germany, 32 percent in Finland, 42 percent in Austria and 56 percent in the Netherlands (see Table 1).

Further institutional contrasts between these four countries and the United States that influence their innovative performance concern their financial and training systems. The financial system influences ownership and the extent to which there is finance for high-risk investments. Our countries differ substantially in the degree of importance of the equity market versus banks as capital providers. That should have consequences for innova-

Table 1. Major Characteristics and Differences of the Four Countries and Comparison to the United States

Country Type B Characteristics	Austria	Finland	Germany	Netherlands	Country Type A United States
Size: Population 94	8.0 mio	5.1 mio	81.4 mio	15.4 mio	260.7
Firms	small and medium	small and few large	all sizes	lack of medium	large
Economic facts:					
Growth rates '91–'97 average	1.7%	2.3%	1.5%	2.5%	2.8%
Unemployment '91–'97	5.8%	15%	9.1%	5.2%	6.2%
Investment growth '91–'97	2.4%	–1.7%	0.2%	2.8%	5.9%
(Exports+Imports)/2 in % of GDP '95	42%	32%	25%	56%	13%
Relationships:					
firm–competitor: *associations as mediator between firms*	compulsory membership in the Economic Chamber	few big competitors; high cooperation; small suppliers dependent on few big firms	mandatory memb. Chamber of Commerce; strong interaction within sector; independent of firm size	many cartels till 1992	weak associations
firm–unions:					
union density '95	46%	72%	33%	25%	16%
coverage rate '90s *works council, codetermination, job protection*	98%	95%	82%	71%	18% weak and decentralized unions, hire and fire
% of workers who stay less than 1 year in a firm	12%	17%	16%	16%	26%
Institutions for Innovation:					
Neocorporatism in the 1990s	strong, very encompassing associations; highly consensual business climate	strong but less encompassing; fair weather corporatism; high in strikes	medium, less consensual climate	strong, very encompassing associations; highly consensual climate	market governed interest groups
Equities issued in % of GDP '96 (Relevance of stock market)	15%	49%	28%	95%	114%
Government support of R&D in % of GDP '96	0.65%	0.95%	0.9%	0.8%	0.86%
Educational System *public schools and universities*	dual vocational training system by social partners; free universities	school-based; state governed; high number of free universities	dual vocational training system by social partners; free universities	dual vocational training but weaker; low fees for universities	strongly decentralized and differentiated; more private

Source: Unger (1997), Traxler (1996), OECD STI Outlook (1998), Adjustment Data Base Max Planck Institute (1999).

tion, assuming that radical innovation usually requires more risky investments. Credit-based systems, with capital channelled largely through banks, tend to produce more patient and growth-seeking financiers, with long-term orientation but also a certain risk aversion, than do equity financed systems (Soskice 1991; Whitley 2000).

An indicator of the importance of the stock market is the value of equities

issued in percent of GDP. Market capitalization of domestic equity issues is still extremely low in Austria (the value of all noted equities was 15 percent of GDP in 1996), and also relatively unimportant in Germany (28 percent). By comparison, it is high in the Netherlands (95 percent). In the United States, the stock market is even more important, in that the turnover of marketable equities is 114 percent of GDP. In Austria, the government and banks finance themselves via the domestic capital market (through bonds), and industry via bank loans and their own capital. The fact that there is little experience in stock exchange trade and that the market is very thin makes Austrian assets rather high risk. Finland is a special case. The relevance of its stock market increased tremendously in the 1990s, reaching a level of 49 percent in 1996 (see Schludi 1999). However, the illiquid money market was a serious handicap to investment and innovation in the early 1990s.

The importance of the stock markets makes the financial systems of Finland and the Netherlands more vulnerable to international capital movements, but at the same time provides a source of capital for more risky investments in innovation. This more flexible capital market seems to correspond with responsive corporatism in these countries. By contrast, rigid corporatism and more conservative bank finance seem to go together in Germany and Austria.

The educational and vocational training system influences labour skills and the involvement of workers in innovative strategies (Whitley 2000), and countries differ substantially in these systems. 'Voice' organized countries have more stable employment relations. Workers stay longer in firms and 'voice' complaints, instead of exiting to another employer. The employer does the same: he voices any complaints rather than firing workers. This is partly the result of statutory job protection and strong unions, but it is also a matter of culture. In such voice systems, employers are more likely to invest in training their workers, as the chance that a competitor will poach them is less. By contrast, in exit organized systems, employers are less likely to invest in their workers as poaching problems are greater; and paradoxically in such systems, there is also a greater need for training as a collective good, but there are fewer facilities for this due to the weaker associational governance in these countries. It may be that this dichotomy is somewhat oversimplified, as Crouch et al. (1999: 85–87) stress. They found differences between the exit countries the United States and the United Kingdom, as well as among the continental European voice countries. Nevertheless, educational systems are remarkably similar in these four countries.

Corporatist voice countries in Europe are characterized by well-developed vocational training systems organized by the social partners, which combine theoretical training in school with practical on-the-job training. Typical is the German and Austrian 'dual' vocational training system organized by the Chambers (Streeck et al. 1987), which are responsible for the entire training programme and content, the duration of training, the syllabi, the inspection, and the certification (Crouch et al. 1999: 140). It produces a

high level of training for medium-skilled workers. The Dutch also have a dual vocational training system, but not as tightly organized. Only 5 percent of workers in Finland follow a vocational training system (Schienstock 1999). However, the Finnish school-based system provides a high level of general skills for its whole population.

Corporatist voice countries also have well-developed public educational systems. Schools are free in all four countries. Universities are free in Austria, Germany and Finland and only have small fees (about 1,800 US dollars) in the Netherlands. Thus it can be said that all four countries have a strong public educational system. Finland has a highly decentralized university system with 20 universities for a population of only 5 million. This ratio is much higher than in the other countries, where one finds about one university per million inhabitants. With regard to R&D personnel per 1000 members of the labour force, Finland leads with twice as many researchers per 1000 workers (13.3) than Austria (6.6). Germany (11.7) and the Netherlands (10.5) are in between these extremes (see OECD 1998).

The results of the different training systems of exit and voice countries differ correspondingly. The OECD (1996) showed that 'exit' organized countries (in particular the United States and the United Kingdom) have a much more polarized labour force in terms of skills. At the high end there are a number of employees who perform highly skilled jobs, and for whom employers are willing to provide job security and investment in training. At the other end of the scale, there are a large number of low-skilled workers who can easily be hired and fired. As a result, the US has a relatively low share of skilled white and blue-collar workers: 37.4 percent (OECD 1998). This contrasts markedly with the corporatist voice countries: 58 percent for Germany and the Netherlands, and 54 percent for Austria and Finland. That is, the four voice countries vary only slightly in the degree of training and skills. However, this differs greatly with the exit countries. The consequence for innovation can be that exit countries display greater flexibility in adapting to new technologies and working methods, but have a potential skill problem. In voice countries, although workers may be more skilled, the system may be less flexible in adapting to change. The polarized skill structure in exit countries might be mirrored in a similar polarization of innovation: either radical or rather preserving.

Different Innovative Performances

Voice countries show a greater stability but lower flexibility on such economic performance indicators as inflation and unemployment than exit countries (Traxler and Unger 1994). For innovative performance, low flexibility could be a handicap. We would expect voice countries to follow fewer high-risk innovation strategies, favouring more incremental rather than radical innovations. For the following empirical rankings of the innovative performance of these four countries, data have been mean and scale transformed into a 0–1 variable. The highest value of the respective data

set for the United States and all the EU countries was set to 1, the lowest value to 0.[3] (The United States and Sweden have the highest scores for most rankings, and Portugal and Spain the lowest.) This standardization procedure makes differences (and similarities) among countries more transparent. It shows whether our four voice countries are more or less closer together on the US–European scale, and allows data to be aggregated. Minor differences among countries that might be overstated when using rank orders can be identified more easily by this method, as discussed in the following sections.

The data given here confirm the greater prevalence of high-risk firm strategies and a generally higher level of innovativeness in the United States than in Europe. They also show, however, that there are substantial differences among European countries. Table 2 at the end of this section summarizes the results on economic performance, input and output indicators.

The study of innovative performance is fraught with all kinds of operationalization and measurement problems (see Kleinknecht 1996 for a good and encompassing overview). For this reason, I will use a variety of indicators in an attempt to compensate for the shortcomings of each.

Research and Development Expenditures and Personnel

This easily available, standardized and internationally comparable indicator has the disadvantage that R&D differs by sector (and hence that the sector specialization of national economies distorts aggregate data), that it accounts for only 40–50 percent of total innovative input (design, trial production, tooling-up, market analysis, training) and that it undercounts small firms' innovative input. Last but not least, since it is an input indicator, it does not measure the innovative result, but only the *innovation effort*.

In 1997, Gross Domestic Expenditures on Research and Development as a percentage of GDP (GERD) were the highest in Finland (2.73 percent), followed by Germany (2.39 percent), the Netherlands (2.09 percent) and Austria (1.52 percent) (see Table 2). Finland ranks top among all OECD countries and even surpasses the US (2.64 percent). Only Sweden ranks higher, with 3.6 percent. Austria is on the other end of the scale, with only Belgium (0.8 percent) and Hungary showing less innovation (0.74 percent) (see OECD 1998). Given the huge amount of money that 1 percent of GDP represents, the differences are substantial. This is also reflected in the large spread of the standardized data. From a historical point of view, it is remarkable that Finland has caught up on this variable. Another remarkable factor is that in 1993 half of the Dutch R&D was imported, pointing to the globalization of R&D efforts. However, many global R&D activities are focused on adapting design and development to local markets (see OECD 1998).

Patents

Patents are available in long time series, do not suffer from secrecy problems, and allow classification by technical fields. New sectors that emerged

from several other sectors, such as biotech, are not included in traditional sector classifications, but can be aggregated from patent statistics. There are also disadvantages, however. Patent statistics measure the result of invention rather than innovation. They can be a throughput instead of an output. In addition, many sectors do not patent. Service sectors (repair services, transportation, communications, banking and insurance) have a high share of non-patentable innovations. Other service sectors (ship transportation, wholesale trade and intermediary trade firms) develop few innovations themselves but apply for patent protection of the products they are selling (Kleinknecht et al. 1993: 55). Patents become public, and this may inhibit firms from patenting certain inventions. Electronics (software), for example, has a low propensity to patent and rely on copyrights. Process innovations are kept more secret than product innovations, and hence are patented less frequently. Small firms patent only after having overcome a threshold. It is also unclear where firms place their patents. Smaller firms mostly patent domestically; larger firms domestically and in the United States. This leads to biases towards large firms when using US patent statistics.[4]

About half of all patent applications are successful. In 1998, 9,108 patents were granted to Germany by the US patent office, 1,253 to the Netherlands, 599 to Finland, and 398 to Austria, compared to 80,009 in the United States. No country comes anywhere near to the United States, which accounts for about 60 percent of all patents in the world.[5] This is due partly to the bias created by the fact that US patent statistics refer to domestic patenting of US firms, but to patenting abroad for all other firms. However, efforts to correct for this bias (by including Japanese and European patent statistics) still confirm the hypothesis that exit countries are highly innovative.[6]

When we correct for size of the economy by dividing patent applications by the number of inhabitants, Finland and Germany lead with 117 and 112 patents per million inhabitants, followed by the Netherlands (81) and Austria (50). The rank order is hence FIN, D-NL-A, the first two countries lying closer together than the third and fourth.

From 'objective' throughput or output indicators, also when using standardized data that include the low patenting of Portugal (0.5 per million of inhabitants), one can conclude that patents show a ranking of FIN, D-NL-A, with the United States scoring much higher on most of the output indicators.

Survey Studies

The sales of innovative products by innovating firms are a direct measure of output of innovation. This measure includes only successful innovations and allows for a distinction between imitations and innovations. The disadvantage is that it is derived from survey data, which often suffer from several biases. The near past seems more important than the more distant past, leading to an overestimation of recent developments. Furthermore, there is the problem of socially desirable answers. It is considered good to innovate, hence people exaggerate this aspect in surveys. Furthermore,

innovators often do not know whether the rest of the industry also innovated, i.e. they cannot distinguish whether an innovation is new to the firm or to the industry. Debresson (1996: 47) quotes surveys where 20–40 percent of the national first respondent firms claimed that they were also world firsts. In addition, differences in life cycles make an inter-sectoral comparison difficult (see Kleinknecht 1996). However, surveys have the advantage that they measure innovation directly and allow for a specification of types of innovation. Recently, the European Community did a representative survey for all member countries: the Community Innovation Survey 1996 — *CIS II* (1999), which provides data at the firm and sectoral level. To the potential bias of overestimation of innovations, a cultural bias has to be added. One example is what could be called the 'Dutch modesty effect'. The data show that the Dutch score is lower in the extremes,[7] whereas the Austrians like to exaggerate and avoid the middle categories. According to the CIS data, Austrian firms are more active in innovation and the Dutch less, which contradicts the scores on other innovation indicators.[8]

Of all enterprises surveyed, 69 percent called themselves innovative in Germany, 67 percent in Austria, 62 percent in the Netherlands and only 36 percent in Finland (Table 2). If the data are standardized (including the optimistic survey results in Ireland and Sweden and the poor results in Belgium and Spain), product and process innovators show the same ranking: D-A-NL-FIN.

Table 2 presents an overview of the innovative performance of the four countries. Finland is rather innovative according to input and patent data, but less so according to the survey data. The explanation could be that innovation is carried out mainly by a small number of rather large firms, such as Nokia in telecommunications. In the other countries, innovation may be more widely spread among firms. From the survey data, we end up with a ranking for innovativeness of D-A-NL-FIN, however the differences are much larger between Finland and the rest than among the other three countries. In order to make this innovation measure comparable with the patent and R&D data, we continue with the ranking of standardized data.

To conclude: The three different ways of measuring innovation present rankings that indicate different patterns of innovation, which will be investigated in the following sections. When we simply add the rank numbers for R&D, patents and the percentage of innovative firms (giving equal weight to every indicator), the overall ranking shows Germany to be on top and Austria at the bottom in innovativeness. The same ranking holds true if we aggregate the standardized scores (D: 1.83, FIN: 1.54, NL: 1.48 and A: 1.27) which allows us to use more information about country differences. The available data for the United States indicate that our 'exit' type systems still perform better than all 'voice' countries.

Table 2. Economic and Innovative Performance of the Four Voice Countries and the United States

	Austria	Finland	Germany	Netherlands	United States
Economic Performance:					
Productivity per person	102	99	105	99	125
employed, and	*0.63*	*0.58*	*0.68*	*0.58*	*1*
per hour worked '96	112	103	121	132	131
(100=OECD average)	*0.71* (3)	*0.57* (4)	*0.84* (2)	*1* (1)	*0.98*
Labour productivity growth '79–'94	1.8%	2%	1.2%	1.8%	2%
Change in relative labour	91	72	111	97	99
unit costs '97 (1991=100)	*0.48* (2)	*1* (1)	*0* (4)	*0.64* (3)	*0.69*
Input Indicators:					
R&D in % of GDP '97	1.52%	2.73%	2.39%	2.09%	2.64%
	0.25 (4)	*0.97* (1)	*0.56* (2)	*0.46* (3)	*0.65*
Total innovation expenditures in % of all enterprises '96	3.5%	4.3%	4.1%	3.8%	
Output Indicators:					
Number of patents granted	398	599	9108	1253	80009
Patent applications per mio of	*0.00*	*0.01*	*0.11*	*0.01*	*1*
inhabitant '96	50	117	112	81	306
	0.16 (4)	*0.38* (1.5)	*0.36* (1.5)	*0.26* (3)	*1*
Survey (CIS):					
(in % of all enterprises)	67%	36%	69%	62%	
innovating enterprises	*0.86* (2)	*0.19* (4)	*0.91* (1)	*0.76* (3)	(EU:53%)
product innovators	60%	20%	65%	56%	
	0.89 (2)	*0.12* (4)	*1* (1)	*0.78* (3)	(EU:48%)
process innovators	49%	25%	53%	46%	
	0.82 (2)	*0* (4)	*0.96* (1)	*0.72* (3)	(EU:39%)
unsuccessful projects or not	29%	34%	33%	38%	
completed	*0.64* (1)	*0.82* (3)	*0.78* (2)	*0.96* (4)	(EU:28%)
Literature Based Indicators:					
number of references to	879	904	7923	1754	240824
scientific journals on patents	*0.0*	*0.0*	*0.03*	*0.07*	*1*
per mio employee '98	255	437	227	289	1928
	0.12	*0.22* (1)	*0.11*	*0.14*	*1*
Technological Activities					
Technological exports/imports	0.25	0.14	0.79	1.01	3.96
'98	*0.02*	*0.01*	*0.08*	*0.11* (1)	*0.47*
	net importer	net importer	net importer	balanced	net exporter
average cites per patent '98	2.1	3.2	2.1	2.4	3.9
Current Impact Index '98	0.50	0.77	0.58	0.71	1.14
	0 (4)	*0.42* (1)	*0.12* (3)	*0.32* (2)	*1*
Current Impact Index '86	0.72	0.61	0.85	0.91	1.01
	0.34 (3)	*0.17* (4)	*0.54* (2)	*0.64* (1)	*0.79*
Technology Cycle Time '98	11.1	8.5	9.5	9.1	9.4
	0.41 (4)	*0* (1)	*0.15* (3)	*0.09* (2)	*0.14*
Technology Cycle Time '86	11.4	12.4	11.0	10.5	11.9
	0.46 (3)	*0.57* (4)	*0.39* (2)	*0.31* (1)	*0.53*

Source: OECD STI Outlook (1998), Community Innovation Survey, US Patent Statistics, CHI Research. Numbers in italic refer to standardized data (0–1), numbers in brackets to rank order, 1=highest performance, 4=lowest of the four voice countries.

Patents	FIN, D - NL- A
Input indicators R&D	FIN- D - NL - A
Survey data	D - A - NL - FIN
Overall Ranking	D - FIN -NL - A

Type of Innovativeness in the Four Countries: Radical versus Incremental Innovations

So far, the data have measured the amount, rather than the type of innovation. The CIS data include one question that makes it possible to proxy radical innovations. This variable 'turnover due to innovative products' was measured as the score of product innovators in manufacturing resulting from the question asking which share of their turnover was due to unchanged products, new or improved products, and to new products also new to the market. According to this variable, the Netherlands and Finland have more 'true innovations' (Debresson 1996), and Germany and Austria more 'improved products' in manufacturing (see Table 3). However, one has to keep in mind that the question refers to 'true' (Debresson 1996), 'offensive' (Freeman 1994) or 'radical' product innovation (Nooteboom 1999) and not to 'radical' in the sense of technology-changing and competence-destroying innovation. As Teece (1987) has pointed out, whether the innovator will reap the profit from technological radical innovation depends on the appropriability regime, i.e. the possibilities for technically and legally protecting the innovation, the necessary complementary assets (e.g. design and distribution channels), firm boundaries, and firm strategies. Competence-destroying technological change can be imitated and imported, to the benefit of imitators and follow-up innovators who are successful in product markets. Nevertheless, as Nooteboom (2000) showed, radical product innovations can have a strong competence-destroying impact on a company, since it can force it to change distribution channels or to relocate.

Two more ways of measuring innovativeness allow for further investigation of the type of innovation.

Literature-based Indicators

Although scientific journal quotations give an indication of the impact of innovations, the data have to be created in quite a cumbersome way. For an overview of this method and its applications, see Kleinknecht and Bain (1993). Cross-country comparative data are hardly available. CHI Research has created a databank on patents that includes the number of scientific references cited on the front page of a company's patents (= science strength). This enables us to distinguish high-tech players from improved design innovators (few or no references to science). Science strength by employee corrects for size and can be used as a proxy for 'importance' or 'radicalness'. Finland (437 scientific references per million employees on the front page of patents) is in the leading position, whereas the other countries' data lie too close together to allow a ranking (the Netherlands 289, Austria 255 and

Table 3. Turnover Due to Innovative Products in Percentage of Product Innovators

NACE Classification	Austria		Finland		Germany		The Netherlands	
	innovative	radical	innovative	radical	innovative	radical	innovative	radical
Total manufacturing	40	7	33	10	50	7	33	9
Food, beverages and tobacco	27	5	17	4	31	5	28	5
Textiles and leather	38	5	24	8	54	8	25	5
wood, pulp, paper, publishing and printing	38	13	14	1	28	3	30	5
coke, chemicals, man-made fibres	25	7	21	9	39	6	35	12
rubber, plastic, o. non-metallic mineral pruducts	36	7	28	7	48	8	29	5
basic metals and fabricated metal products	39	3	15	3	35	3	21	7
machinery and equipment n.e.c.	39	8	59	5	49	7	40	12
electrical and optical equipment	59	8	70	32	63	8	51	12
transport quipment, manuf. n.e.c.	49	7	39	9	66	8	41	11

Source: Community Innovation Survey II (Eurostat 1999).

innovative = improved products and products new to the firm
radical = products that are also new to the market

Germany 227, with standardized data between 0.14 and 0.11). With 1,928 linkages, scientific linkage in the US, however, is much larger (see Table 2).

Another indicator for radicalness is the number of times a company's previous five years of patents are cited in the current year, relative to all patents in the US patent statistics (= current impact index; 1 represents average citation frequency). The United States is above average (1.14) on this indicator, followed by Finland (0.77), the Netherlands (0.71), Germany (0.58) and Austria (0.50).

A third indicator, the citations received by a company's patents from subsequent ones, makes it possible to assess the technological impact of patents. The ranking is again US-FIN-NL-D-A.

The same ranking for the voice countries holds for the average technology cycle time, where Finland even surpassed the United States. A comparison of the data for 1998 and 1986 show that the technological rankings have changed quite dramatically in favour of Finland.

Technology Balance of Payments

Data from 1995 on technology exports, divided by imports, reveal that the US (3.96) is a net exporter. Our four countries are weak in technology receipts. Three of them are net importers of technology with country differences too small to allow for a ranking. Only the Netherlands has a balanced technology trade balance (1.01) (see Table 2).

Taken together, those indicators that allow a ranking, show a higher percentage of 'radical' innovations in the Netherlands and Finland and more 'incremental' ones in Austria and Germany. A higher share of unsuccessful projects in the survey data might indicate the greater riskiness of inno-

vations in the first two countries. The higher number of references to scientific journals on patents, the higher impact index of patents, the lower technology cycle time all indicate that innovations are shorter lived and more drastic than in Austria and Germany. The Dutch import half their R&D and engage in global R&D of design and developmental activities with a view of adapting them to local markets (OECD 1998). They are creative with product variations based on a single technology. The Finns owe their success almost exclusively to a few large high-risk-taking firms, such as Nokia. Whereas the other two countries rely on a broader set of more conservative innovation strategies.

What is to be explained now is why countries with similar stable relationships between economic actors differ in economic and innovative performance; why different innovation indicators point in different directions; and why in some countries firms are more inclined to engage in risky innovations than in others.

For explanations, economists look for differences in technology, market structure and competition, i.e. in the prevalence of high- versus low-tech, and sheltered versus exposed sectors in national economies (Freeman 1994). In addition, the literature on national innovation systems stresses the importance of institutions (Lundvall 1992; Edquist 1997). Technology, market structure and competition, and institutions, constitute the framework within which firms operate (Teece 1997). These different explanations will be studied in the following sections.

Sector Specialization

The original sector specialization of a national economy can sometimes be traced back to its geophysical location and/or its endowment of natural resources and other production factors. Alternatively, it may be based on past policy choices and the institutional arrangements governing them, such as trade policy or investment in public research or a training system. These influence the amount and quality of factor endowment and, thus, the comparative advantage of specific production and products. The pattern of industrial specialization, once in place, may determine the structure at later points in time, effectively producing a sector lock-in. Sector specialization might explain why some countries rank higher in overall innovative performance than others. Germany, for example, might be specialized in patent intensive sectors, Finland in R&D intensive sectors, and Austria in neither.

Production patterns measured as value added of the sector as a percentage of total value added reveal that the Netherlands is strong in agriculture, and Finland in the forest industry. Manufacturing is relatively unimportant in the Netherlands as compared to services. Austria exhibits a similar but less extreme pattern. Its strong reliance on tourism shows in the important service and hotel and restaurant sector. Germany and Finland are stronger in manufacturing than the other two countries (OECD 1998). These patterns

of specialization result in part from the natural resources and historical experiences of these countries. Finland has extensive forests, Austria's mountains used to be sources of minerals and are currently tourist attractions, the Dutch high groundwater table favoured dairy farming, and its geographical location favoured the development of trade in the 16th Century and a staple market, which, in turn, created opportunities for adding value to traded goods. German strength in machine tools and handicraft can be traced back to the hilly countryside in the south and the rainy climate, which led to the early development of water-powered smithies and to the poor farming soil which provided surplus labour that could be employed in artisan shops. The sectoral peculiarities of each country prevail, even when technologies in each sector become more similar, or, to put it into Archibugi and Pianta's (1994) introductory words: 'countries converge by becoming more different'.

A new typology of manufacturing has been made recently for the EU. While Pavitt (1984) categorizes by sources of innovation (science based, supplier dominated, etc.), Peneder's (1999a) classification distinguishes sectors by their dominant input: labour intensive, capital intensive, R&D intensive, advertisement intensive, and mainstream manufacturing, a category where the various inputs are about equally important. The advantage of this categorization is that it is compatible with the NACE standard classification, and hence can use available statistics. Table 4 shows that our four countries display quite different patterns with regard to these input factors. High R&D expenditures are only to be expected in technology-driven industries, and partly in mainstream industries.

According to Peneder's (1999) findings:

1. Marketing-driven industries have lower R&D investments. The poor input indicator performance results of the Netherlands can thus be due to its high share of advertising-intensive industries, such as the food sector.
2. Such marketing-driven industries differentiate themselves primarily through the creation of new product varieties. This is in line with the finding from the CIS data that product variation is among the three most important firm strategies in the Netherlands.
3. The relocation of production is more of a concern in labour-intensive industries, whereas technology-driven industries are bound in their location choice by the available human resources (see Peneder 1999).

Labour-intensive industries are typical for Austria, where the poor R&D performance and low score on patents is due to specialization in sectors with traditionally few innovations and low propensity to patent. Austria's labour intensive small and medium-sized firms need less R&D and patents, thus explaining why survey data report much higher innovativeness than OECD data. However, Austria, together with Germany, is also strong in mainstream manufacturing. Finland's strength in capital intensive pulp and paper industries and telecommunications, which is partly found in mainstream manufacturing (electronic equipment) and partly in R&D-intensive sectors (new communication technologies), explain its good overall R&D performance.

Table 4
Country Specialization by Input Factor: Value-added Shares in Total Manufacturing, 1997 (in %)

Country	Mainstream Manufacturing[1]	Labour Intensive[2]	Capital Intensive[3]	Advertising Intensive[4]	R&D Intensive[5]
Austria	26.39	18.83	16.29	24.61	13.88
Finland	22.82	14.98	28.59	17.54	16.07
Germany	28.06	14.13	15.46	16.22	26.13
Netherlands	21.50	11.75	19.23	31.20	16.37
United States	21.26	12.22	13.51	23.17	29.84

(Peneder 1999)
[1] includes the machinery sector, articles of paper, plastic products, electronic equipment and motorcycles;
[2] includes textiles and clothing, wood processing, construction material and metal processing;
[3] includes pulp and paper, refined petroleum, basic chemicals and iron and steel;
[4] includes mainly the food sector;
[5] includes chemicals and biotechnology, new information and communication technologies, and vehicles for transport.

Part of the country differences in innovative performance can be explained, then, by sector specialization. A puzzle that still remains to be solved is the paradox that the Dutch seem to do well on economic performance indicators such as labour productivity and economic growth, even though they are not top innovators. The opposite seems to hold for Germany where, in the 1990, there was good innovative performance but less economic success. Therefore sector specialization cannot completely explain differences in country economic performance. Furthermore, even to the extent that it does, what remains to be explained is why countries have come to be specialized in particular industries in the first place.

While historical sector or technology specialization can bring competitive advantages, it can also become detrimental. Nevertheless, countries differ in the degree to which they can escape such lock-ins. For example, in the late 1980s, some large Finnish firms seem to have been able to change their competitive competences from those dominant in the highly business-cycle-dependent wood and paper industry towards those more suited to the mobile telephone industry, replacing the loss of traditionally important Russian markets by the big new Chinese market, at annual growth rates of 30–50 percent in the 1990s (*Volkskrant* 4.6.1999). The Austrians and Germans appear to be much more stable in their sector specialization pattern than the Dutch or the Finns, so sector specialization does not explain why some of our 'voice' countries are more open to change and innovation than others. Could it be that institutions explain the difference between countries that did get locked-in in a less favourable sectoral specialization pattern and those that managed to escape? If so, we would expect different institutions of economic governance in these countries.

Some Institutional Explanations: Inertia versus Flexibility

However, superficially, all four countries have similar institutions of eco-

nomic governance. We have defined them all as 'voice' countries, i.e. countries where relations between economic actors are relatively stable over time and where conflicts and disagreements get solved in the first place through 'talking', consultation, negotiation, and concertation, rather than through 'exit' or partner swapping. At the more macro level, such forms of economic coordination have been called corporatist. However, a roughly similar institutional structure can produce more or less flexible policy responses, depending on how much it is challenged. Hemerijck (1993) and Hemerijck and Visser (1997) have shown that, under certain circumstances, corporatist regimes can learn to respond flexibly to outside challenges and internal pressures. In applying this idea of 'responsive' corporatism, borrowed from macroeconomics, to innovation at the meso level, we can formulate the following hypothesis:

H1: 'Voice' systems of economic coordination will be more responsive, (a) the more they are challenged from outside, e.g. the more the country is exposed to international trade and capital movements, and (b) the more they have experienced major crises.

Our three smaller countries have all experienced such external vulnerability and crises. The Netherlands is probably most exposed to external threats. For centuries it has had to rage a war against the sea, trying to protect and regain land from the sea and the big rivers that flow through the delta. The experience of high vulnerability went hand in hand with an experience of being able to do something to combat it — to control the floods, by constructing '*terpen*' (artificial mounds), dykes, by draining lakes, building dyke systems, and, in the post-war years, the huge Delta hydraulic works. This belief that something could be done to control external threats carried over into the economic arena, where the country has become equally vulnerable. After Belgium, it has the most exposed economy, as measured in the share of exports in GDP. This capacity to learn pragmatically has made Dutch corporatism rather responsive, more public and more open to drastic change than in Austria or Germany (Unger 1997).

Finnish corporatism, on the other hand, is more conflictual and more restricted to the labour market. It has its own variety of vulnerability. Though less exposed to international trade, Finland is highly dependent on its domestic natural resources, on specific export partners, and on the export performance of only a few big firms. Given its relatively undiversified trade pattern, crisis can and has hit Finland very drastically. The breakdown of the Russian market, to which Finland was bound by bilateral agreements, was a major shock to the country and resulted in a complete reorientation of its trade. Finnish macro-corporatism was forced to become more flexible than in the other countries. The Swedish author Rehn called it 'fair weather corporatism', because centralized wage bargaining only seemed to work in boom periods, with individual trade unions deviating from wage agreements during recessions. This produced frequent strikes, a feature quite uncommon to corporatist countries. Recently, Finnish 'flexibility' has

implied a gradual change away from associational to market governance (see Lilja 1998). It is hence coming closer to 'exit' countries. That means that while Finland's corporatism is the most flexible, it is also the least stable of the four countries. Even as early as 1982, Lehmbruch ranked it as the weakest corporatist regime of the four countries, because the capacity of associations to be involved in all policy agenda and to implement them firmly was not as encompassing as in the other countries. Its corporatist features, in particular on the labour market, are, however, still very strong.

Austria has had its own specific experiences of vulnerability: externally the period of foreign occupancy, and its geopolitical location between the West and the East; internally the experience of civil war in 1934. Along with the United Kingdom and Sweden, Austria is the country that is most vulnerable to financial capital flows (Unger 1997). Its also has a high trade exposure, though less than the Netherlands, but is less crisis shaken than Finland. The civil war has taught the Austrians the lesson that it is better to resolve conflicts between labour and capital by negotiations, than by guns. It lies at the basis of Austrian post-war corporatism. However, the lower degree of external exposure and the creation of a large nationalized, sheltered sector have made it somewhat less responsive.

Thus all three small countries have experienced a sense of vulnerability, though of different kinds and to different degrees. Furthermore, their political responses have differed. Austrian corporatism has been quite secretive, taking place behind closed doors, and, in the absence of major challenges, incremental. It has been rather effective in implementing change, but highly reluctant to do so. 'Diving through crises' has been the major reaction of the Austrian corporatist regime since the 1970s, i.e. reacting, but reacting slowly and without major changes. This political strategy was feasible because the strong domestic institutions could filter exogenous shocks without major turbulence. Nevertheless, it has not been open to major changes. 'Discovery of slowness' and 'Dinosaur' are labels given to Austrian corporatism (Unger 1999; Crepaz 1995).

As a big country, Germany has been less exposed to international trade and capital movements (Unger 1997). German corporatism is encompassing, though less than in the other two countries, and less consensus-oriented. It can be considered medium-responsive. The challenges of the actors by outside events are less pronounced than in small countries, and the learning capacity of actors is weaker, partly because the ideological distance between labour and capital is much greater.

In terms of the responsiveness of institutions, then, it seems reasonable to suggest the following ranking: FIN the most flexible corporatist country, followed by the NL with highly responsive corporatism, and A and D with more rigid corporatist regimes. So far institutional responsiveness has been outlined in qualitative terms. Further work will have to be done to operationalize institutional responsiveness in quantitative terms, such as the number of policy changes or the time lag of adjustments *vis à vis* other countries.

Different Types of Innovations in Responsive- versus Rigid Corporatist Regimes

The types of innovations likely to occur will be influenced by both the macro-institutional regime, and sectoral exposure. As regards the institutional regime, the simple hypothesis that 'exit' countries will exhibit more radical innovations and corporatist or 'voice' countries more incremental ones has to be modified. Incremental innovations are more likely in a rigid corporatist regime, which enhances cautious strategies and dampens the necessity of major changes. Radical innovations are more likely under responsive corporatism and in market governed economies.

The empirical finding that Finland and the Netherlands are more radical innovators and Germany and Austria more incremental confirms this hypothesis. Finland and the Netherlands provide a relatively flexible institutional environment that allows for (or necessitates) more uncertainty-involving activities. Austria and Germany have the more rigid regime and exhibit more adaptive and fewer risk-taking innovation strategies.

The CIS (1999) data allow a first rough test of this hypothesis. Firms were asked about their motives to innovate. Cost-based innovation strategies, in particular the reduction of labour costs, were important for about 50 percent of all innovators in Germany and Austria, both in manufacture and services, and might be a first proxy for adaptive innovations. In the more flexible corporatist countries NL and FIN, this strategy was only mentioned by 20 percent of innovators. To improve production or internal business, process flexibility was judged to be very important only in Germany, in particular in the service sector (by 52 percent of all innovators). This might be a further indicator for adaptive innovations in low responsive corporatist regimes, as indicated by Whitley (2000).

Different Exposure to Competition

The macro-institutional regime is only part of the explanation. What will firms do in an institutional environment more or less prepared to react to international challenges? Corporatism can give business the safe feeling of being institutionally well embedded and sheltered from the outside world. In this shock-protected environment, business can either fall asleep like Sleeping Beauty, or become highly active and innovative.

Whether firms engage predominantly in developmental and strategic innovations with high risk and uncertainty, or whether they follow low risk-taking and cost-reduction strategies, depends on the presence or absence of competitive pressures. The higher the exposure of a sector to international trade and external or internal competitiveness, the more flexible and responsive to change firms are likely to be.

National and sectoral exposures do not have to be the same. A country in general highly exposed to international trade can still harbour sectors with low competitive pressures, either because these sectors are not exposed to international markets or because the government protects them. For exam-

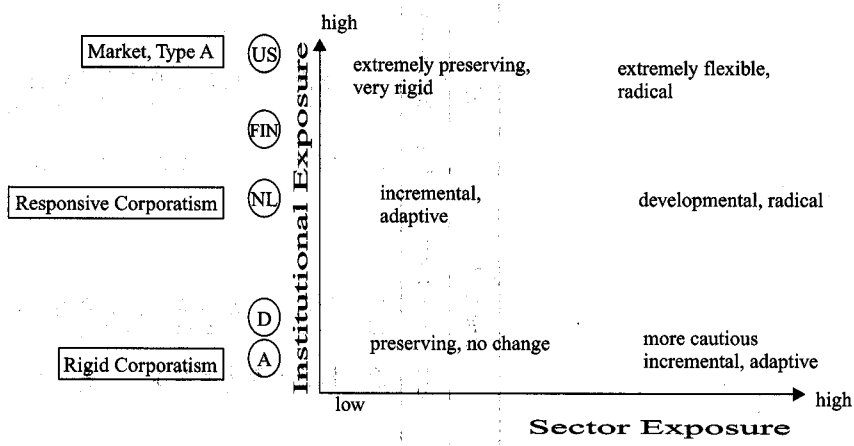
ple, for a long time, the Austrian nationalized steel industry was highly exposed to international markets, but nevertheless it was sheltered, since it enjoyed huge subsidies and its deficits were covered by the state. With only slow responsiveness and sheltered business, Austrian corporatism followed cautious preservation strategies, which resulted in little innovation. Similar conditions prevailed in the sheltered service sectors, which supplied local markets. The cost-reducing emphasis of investments of many Austrian small firms would fit this picture.

If the country exposure to international trade, capital mobility and competition is high, and if it has successfully developed shock-absorbing institutions and economic policies that are responsive to change, this can result in adaptive innovation strategies in sheltered sectors, since they do not necessitate major changes. If competition is high, the safe but responsive economic environment can result in more flexible, e.g. complex and risky, innovation strategies, as hypothesized by Whitley (2000).

If the country exposure to international trade, capital mobility and competition is low, as is the case with the almost closed economy of Japan and the United States, more extremes occur. Since international shocks occur less drastically, domestic economic policy-making has been less oriented towards shock absorption and reduction. Floating exchange rates, flexible prices and wages, flexible employment policy, go in line with this. The innovation strategies that occur in such a business environment are more extreme. If firms in the sector face high competition from within or from abroad, they tend to engage in highly risky or uncertain strategies. If, however, competition is low, as was the case with the domestic American banking sector, rather conservative and change-averse strategies are followed.

Sheltered sectors, such as the dairy industry, tend to create higher rents in many countries, without being innovative, or with only minor innovations taking place. Exposed sectors tend to overcome the institutional inertia inherent in corporatist regimes and can profit from the combination of a stable macroeconomic institutional environment that constitutes a public good for more adventurous innovation strategies. If, however, the sector becomes 'global', then the borders of the national regime get lost. The Dutch chemical sector, for example, displays much less corporatist governance than other sectors. A good example for the difference between exposed and sheltered sector strategies is the construction industry. As Unger and Van Waarden (1993) found in a fifteen-country comparison, the Dutch construction industry was more exposed to internal and external competition and was the most productive and innovative, whereas the Austrian construction industry was sheltered and the least productive and dynamic. Since both the Netherlands and Austria are corporatist countries, the difference in results can be traced to the different degree in responsiveness of corporatist regimes and to the different competitive exposure of the sector. The strategic choice of firms and sectors embedded in a safe economic environment depends highly on the outside pressure which firms face, and whether these pressures come from within the sector or from outside. In

Table 5
Exposure and Types of Innovation



the absence of such competitive pressures, institutional inertia can transform into firm inertia and stability is reached at the cost of flexibility. In the presence of competitive pressures, institutional stability can be an asset and input for increased flexibility by increasing actors' planning horizons. Responsive institutions will encourage more flexible strategies than non-responsive ones.

The combined regime and sector exposure effects can be seen as determining innovative behaviour in the following manner:

1. 'Voice' countries will not always display incremental innovations. In a responsive corporatist regime and in an exposed sector, firms will invest in more uncertainty-involving innovations.
2. 'Exit' countries will not always display radical innovations as is stated in the generic-type literature on innovations (Nooteboom 2000), but only in exposed sectors. In sheltered sectors they will display the other extreme of high rigidity.

Sector Exposure and Corporatist Responsiveness: Some Empirical Findings

Sector Exposure to International Competition

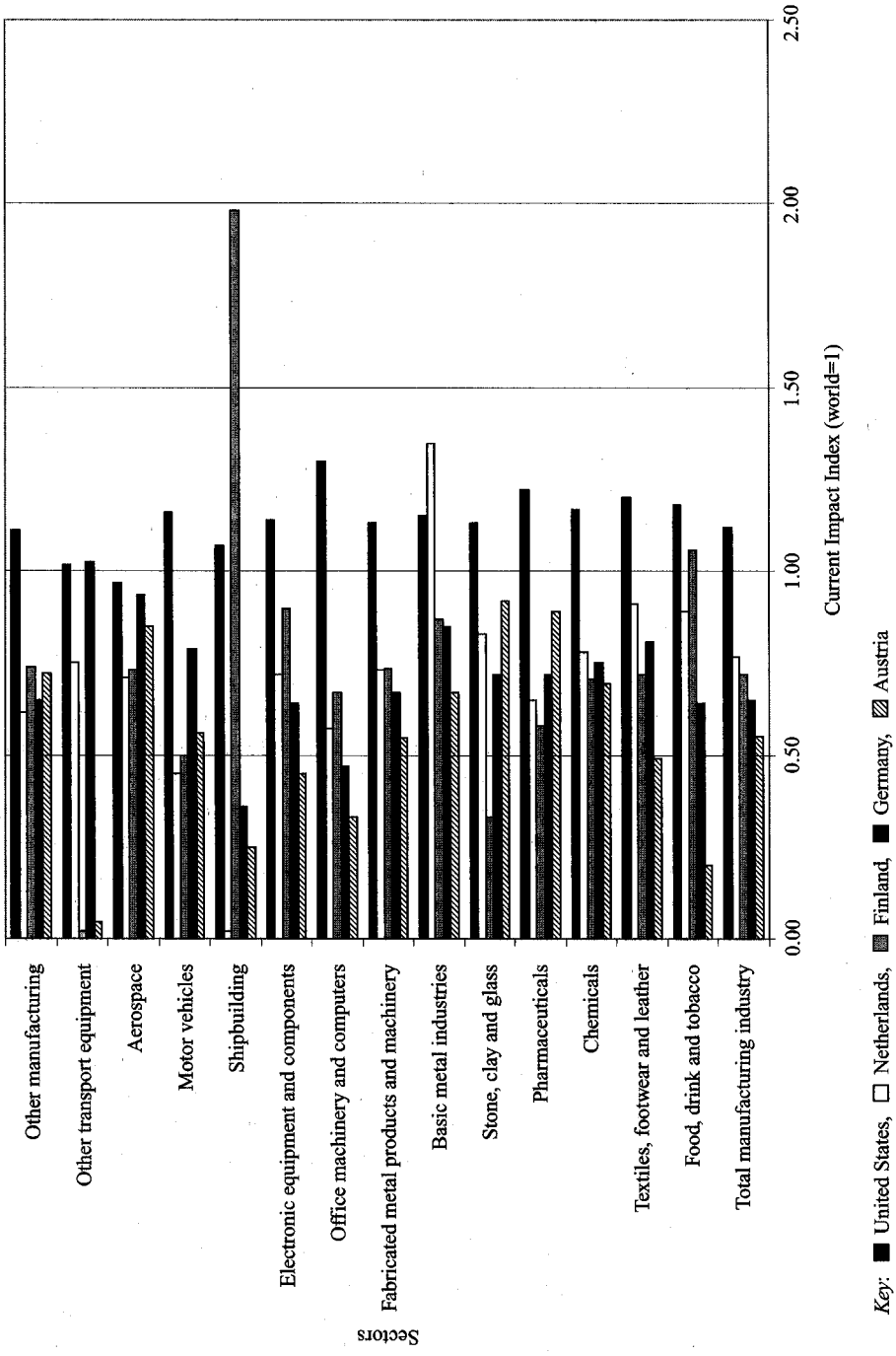
Sector exposure to foreign competition (measured as export and import shares in percent of domestic absorption) differs among countries (see Table 6). Overall manufacturing is most heavily exposed to foreign competition in the Netherlands, followed by Finland, Austria and Germany. However, a 50 percent exposure of domestic production in Germany is almost twice as high as for the United States (28 percent). Sector exposure is not only reflected in the survey data, where the Netherlands and Finland report slightly higher radical innovations than Germany and Austria (see Table 3), but also in the patent data by sector (see Tables 6 and 7). The current

Table 6. Sectoral Exposure to Foreign Competition and Radical Innovation CII in 1996

ISIC 3 Classification	Austria		Finland		Germany		Netherlands		US	
	Exp.	Rad. Innov.	Exp.	Rad. Innov.	Exp.	Rad. Innov.	Exp.	Rad. Innov.	Exp.	Rad. Innov.
3 Total manufacturing industry	64	0.55	67	0.72	50	0.65	95	0.77	28	1.12
31 Food, drink and tobacco	18	0.20	17	1.06	27	0.64	77	0.89	11	1.18
32 Textiles, footwear and leather	89	0.49	82	0.72	79	0.81	84	0.91	37	1.20
33 Wood products and furniture	42		63		30		70		15	
34 Paper, paper products and printing	57		64		39		48		9	
35 Chemicals	64	0.70	71	0.71	46	0.75	100	0.78	22	1.17
3522 Pharmaceuticals	75	0.89	74	0.58	57	0.72	90	0.65	13	1.22
36 Stone, clay and glass	36	0.92	47	0.33	24	0.72	57	0.83	15	1.13
37 Basic metal industries	72	0.67	64	0.87	40	0.85	99	1.35	21	1.15
38 Fabric metal products and machinery		0.55		0.74		0.67		0.73		1.13
3825 Office machinery and computers		0.33	91	0.67	82	0.47		0.57	76	1.30
3832 Electronic equipment and components	99	0.45	94	0.90	54	0.64	95	0.72	54	1.14
3841 Shipbuilding		0.25		1.98		0.36		0.00		1.07
3843 Motor vehicles	96	0.56	99	0.50	60	0.79	100	0.45	39	1.16
3845 Aerospace		0.85	55	0.73	100	0.94	80	0.71	43	0.97

Source: CHI Research, CII Current Impact Index from US Patent Statistics referring to patents granted.
STI Outlook, Paris 1998. Exposure was calculated as (exports/production) + (1-(exports/production))(imports/(production+imports–exports)) in %.
Data for exposure refer to 1994.
The correlation coefficient is –0.354, obmitting missing values.

Table 7. Institutional Exposure and Radical Innovations by Sector: Current Impact Index 1996



impact index (the number of times a company's previous five year's patents are cited in the current year — high citation counts are often associated with important inventions) is higher in the Netherlands and Finland than in Germany and Austria for the total manufacturing industry. The Netherlands is specialized in some highly exposed sub-sectors. While the food, beverages and tobacco sector is usually little exposed to international competition, in the Netherlands this is highly so (see Table 6). In Table 3, which lists sectoral product innovation survey data, we find no significant differences in innovativeness in this sector, except for Finland. Turnover due to improved products was 31 percent in Germany and 28 percent in the Netherlands, and 27 percent in Austria as compared to 17 percent in Finland. Sales due to radical innovations are, however, very low in all four countries. Patent data on 'radicalness', however, support our hypothesis by revealing that Finland almost reaches the US citation impact in the food, drink and tobacco industry, followed by the Netherlands. In the Netherlands, both the regime and the exposed sector effect seem to be responsible for higher radicalness, whereas in Finland the 'Nokia' effect also seems to hold for the food sector. Few, large, very innovative firms compete in the world market, as opposed to the rest of the small firms' sheltered sector. The German and Austrian food industry is sheltered and less radically innovative, a fact which might be due both to the sector and regime effect.

The sectors that are generally highly exposed to foreign competition, thereby allowing the regime effect to be identified, are the textile industry, chemicals, pharmaceuticals, computers, telecommunication, motor vehicles and aircraft manufacturing. The highly exposed textile industry is more innovative in Germany, where 54 percent of turnover was due to improved products, as compared with 24 percent in Finland, 25 percent in the Netherlands and 38 percent in Austria. It is interesting that, according to survey data, radical innovations in this sector are highest in Germany and Finland, whereas patent data reveal that the Netherlands does not lag behind. The regime effect is, hence, only partly demonstrated.

The chemical industry is the most exposed in the Netherlands, followed by Finland. This is reflected in its radical innovativeness. The Netherlands has the highest share of radical innovation in turnover (12 percent) and Finland the second highest share (9 percent). The chemical industry in the Netherlands is 'global' and almost 'exit'-like organized. Patent data reveal that the Netherlands is leading in current impact, but all four countries are highly innovative. For this reason, we cannot clearly identify the regime effect.

The specialization of Finland in telecommunications is reflected in the innovativeness pattern. Telecommunication is a highly exposed sector in all countries (though, again, less so in Germany). All four countries are innovative in this sector (here: electrical and optical equipment), However, Finland is outstanding in radical innovation in this sector, with 32 percent of turnover, followed by the Netherlands (12 percent). Patent data confirm the Finnish leadership, followed by the Netherlands, Germany and Austria.

This highly internationally, almost 'global' sector supports our hypothesis about the regime effect. Finland and the Netherlands are more radical than Germany and Austria.

So far, we have found evidence that (a) technology and sector specialization, and (b) sector exposure to international trade and (c) institutional responsiveness matter for innovation.

Sector specialization helps to explain parts of the differences in innovativeness rankings (R&D, patent, survey data differences), as the specialization by input factor showed.

Comparing the rankings of sectoral exposure, the amount of innovation by sector and the type of innovations (see Tables 2, 4 and 6) and keeping in mind the regime effect, reveals that the amount of innovation does not seem to depend on external sector exposure. According to the CIS survey data, German innovators rank top in almost all sub-sectors, independent of the degree of sectoral exposure, and Finland ranks bottom. (There might, though, still be internal competitive pressure which does not appear in the foreign exposure data!) The regime effect, however, seems to explain the type of innovation quite well. The Netherlands and Finland display more radical innovations in almost all sub-sectors. The degree of radicalness of innovation seems to conform to our *a priori* expectation of the effects of flexible and responsive corporatism. However, more empirical research with a larger data set needs to be carried out.

Some Conclusions on Voice Countries and Innovative Firm Behaviour

All four countries studied in this paper are 'voice' countries that have relatively stable and long-term relations between economic actors, be they customers and suppliers, competitors, or employers and employees. The countries have a number of institutions in place that 'fit' with such forms of coordination and which have been labelled corporatist. These organizational patterns and institutions facilitate the long-term orientation of businesses, including, one may expect, their innovative behaviour. Nevertheless, they differ in economic and innovative performance, and particularly in the pattern of innovation. Finland and the Netherlands are relatively strong in radical product innovations, Germany more in incremental innovations, while Austria is innovative in some sub-sectors, but ranks low in overall innovative performance.

These differences are related to (a) historical sector specialization that led to the establishment of (b) specific national institutions, that under (c) external exposure experienced different crises and challenges and developed (d) different capacities to react to them. Historically developed sector specialization influences firm relations, not only directly through technology, organizational possibilities, the market structure and trade exposure, but also indirectly, through the institutional regime effect. Firms operating in a historically established sector face the institutional environment in which they

are embedded and the competitive pressure from trade exposure or competition within the sector. The combination of all these effects determines the amount and the type of innovation and economic performance. Sector specialization emerged as being important for the amount of innovation, in particular when measured with conventional innovation indicators, that favour R&D and the patent-intensive sectors. The countries that are specialized in these sectors (Germany and Finland) appear to be more innovative than countries specialized in labour-intensive (Austria) and advertisement-intensive (the Netherlands) industries.

However, sector specialization does not explain the type of innovation and why some countries escape technology lock-in, and others not. Institutions and external pressure for change explain the type of innovation — notably in the distinction between radical versus incremental innovation — quite well.

Finland had a traditionally low-tech sector specialization that threatened to become a liability. However, the experience of vulnerability and crises allowed it to overcome its sector lock-in and to develop new products and sectors, thereby allowing it to conquer new markets. In this, it was aided by its institutions: a relatively responsive 'fair weather' corporatism, an increasingly dynamic capital market, strong government support, and a well-developed higher educational system producing skilled researchers.

The Dutch also experienced somewhat of a sector lock-in, but this was less of a liability, as the country has been able to innovate substantially in such sectors as agro-food, chemicals, and transport and logistics, which have traditionally been considered relatively low tech, but which the Dutch have been able to turn into high tech. This flexibility has been enhanced by their historical experience of vulnerability and crises, and the presence of flexible institutions, for example, responsive corporatism (allowing the country to learn from crises), an important equity market, and a flexible training system. In addition, the presence of large multinationals has facilitated the importation of R&D.

Germany and Austria seemed to have remained more locked-in to their sector specialization. There has been less of a sense of vulnerability, partly because the credit-based financial system has shielded them from international capital markets. The Austrian strategy has been to build a large sheltered sector, notably the nationalized industries, to absorb international shocks and to build niches. Since vulnerability was relatively low in Germany, there was less pressure on corporatist institutions to become more flexible, to change working-time arrangements and to develop learning capacities. This has resulted in a relatively low degree of innovation in more incremental ones, continuing the sector specialization of the country in traditional industries such as chemicals, pharmaceuticals, engineering, and transport industries.

Whereas the regime effect on the type of innovation was supported by our data, the sector exposure effect was not. The correlation coefficient between sector exposure and radicalness was low and had the wrong sign (–0.354). Whether firms are more radical or incremental in an exposed sector than

in a sheltered one, could not be empirically proven. So far, there is some indication that a flexible institutional environment (the regime effect) is more important than the sector-exposure effect for radical innovations.

Notes

* The author wuold like to thank the Netherlands Institute for Advanced Study in the Humanities and Social Sciences (NIAS) who provided the necessary funds and a unique location for an inspiring research year. Particular thanks go to the NIAS Innovation group consisting of Richard Whitley, Frans van Waarden, Bart Nooteboom, Marius Meeus, Ernst Homburg, Rogers Hollingsworth, Jerald Hage, and Steve Casper. Thanks also to Eric Brouwer, John Cantwell, Alfred Kleinknecht, Stefan Kuhlman, Christine Larson, Kari Lilja, Francis Narin, Herman Oosterwijk, Gerd Schienstock, Uli Schmoch, and to my Austrian colleagues Christian Bellak, Reinhold Hofer, Michael Peneder and Wolfgang Polt, who provided helpful information and data. Comments from two anonymous referees helped to restructure the paper.

1. The extremely high and increasing numbers for Finland are due to the fact that unions administer unemployment benefits and that unemployment rates exceed 16 percent (see Lilja 1998: 173).
2. For further structural requirements such as a medium strong state, strong trade unions, predominance of small and medium-sized firms, etc., see Schmitter and Lehmbruch (1982).
3. The transformation formula was (data value - min value) * (1/(max - min value)).
4. I owe this point to Alfred Kleinknecht.
5. See US Patent and Trademark Office, Patent Counts by Country and Year, all patents all types 1977–1998. In 1995, of the 113,955 patents granted, 64,510 were from the United States, 359 were granted to Austria, 387 to Finland, 6,874 to Germany and 894 to the Netherlands.
6. I owe this point to John Cantwell.
7. This 'Dutch modesty effect' can also be found in other comparative studies. The results of the World Value Study, for example, show that the Dutch, when asked to rank between 1 and 10 whether they find something very good or very bad, tend to cross in the middle and to avoid extremes.
8. The survey study was done in all EU-15 countries and consisted of about 30 questions. (The precedent CiSI survey was done in the EU-12 countries and consisted of about 200 questions. Unfortunately, Austria and Finland were not included in this first report). The total population was 133,284 enterprises in the four countries of which 37,004 enterprises were in German manufacturing and 79,602 in German services. In the Netherlands, 6,903 were in manufacturing and 11,443 in services; in Austria, 4,139 were in manufacturing and 5,348 in services; and in Finland, 2,285 were in manufacturing and 2,182 in services. The realized sample in percentage of the population differs quite substantially. It was 5 percent in Germany, 20 percent in Austria, 40 percent in Finland and the Netherlands. The German sample size is far below the EU average of 16 percent, while the other return rates are quite high for this kind of survey.

References

Archibugi, D., and M. Pianta
1994 'Aggregate convergence and sector specialization in innovation'. *Journal of Evolutionary Economics* 4/1:17–33.

Casper, S.
2000 'Institutional adaptiveness, technology policy, and the diffusion of new business models: The case of German biotechnology'. *Organization Studies* 21/5: 887–914.

Crepaz, M.
1995 'Austrian social partnership: A dinosaur'. *West European Policy Studies* 18/4: 64–88.

Crouch, C., D. Finegold, and M. Sako
1999 *Are skills the answer? The political economy of skill creation in advanced industrial countries*. Oxford: Oxford University Press.

Debresson, C.
1996 *Economic, interdependence and innovative activity. An input–output analysis.* Cheltenham: Edward Elgar.

Dore, R.
1986 *Flexible rigidities*: London: Athlone Press. London.

Edquist, C.
1997 *Systems of innovation — technologies, institutions and organizations.* London: Pinter.

European Commission
1994 *The European report on science and technology indicators.* EU: Luxembourg.

Eurostat
1999 *The Community innovation survey 1996.* (CIS II). EU: Luxembourg.

Freeman, C.
1994 'The economics of technical change'. *Cambridge Journal of Economics* 18: 463–514.

Hemerijck, A.
1993 'The historical contingencies of Dutch corporatism'. Balliol College, Oxford.

Hemerijck, A., and J. Visser
1997 *A Dutch miracle, job growth, welfare reform and corporatism in the Netherlands.* Amsterdam: Amsterdam University Press.

Katzenstein, P.
1985 *Small states in world markets, industrial policy in Europe, Ithaca and London.* Ithaca, NY: Cornell University Press.

Kleinknecht, A.
1996 *Determinants of innovation, the message from new indicators.* London: Macmillan.

Kleinknecht, A., and D. Bain
1993 *New concepts in innovation output measurement.* New York: St. Martin's Press.

Kleinknecht, A., J.O.N. Reijnen, and W. Smits
1993 'Collecting literature-based innovation output indicators: the experience of the Netherlands' in *New concepts in innovation output measurement.* A. Kleinknecht and D. Bain (eds.), 369–394. New York: St. Martin's Press.

Lehmbruch, G.
1982 'Introduction, neo-corporatism in comparative perspective' in *Patterns of corporatist policy-making.* G. Lehmbruch and P. Schmitter (eds.), 1–28. London and Beverly Hills: Sage.

Lilja, K.
1997 'Bargaining for the future: The 1997changing habitus of the shop steward system in the pulp and paper mills of Finland' in *Governance at work.* R. Whitley and P.H. Kristensen (eds.), 123–136. Oxford: Oxford University Press.

Lilja, K.
1998 'Finland: Continuity and modest moves towards company-level corporatism" in *Changing relations in Europe,* 2nd Ed. A. Ferner and R. Hyman (eds.), 171–189. Oxford: Blackwell.

Lundvall, B.-A.
1992 *National system of innovation: Towards a theory of innovation and interactive learning.* London: Pinter.

Nooteboom, Bart
2000 'Institutions and forms of co-ordination in innovation systems'. NIAS Workshop, Wassenaar.

Nooteboom, Bart
1999 'Institutions and forms of co-ordination in innovation systems'. *Organization Studies* 21/5: 915–939.

OECD
1996 *The OECD jobs study: Technology, productivity and job creation, analytical report.* Paris: OECD.

OECD
1998 *Science, technology and industry outlook.* Paris: OECD.

Ophem, v., Brouwer, and A. Kleinknecht
1999 'The mutual relation between patents and R&D'. TSER Workshop, Delft.

Pavitt, K.
1984 'Sectoral patterns of technical change: towards a taxonomy and a theory'. *Research Policy* 13: 343–373.

Peneder, M.
1999a *Intangible assets and the competitiveness of European industries. An international comparison.* WIFO: Vienna.

Sako, M.
1992 *Prices, quality and trust: Inter-firm relations in Britain and Japan.* Cambridge: Cambridge University Press.

Schienstock, G.
1999 'Interview on Finland'. University of Tampere, June 1999.

Schludi, M.
1999 *Adjustment data base.* Max Planck Institute: Cologne.

Schmitter, P., and G. Lehmbruch
1979 *Trends towards corporatist intermediation, contemporary political sociology.* London: Sage.

Soskice, D.
1991 'The institutional infrastructure for international competitiveness: a comparative analysis of the UK and Germany' in *The economics of the new Europe.* A.B. Atkinson and R. Brunetta (eds.), 45–66. London: Macmillan.

Streeck, Wolfgang, J. Hilbert, K.H. van Kevelaer, F. Maier, and H. Weber
1987 *The role of the social partners in vocational training and further training in the Federal Republic of Germany.* Berlin: European Centre for the Development of Vocational Training (CEDEFOP).

Teece, D.
1987 *The competitive challenge: Strategies for industrial innovation and renewal.* Cambridge: Cambridge University Press.

Traxler, F.
1996 'Collective bargaining and industrial change: A case of disorganization? A comparative analysis of 18 OECD countries'. *European Sociological Review* 12/3: 271–287.

Traxler, F., and B. Unger
1994 'Governance, economic restructuring and international competitiveness'. *Journal of Economic Issues (JEI)* 28/1: 1–23.

Unger, B.
1997 *Room for manoeuvre, choices left for national economic policy making.* Vienna: University of Economics and Business Administration.

Unger, B.
1999 'Social partnership in a midlife crisis' in *Renegotiating the Welfare State.* G. Lehmbruch and F. van Waarden (eds.). London: Routledge.

Unger, B., and F. van Waarden
1993 'A comparison of the construction industry in Europe: Characteristics, governance, performance and future perspecitves.' *Working Papers of the University of Economics, Vienna* 18/1: 1–58.

Van Waarden, F.
1995 'The organizational power of employers' associations: Cohesion, comprehensiveness and organizational development' in *Organized industrial relations in Europe: What future?* C. Crouch and F. Traxler (eds.), 45–97. Aldershot: Avebury.

Van Waarden, F.
1999 'European harmonization of national regulatory styles' in *Compliance and enforcement of European Community law.* J. E. A. Vervaele (ed.), 95–124. The Hague: Kluwer.

Volkskrant
1999 'Finnen zitten het liefst in het zadel'. 1 June, p.15.

Whitley, R.
2000 'The institutional structuring of innovation strategies: Business systems, firm types and patterns of technical change in different market economies'. *Organization Studies* 21/5: 855–886.