CO-OPERATIVE BEHAVIOUR OF INNOVATIVE FIRMS IN AUSTRIA

FOCUS GROUP: INNOVATIVE FIRMS NETWORKS

STUDY PREPARED FOR THE OECD PROJECT ON NATIONAL INNOVATION SYSTEMS

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1 Introduction

The project

As part of the focus group activities of the OECD NIS **(Knowledge Flows In National Innovation Systems)** project, the present **tip**-study reports the major results from an Austrian survey on innovation and inter-firm co-operation covering about 1.000 Austrian manufacturing firms. One of the main objectives of the surveys undertaken within this focus group is to provide a better understanding of the role of inter-organisational co-operation and industrial networks in promoting innovation.[1]

As Austrian contribution to the focus group on innovation and inter-firm co-operation, the present reports aims at deepening the understanding of the specific knowledge and information flows among enterprises and to assess the *culture of collaboration* prevailing in Austria. For policy makers, an understanding of the NIS in general and specific aspects of knowledge flows in particular is instrumental to identify leverage points for enhancing innovative performance and hence overall competitiveness.

The Austrian **tip** ('technology, information, policy consulting') Research Programme:

tip is a research and consulting programme which is based on an initiative of the Austrian Federal Ministry of Science and Transport and the Austrian Federal Ministry of Economic Affairs. **tip** is carried out by the Austrian Institute of Economic Research (WIFO) in co-operation with the Austrian Research Centre Seibersdorf (ARCS). WIFO is in charge of directing the programme. **tip** produces information and recommendations relevant to Austrian technology policy, based on analyses of technological change and its impact on the national system of innovation at the macro level (enterprises, public and private institutions and their interactions), the meso level (structural analyses of the Austrian economy) and the micro level (analyses of firms behaviour).

Despite an increasing awareness of the importance of inter-firm linkages and linkages between firms and knowledge institutions of the service sector in connection with product innovation, few attempts have been made to systematically collect empirical data mapping such relationships enabling cross-country comparisons. So far, comparative data mainly have been based on case studies. A more recent comprehensive approach to survey the collaboration of innovative firms include the Community Innovation Survey (CIS). Yet, this survey was not launched in Austria in the first phase. Moreover, the evaluation of the CIS survey indicated a lack of comparability across countries (Archibugi et al., 1994).

The dichotomy between an increasing focus on the collaborating, network-embedded firm on the one hand and the lack of systematic data on how, why and with whom firms interact in product innovation on the other, has been the main impetus for participating in the focus group. The characteristic of this project was the use of a guided telephone interview with supporting software or Computer Aided Telephone Interview (CATI). An agree-

[1] For a description of the NIS project and the activities within the focus groups see http://www.oecd.org/dsti/sti/s_t/inte/nis/index.htm

ment between the participating countries[2] could be achieved by adopting the research design developed within the Danish DISKO[3] Project to be used for the survey.

Systemic character of innovation

Both empirical and theoretical research have drawn attention to the fact, that innovation should be considered as a complex process involving other factors than those related to the firms itself. Hence, the concept of "systems of innovations" is therefore deeply rooted in the belief that innovation is an interactive process where agents and organisations communicate, co-operate and establish long-term relationships. Although there is no single accepted definition of "systems of innovations", the concept is based on the premise that understanding the linkages between the actors involved in innovation is the key to the improvement of technological performance. Innovation and technical progress are the results of a complex set of interactions among actors producing, distributing, and applying various kinds of knowledge. The innovative performance of a country depends to a large extent on how these actors relate to each other as elements of a collective system of knowledge creation and use. These actors are primarily private enterprises, universities and public research institutes and of course the people within them. The linkages can take the form of joint research, personnel exchanges, cross-patenting, acquisition of equipment, and a variety of other tracks (OECD, 1997b).

Several contributions of the literature on innovation systems (among others Lundvall, 1992, Nelson, 1993) stress the fact that national specificities of patterns of interaction are at the very core of what defines a national innovation system. The NIS approach, hence, increases awareness of the importance of the fact that the flows of technology and information among people and institutions within nations are the key to the efficiency of innovative processes in national economies, thus fostering their competitiveness. These flows are constituted and regulated by institutions in terms of rules, norms, and habits which are highly shaped by national patterns. However, it has also kept in mind that national innovation systems are open systems as well. However, interaction in the innovation process can be expected to take place across national borders. It is therefore no coincidence that the National Innovation Systems approach has emerged at more or less the same time as the debate and the sometimes overheated discussion on *globalisation* has started. Insofar, in a globalisation era the question, *How national is a National Innovation System?* goes to the heart of the concept (OECD, 1997a). As a matter of fact advocates of the systemic approach are divided as to where the systems borders are adequately drawn.

A new innovation measure

The OECD adopted the NIS concept in the early 90s and in 1994 the Project on Knowledge Flows in National Innovation Systems was launched. The first part of this project has resulted in the production of pilot case studies for each participating country[4], which suffer from a lack of comparable approaches across countries. It became increasingly clear that the measurement of knowledge distribution and interaction is difficult because there is a lack of data and structured and comparable information supporting this type of systemic approach. Technological

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2 Thus far, Austria and Denmark have completed their surveys. Others are at different stages in the process: Spain is currently launching the survey. Finland, Norway and Sweden have confirmed participation. Italy, France and UK are willing to implement but are still awaiting clarification on funding matters.

3 Det Danske InnovationsSystem: Komparativ analyse af udfordringer, styrkepunkter og flaskehalse (DISKO). In English: The Danish Innovation System: Comparative analysis of challenges, strengths and bottlenecks.

4 For Austria see: Hutschenreiter et al. (1996) and Müller (1996).

change and innovation were usually measured by conventional Science & Technology (S&T) indicators: (1) measures of *input* into the process, such as R&D expenditures, or the number employees involved in R&D activities; (2) measures of *intermediate output* such as the number of inventions that were patented. These indicators are only able to draw a rather rough picture of knowledge flows in the innovative process. It is well known that a patent reflects new technological knowledge, but it does not indicate whether this knowledge has a positive economic value. Only those inventions which have been successfully introduced into the market can be claimed to being innovations. A similar conclusion can be drawn with respect to measures of R&D input. R&D reflect only the resources designed to produce innovative output, not the returns of innovative activities.

The NIS project now focuses on a different type of measure - the measure of *direct innovative output*. Hence, the second phase of the OECD NIS project is seeking to develop new types of innovation flow analyses which aim at a higher degree of comparability across countries. This includes the mobility of human resources, the mapping of innovative clusters and the mapping of the structure and the characterisation of innovative firms. Hence, in the second phase of the OECD analysis of NIS, work is proceeding along a more in-depth analysis of specific aspects organised in focus groups.

Outline of the Report

The present report is not only limited to the presentation and interpretation of the data. Hence the first chapters are rather theoretical considerations and concentrate on the presentation and analysis of the NIS approach as well as the theory of the firm in general. It is therefore no necessity to study these first chapters in order to get a clear picture of the co-operative behaviour of innovative firms in Austria. The report is organised as follows:

Chapter 2 gives a brief introduction to the theoretical background of the NIS approach with a short overview of the features of the Austrian innovation system.

Chapter 3 discusses two approaches within the theory of firm in the context of innovation and co-operation among firms. Contrary to mainstream economic theory, industrial co-operation is present in most markets so that economic co-ordination solely by prices or perfect competition is extremely rare and indeed almost no-existent. Although knowledge flows and the institutional setting are seen as the driving forces behind co-operations (Richardson, 1972), *transaction cost analysis* is often invoked as a reference point in the discussion of co-operative firm behaviour. The transaction cost approach as a framework for analysis of co-operations however is critisised on the presumption that it ignores the firm as a central institution for the transformation and creation of resources. Hence, it presents firms as an alternative to markets, focusing only on the allocation (and not creation) of resources, with markets held to be the ideal form in most cases. In finding a way out of the sterile market-hierarchy approach the *competence-based theory of the firm* places the primary emphasis on the firm's endowment of capabilities. Firms are seen in this perspective as essentially heterogeneous due to the tacit and social components of knowledge as embodied in firm specific capabilities.

Chapter 4 argues that the new modes of knowledge production makes it more important than ever to study the role of inter-firm co-operation in innovation system. The differences to earlier empirical work is outlined in this chapter.

Chapter 5 gives an overview of the **tip** survey describing the CATI-method, the sample, and summarises the preliminary findings of the survey.

Chapter 6 proceeds along the modules of the questionnaire and summarises the main findings of the survey. This chapter provides information about the importance of external partners for innovative firms and supports the importance of external sources for innovations. *Soft factors* of co-operation, like motives, problems or exchange of personnel, are analysed in more detail. Further, attention is drawn to some general questions due to a general assessment of co-operation with Austrian and foreign firms, respectively.

The final chapter summarises the main findings and points to some general policy implications.

2 Theoretical background

2.1 The National Innovation System approach

Two developments both in the theory and empirics of innovation economics form the basis of the analyses in the present report: the conceptualisation of National Innovation Systems (NIS), and, as a specific aspect, knowledge flows through inter-firm co-operation. These two concepts are not independent - the first provides a basis for the focus on how interaction and knowledge transfer between firms support innovation. These relationships provide a framework for interactive learning which is the major aspect of knowledge creation and diffusion connected with product innovation.

Freeman (1987) introduced the concept of a "National Innovation System" to describe and interpret the performance of the economically most successful country of the post-war period, Japan. Over the subsequent years this concept has experienced a remarkable diffusion and has been applied to several countries and to different areas. The NIS concept appeared in the late 1980s as the result of a number of theoretical and empirical efforts to describe how the innovative performance of firms is determined by the interaction between social, economic and technical institutions at the national level (Lundvall, 1988; Nelson, 1988).

Following these initial contributions, two major developments appeared in the early 1990s, representing two approaches which differ with respect to how they define and understand the role of institutions. The first approach (Lundvall, 1992) describes the NIS as a social system and attempts to combine evolutionary and institutional theorising. Innovation is analysed as the outcome of cumulative causation in learning which "is predominantly an interactive and, therefore, a socially embedded process which cannot be understood without taking into consideration its institutional and cultural context" (Lundvall, 1992). Heavy emphasis is therefore placed on interactive learning (through inter-firm relationships) as an important basis for innovation. Inter-firm relations are supposed to reflect the efficiency and effectiveness in producing, diffusing, and exploiting economically useful knowledge. R&D expenditure is only one kind of relevant input to the process of innovation - "learning in connection with routine activities may be more important than R&D" (Lundvall, 1992).

The second approach (Nelson, 1993) describes the national innovation system as "a set of institutional actors that, together, plays the major role in influencing innovative performance" (Nelson, 1993). Although this approach shares the idea of cumulative causation in learning processes, it places less emphasis on interaction on a microeconomic level and is more occupied with the role of and the interplay between dominant institutional actors.

Although the NIS concept is defined and applied differently, its proponents share a common view due to three factors: (i) the recognition of the economic importance of knowledge; (ii) the increasing use of systems approaches; and (iii) the growing number of institutions involved in knowledge generation. While modern innovation theory emphasises the different aspects of technological knowledge in advanced economies, the systems approaches vary in their emphasis and level of analysis, but they share a common core idea (Smith, 1995). This is that the overall innovation performance of an economy depends not so much on how specific formal institutions (firms, research institutes, universities, etc.) perform, but on how they interact with each other as elements of a collective system of knowledge creation and use, and on their interplay with social institutions (such as values, norms, legal frameworks and others). Following these categories, the NIS approach can be understood as a

relatively wide understanding of learning and knowledge accumulation, particularly emphasising institutional aspects and various forms of interaction among innovators.

The knowledge system approach

The knowledge system approach developed by David and Foray (1995) is far less all inclusive than that proposed by Nelson (1993) and hence in one way much narrower. But at another level this approach is more complex, since it seeks to produce a descriptive account of the multi-dimensional character of scientific and technological knowledge. Not all forms of knowledge, or related interactions, which are relevant to firm-level economic performance are equally observed: they abstract from such issues as finance, marketing, design, etc. The David and Foray approach focuses explicitly on "learning systems for scientific and technological knowledge", but such knowledge is seen in a highly differentiated way, both in terms of its characteristics and functions and its institutional features. Their argument within this complex structure of differentiated forms of knowledge is that what determines performance is not so much knowledge creation as the "distribution power" of the system: "the system's ability to support and improve the efficient functioning of procedures for distributing and utilising knowledge." (David and Foray, 1995).

In the David and Foray approach, neither the role of learning as central to the activities of individual economic agents and organisations, nor the pertinence of the systems approach to analysing the determinants of innovation and adaptive capability, imply that the national economy should be the relevant unit of analysis. Although national policy matters and national governments play a quite obvious role in determining corporate strategies in S&T it is in their view not an automatically consequence linking these two and speaking about *national systems*. Their resistance is due to the emphasis of the role of knowledge in examining the relationship between a society's knowledge base and its capacity to generate and utilise economically-beneficial innovations. "Therefore, rather than an analysis of 'national systems of innovation', our goal is to identify and *reveal national profiles in systems of learning and innovation based on scientific and technological knowledge*" (David and Foray, 1995; emphasis in original).

National system of innovation versus globalisation

It appears that the emphasis on different issues of innovation and competitiveness can be situated in the context of recent discussions about the internationalisation of firms and the globalisation of economies, which tend to diminish the importance of national systems. Terms such as "techno-globalism" have become fashionable and international conferences have been devoted to explore the nature of technological and economic globalisation. Indeed, many studies have demonstrated how firms have exploited the new opportunities and developed "global research strategies" (Casson, 1991) and "networks" (Howells, 1990) to undertake their innovation programmes which largely by-pass their home country. All this has several implications for the understanding of the role of nation states. It is generally assumed that globalisation will reduce the role and scope of nations, and it is not uncommon for the terms *national* and *global* to be seen as opposites. In this case, globalisation reduces the effectiveness of policies at the national level for promoting and organising technological advance, interactive learning and co-operation.

The opposite view states that the formation of technological capabilities of a nation's firms are not only a key source of their competitive edge, but that the formation of such capabilities is also amenable to governmental management - that is, competitive capabilities can be built by national action.

Contrary to these points of view, some authors have analysed these issues in more detail by defining several categories of technological globalisation: (i) global exploitation of technology, (ii) global technological collaboration, and (iii) global generation of technology (Archibugi and Michie, 1997). According to Archibugi and Michie (1997) the patterns of globalisation differ significantly between the three categories of technological activities. The globalisation of technological activities, they conclude, has not led to a convergence either in the methods adopted by countries to innovate or in their profiles of sectoral specialisation. Because unique domestic economic, institutional, and technological conditions matter, the role of national innovation policy is not becoming less important because of globalisation. The exploitation of innovation requires national governments to settle the regime according to which new technologies can be exploited within their borders. Even international co-operation rely on the nature of the national technological capabilities - this is still largely organised within the boundaries of nation-states. All these results are consistent with the NIS-literature emphasising the role of national systems in organising and promoting innovation.

The dichotomy global/national is therefore not the adequate categorisation to analyse the impact of globalisation on national technological capability. Moreover, among the development of the NIS concept were empirical observations that convergence in macro-economic performance does not entail the homogenisation of underlying regional, national and local patterns of scientific, technological and innovative activities. This is reflected both in a deepening of the division of labour between countries and different historical-grown institutional settings which determine country-specific paths of development and innovation climates. Thus the persistence of distinct specialisations patterns indicates that countries will develop along certain *technological paths* or *trajectories*, determined by past and present patterns of knowledge accumulation and use.

This is not a contradiction with the rapid internationalisation and globalisation of economic and technological activities but rather confirms that capabilities are nation-specific, differentiated and cumulative. They have different impacts on sectoral strengths and weaknesses (Patel and Pavitt, 1991). Hence, globalisation does not only facilitate the diffusion of best production practices and increase the impact of innovative networks but also magnifies the impact of some nation-specific factors of innovation-based competitiveness.

One of the factors which influence firms in either co-operating with foreign firms or investing in a foreign country is the technical expertise that those firms or countries have to offer, and that firms try to exploit these advantages. Although national technological capabilities may or may not be easily appropriated by foreign firms, the technological complementarity is the key factor promoting joint R&D or foreign direct investment (Hagedoorn and Schakenraad, 1990). The effects of techno-globalism on national technological specialisation does not seem therefore to lead to any greater uniformity in patterns of strengths and weaknesses. Nations become increasingly different in technological capability which configure international competitiveness (Porter, 1990; Fagerberg, 1991)[5].

[5] "Competitive advantage is created and sustained through a highly localised process. Differences in national economic structures, values, cultures, institutions and histories contribute profoundly to competitive success. The role of the home nation seems to be as strong or stronger than ever. While globalisation of competition might appear to make the nation less important, instead it seems to make it more so. With fewer impediments to trade to

2.2 Institutional Setting

If the subject of research is innovation and inter-firm co-operation, then the economy will be pictured more as a process of communication and cumulative causation than as an equilibrium system, i.e. from an institutional rather than a neo-classical point of view. If innovations are regarded as the creation of new knowledge or, as it is in most cases, as the new combination of existing knowledge, then innovations are mainly the result of interactive learning processes. Through interactions in the economy different pieces of knowledge become combined in new ways or new knowledge is created and this sometimes results in new processes or products. The interactions occur within firms (between different individuals or departments), between firms and consumers, between different firms, or between firms and other organisations.

Innovations can be regarded, as mentioned above, as cumulative processes. It is now a well established fact that in many areas of technical change there is strong cumulativeness in the form of *technological trajectories*. Both these characteristics of learning processes - being interactive and cumulative - mean that the institutional set-up will affect innovation processes. Institutions by their very nature affect interactions between people or between organisations (like firms, universities, state agencies, etc.) and are often considered to be the "glue that keeps society together", although little is written about the role that institutions play in processes of learning and innovation as is mentioned by Edquist and Johnson (1997).

The concept of "institutions" has been defined in various ways and has come from a number of different angles. Even if there are several varieties of the concept, institutions tend to be used to refer to important and general economic phenomena like basic behavioural patterns and ground rules. Edquist and Johnson (1997) define institutions as "sets of common habits, routines, established practices, rules, or laws that regulate the relations and interactions between individuals and groups." Although in everyday language there is no clear distinction between institutions and organisations, according to North (1990) the latter are partly formed by institutional framework and are, at the same time, vehicles for their change.[6] Individuals or groups constituting an organisation have a common purpose to achieve certain objectives. Organisations include, according to North (1990), many kinds of entities: political bodies, economic bodies, social bodies and educational bodies[7]. In the context of innovation the reason of distinction between different organisations on the one hand and the distinction between organisations and institutions on the other hand are that they play different roles in the process of innovation and are important determinants of economic behaviour.

Concerning the strong impact of institutions on technical change, a tension between technology and institutions and a pressure for institutional change is often provoked. At the same time institutions are normally quite rigid and do not change easily. They are often thought simply as a source of "institutional drag", i.e. of inertia of the

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shelter uncompetitive domestic firms and industries, the home nation takes on growing significance because it is the source of the skills and technology that underpin competitive advantage" (Porter, 1990).

6 "Institutions are the rules of the game in society or, more formally, are the humanly devised constraints that shape human interaction. [...] The purpose of the rules is to define the way the game is played. But the objective of the team within that set of rules is to win the game - by a combination of skills, strategy and co-ordination; by fair means and sometimes by fouls means. [...] Organisations are created with purposive intent in consequence of the opportunity set resulting from the existing set of constraints (institutional ones as well as the traditional ones of economic theory) and in the course of attempts to accomplish their objectives are a major agent of institutional change." (North, 1990).

7 "Organisations are formal structures with an explicit purpose and they are consciously created. They are players or actors." (Edquist and Johnson, 1997). A more loosely definition of an organisation used Andrew Tylecote at the last EAEPE summer school in Crete. He defined an organisation as "an institution with a telephone number".

system. The institutional-technological mis-match may cause problems, which prevent the full realisation of the productivity potentials of technical innovations. The term "institutional sclerosis" has been introduced by Mancur Olson to characterise this phenomenon (Olson, 1982). On the other hand, the content of communications and interactions in relation to innovation activities are shaped by the institutional set-up of the economy. They exist at the levels of the firm where institutions affect the relations between R&D, production and marketing - relations which strongly influence innovations. They also exist at the level of markets, i.e. the relations between firms and between firms and households. Feedback mechanisms for consumer reactions on new products, durable and selective user-producer relationships and network relationships are essential to many types of innovation processes. Relations between government agencies and private firms or technology policy are examples at a third level at which institutions influences innovation. Thus, connections between institutions and innovation are ubiquitous and exist at many levels. According to Edquist and Johnson (1997), three main functions of institutions can be mentioned regarding innovations:

(i) to reduce uncertainty by providing information;

(ii) to manage conflicts and co-operation;

(iii) to provide incentives.

Of course, there are limits to how fast institutions can change and still be the things that are responsible for stable patterns of behaviour. Continuously changing institutions are a contradiction in terms (Edquist and Johnson, 1997), while institutional rigidity is in the long run a threat to technological change or disincentive for co-operation. However, the capability of national economies to cope with this problem, i.e. to learn about, adapt and change their institutional frameworks - to engage in "institutional learning" (Johnson, 1992) - is important for the development of the international competitiveness. Hence, institutional innovations may give new impetus to technical and economic change.

2.3 Features of the Austrian Innovation System

The main reason to think about national innovation systems or why national governments engage in innovation and technology policy is the assumption that innovation is a key element in economic growth. Different indicators of economic growth are relevant when it comes to compare systems. But such well known indicators will reflect factors which give little insight into how innovations take place in different countries. Institutions shape the particular modes of interactive learning and thus the outcome of the innovation process. They also shape the organisational behaviour of firms. Hence, "it is difficult to imagine innovations that are not to some extent formed by the institutional set-up" (Edquist and Johnson, 1997). In this context it is useful to distinguish between institutions that are *formal* (laws, e.g. patent laws, government regulations, etc.) and institutions that are *informal* (common law, traditions, work norms, norms of co-operation, conventions, practices, etc.). This distinction is important because the balance between formal and informal institutions may differ between countries, between sectors within countries, or between small and large enterprises within sectors.

These institutions play a significant role in a small country such as Austria. They shape national strategies necessary when confronted with international competition and characterise specific differences in the ability to create and use knowledge. However, it is difficult to integrate the institutional set-up into comparable empirical figures.

Moreover, most of the studies within the NIS literature provide no real guide how to empirically define and monitor the structure and dynamics of a system.[8] Most of the approaches within the NIS literature are notable for their conceptual innovations and the novelty of their approaches, rather than for quantification or empirical description. It is therefore suitable using currently existing data and methods for explaining the economic structure of a country although understanding knowledge profiles is not something which can be achieved simply via statistical analysis.

The Austrian Research System

A complete description of the Austrian Innovation System is not possible within this framework, hence only a few distinctive features of the Austrian Innovation System are touched.[9] According to the findings of economic research, the most important driving force behind long-term economic growth is technological change. In this context, private and public investment in research and development (R&D) plays a crucial role. The following Table 1 compares Austrian gross domestic expenditure on research and development (GERD) as a percentage of the gross domestic product (GDP) and the Austrian technology balance of payments (TBP) to their counterparts in other selected countries. According to these indicators, Austria spends little on research and development (R&D) and is net importer of technology.

Table 1: International Comparison of GERD/GDP and TBP

	GERD/GDP (%)			TBP (1994)[10]	Ratio
	1991	1993	1995	(mill. $)[11]	(receipts/payments)
Austria	1.5	1.49	1.53	-323	0.29
Sweden	2.89	3.28	3.02	353	8.89
Finland	2.07	2.21	2.32	-264	0.14
Germany	2.61	2.43	2.28	-2.350	0.77
Ireland	0.96	1.21	1.4	-	-
Spain	0.87	0.91	0.8	-863	0.10
Norway	1.65	1.73	1.59	-61	0.67
Denmark	1.7	1.79	1.82	-	-
France	2.41	2.45	2.34	-779	0.72
United Kingdom	2.11	2.15	2.05	554	1.17
Italy	1.32	1.26	1.14	-753	0.58
Netherlands	2.05	2,0	2.04	69	1.01
Japan	3.0	2.88	3.0	895	1.25
USA	2.84	2.64	2.58	16.770	3.96
EU[12]	1.96	1.94	1.84	-3.913	0.80
OECD	2.31	2.2	2.16	13.599	10.84

Source: OECD quoted in Hutschenreiter et al. (1998)

8 Lundvall (1992) is primarily a qualitative study, with the exception of two papers on trade performance. Nelson (1993) is explicitly descriptive, but with some exceptions this turned out to involve rather conventional data use on industrial structures, R&D flows, and foreign patenting. By far the most comprehensive quantitative work is Archibugi, Pianta (1992) which develops a range of indicators for identifying specialisation patterns in science and technology in OECD countries.

9 For a broader description of the Austrian Innovation System cf Hutschentreiter et al. (1998).

10 Or closest year.

11 At current exchange rates

12 TPB include the flows within the zone.

The fact that in Austria this ratio has stagnated at an internationally low level of 1.5% since the early nineties, does give cause for discussion. The structure of R&D expenditures, which is not usually considered in the general discussion, is however of equal significance. The structure of R&D expenditure has not changed very much during the last decade: industry pays for about 57,3 per cent of R&D expenditure and the numbers for educational organisations and other research organisations are 35,3 per cent and 7,3 per cent, respectively. Compared to other countries the share of industry in research is rather low. This relatively low R&D investment might be related to the larger presence of multinational firms, who typically undertake R&D in their home countries.[13] Other factors involved are the small pay-off to innovation due to small home market size and uncertainty about market growth, organisational problems, regulations, and difficulty in obtaining personnel with the requisite R&D and production skills (OECD, 1995a). Austrian universities, on the other hand, usually have a very broad spectrum of research topics without outstanding national specialisation (Jörg, 1997). Government traditionally concentrates its financial support on universities. About 71 per cent of the public R&D expenditures are allocated to higher education organisations, whereas the international average is less than 50%. Universities execute little commissioned research, either. About 97 per cent of the universities' research budget are financed by the public hand, only 2 per cent are financed by industry. The immediate conclusion from this fact is the weak linkage of Austria's higher education research with other sectors, in particular with the business enterprise sector. Hence, the links between industry and universities are weak.

Analyses of international trade in manufactures provide estimates of the volume of international technology flows embodied in tangible products. The Technology Balance of Payments (TBP), however, is designed to determine a country's position in international trade in technical knowledge and services with technical content. The Technology Balance of Payments covers financial flows between countries relating to the acquisition or sale of scientific or technical knowledge. As Table 1 reveals, Austria has a structural deficit in its TBP (surplus of payments over receipts). The coverage ratio (ratio of receipts to payments) shows a long-term fluctuation (since the early seventies) around a slightly increasing trend. In recent years, the receipts from trade in technology have been covering a little less than one third of the corresponding expenditures.

Technological specialisation in traditional fields

Another aspect of the specialisation of innovation systems is the structure of patent activities. The examinations of Austrian patent applications correspond with the findings regarding the research and development system: relatively modest patent intensity and internationalisation of patent activities. In addition to this, the patent specialisation in Austria shows certain particular characteristics: the emphasis of Austria's patent applications filed with the European Patent Office lies on the technological field of 'construction' (due to some innovative enterprises which frequently occupy a significant position in the international market within their respective market niche) (Gassler et al., 1996). International comparison reveals that industry in Austria concentrates its R&D efforts in traditional fields while lacking in core areas such as instruments, electronics and communications.

The evolutionary theory of innovation emphasises the cumulative and path-dependent character of technological development. Together with external effects and increasing scale yields, technological learning effects result in

[13] But even the share of foreign firms on business financed R&D in Austria is rather high. The share of foreign multinational firms on the business expenditure on R&D in Austria is reported to have increased from 35% at the beginning of the 90's to 50% in 1995 (see: Der Standard, 5.2.1998).

the fact that individual countries (or enterprises) do (can) not easily change the technological path they once have adopted.

In this way, the thesis of the path-dependency of technological change was also confirmed by the example of the Austrian innovation system. In a number of empirical analyses, this hypothesis is supported by the evidence of a distinctive temporal stability of the national specialisation patterns. A marked temporal persistency of the technological specialisation pattern was also revealed for Austria (Gassler et al., 1996). The degree of auto-correlation of technological profiles between 1987-1994 (Database: European Patent Office) is extremely high.

The differences in market conditions (concentration of the market, increase in demand, etc.) as well as in technological possibilities lead to a specific pattern of the innovation behaviour, typical for certain sectors. Thus the patent activities in Austria are highly concentrated on a few sectors and technological areas, a fact which incidentally also comes to light in R&D statistics and innovation assessments.

Austria underwent a fast catching-up process

When Austria nevertheless has a GDP per capita exceeding 24.000 US$[14] and has been able to maintain and increase the standards of living, the explanation must be sought in a broader set of factors, which have let to the present generally favourable position. As many studies have pointed out, Austria's economic development after World War II was largely marked by importing advanced capital goods (embodied technical change) from abroad. The strategy of rapid adoption of externally provided equipment and production techniques without investing substantially in domestic R&D appeared as a viable option for economic development. The dictum *technological progress without research* tries to capture this historical experience, i.e. to link the positive growth differentials of per-capita income levels vis-à-vis initially more advanced countries with a comparatively low level of domestic R&D activities.

Another important factor which explains the high standard of living were the high productivity gains characterising the rather fast catching-up process in Austria. This productivity growth showed by 1990 an output per worker in the business sector just below the OECD average, whereas it had only two-thirds the OECD average in 1966 (OECD, 1995a). This demonstrates a strong catching-up process, which occurred overwhelmingly in the open sectors: manufacturing productivity increases since 1974 have been much greater than in Germany. Reflecting the nature of the catching-up process, a significant part of the early productive increases arose from total factor productivity (TFP) growth (technological progress and other intangible elements).[15] In the more recent period, as the productivity gap narrowed, TFP's growth rate declined - but from a much higher level of TFP in the late 70's compared with other economies.

Strategy of a small country

Some of these factors are simply related to the national strategies which small countries have to adopt when confronted with international competition. In order to get access to foreign resources a small country has to open and to eliminate barriers to trade. It is therefore not surprising that the small developed countries of Europe opened their economies and actively advocated to adopt a non-tariff, non-barrier world trade system. In the case of Austria the opening has been an ongoing process beginning with commodities and later encompassing services, capital, and knowledge. In order to secure this process, and to balance the different sectoral interests, a strong central government was needed - a government with detailed economic information on all major aspects of the society, and with the power to co-ordinate the liberalisation process. Close institutional and personal connections and extended informal networks between the central administration of government and the business associations, organised labour, and the political parties, became a prerequisite for a successful outcome.

Once the domestic market for commodities had become sufficiently open, even a small country without any major initial advantage utilise economies of scales to establish an internationally competitive manufacturing industry (Krugman, 1991). But the small size of a country like Austria place a tight restriction on the ability to function as a

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14 Among the 15 present members of the EU, Austria has risen in terms of GDP per capita (at current prices and PPP) from rank 9 in 1970 to rank 4 in 1995 (after Luxembourg, Denmark and Belgium). On OECD level Austria has risen in terms of GDP per capita from rank 14 in 1970 to rank 7 in 1995 at current PPP. Austria´s GDP per capita is thus significantly above both the corresponding EU and the total OECD or OECD-EU average.

15 See Egger and Hutschenreiter (1998).

buffer for fluctuations in international demand. Also the limited size of the national knowledge and capital base influence the range of industries in which small nations might successfully specialise.

The restrictions of size have thus gradually channelled the process of specialisation towards industries with rather stable demands and low price-elasticity. These industries are often medium or low-tech, but can nevertheless yield high profits. Front edge, high-tech industries are to a great extent left to bigger nations, either by choice or by necessity. Furthermore, the new trade theory (Krugman, 1990) claims, that countries are likely to specialise in sectors and commodities, where domestic market are of particular importance. The home market for high-tech commodities do seldom play such a role in small countries. Especially in Austria technological change and development were based on the import of advanced capital goods in order to create positive growth differentials to advanced countries. But this catching-up process has proceeded and the appropriation of international R&D spillovers through the import of advanced capital goods has become now less effective (Hutschenreiter, 1994). This implies that the *advantages of backwardness* vanish as a source of positive growth differentials.

The Austrian specialisation pattern is typically in this respect with a long bias towards wood and wood products, metallic products and textiles (Peneder, 1994). It is also striking that most of these national clusters has now become branches with huge problems as a step in the restructuring of the industrial structure. Only recently Austria has also gained ground in high-value subsectors, but the nations' few high-tech firms are mostly branches of big foreign firms. But being specialised towards low-tech or medium-tech products with relative stable demand and low price-elasticity raise little hope of creating high-flyers with extraordinary growth rates and vast net revenues. On the other hand it reduces the danger of damaging domestic economic consequences, when the international demand or competitive situation changes. But with increasing openness of the world economy and an increasing number of (potential) competitors, the opportunities for creating competitive advantages by more or less passively adopting widely available equipment and technologies are increasingly wiped out. This enhances the role of innovation in contemporary growth. In other words, as productivity levels came nearer to those prevailing abroad, Austria could no longer count simply on *osmosis effects* from abroad to ensure a fast pace of technological progress, but had to participate with an innovation effort of its own. The international economy is thus favouring firms, which are able to learn, change and adapt a little faster than their competitors. The competitive edge has gradually shifted from static price competition towards dynamic improvements. Product differentiation, quality improvements, the flexibilization of production, etc. tend to increase the importance of product innovation vis-à-vis process innovation.

Being reactive and to adjust to changes in the international economy sometimes imply the adjustment of a domestic production system, i.e. an incremental and flexible pursuit of industrial adjustment of changes in the international economic environment. A larger nation might choose to reduce the domestic effects of international economic changes by various measures such as protective measures. A small nation simply do not has the political power to do so.

2.3.1 Institutional set-up in Austria

After the second world war, rebuilding the Austrian economy seemed a natural task for the public hand. Most of the Austrian heavy industry and infrastructure remained in public hand. In the post-war period the independence of Austria hinged on close collaboration of all Austrian interest groups. The relation between the representatives

of capital and labour in Austria is often described as highly co-operative, i.e. consensus oriented. This co-operation is an important institutional factor and enhances a genuinely Austrian form of "corporatism". The *social partnership* is thus a complex set of institutions based on voluntary co-operation between the employers' and employees' representatives and extending over all major fields of economic policy and beyond (Egger and Hutschenreiter, 1998) . As stated by Aiginger (1994): "The social partners helped to insert a long time horizon into economic policy and implicitly reduced the time discount of policy makers. Making economic policy predictable and stabilising demand, prices and profit shares are important parts of a strategy to reduce future risks. Production is higher under reduced uncertainty."

The catching-up process in Austria was favoured to a large extent by the system of *social partnership*, which hence "ruled the game" for development. It comprises not only legal institutions and regulations, but also the informal institutions which shape the way of formal decision making. This comprehensive network designed for the long perspective may not only lower the cost of economic transactions, but also stabilises expectations of economic agents. This may be one explanation for the fact that Austria, together with Switzerland, exhibits the lowest ratio of labour strikes among all industrialised countries.

Hence, the social partnership is among those institutions, which may effectively favoured the rate of growth of an economy. It did not only affect income distribution but also mobilised a high degree of "social capabilities" (Abramovitz, 1986), which gave rise to a distinct framework for macroeconomic policy and the relatively favourable levels of education and training in the labour force. The development of these social capabilities created one of the most important conditions for the catching-up process in Austria.

Although this institution is an expression of an Austrian tradition to evade conflicts and to find compromises there is a quite intensive discussion on the trade-off between the stabilising and hence development-enhancing function of the social partnership and the conservation of existing structures and thus development-impeding institutions. Some features of the social partnership like the Parity Commission is nowadays part of the history and does not play the role in economic and social life as two decades ago. The economic and social development of the last years led to a quite critical assessment of different forms of corporatism as the discussion in the two countries with the highest forms of corporatism - Austria and Sweden - shows. This indicates that every long lasting institution is confronted with some kind of petrifaction. Moreover, institutions have to adapt and change even more, if the surrounding conditions are seen in a fast mutation.

Political corporatism does not lead to co-operation in the business sector

The business community in Austria is still more or less characterised through mechanisms, which link the actors or firms in any sector and build the base for several kinds of relations. In most lines of business, and certainly within all sectors of manufacturing industry, the domestic producers know each other either directly of indirectly. Even in sectors dominated by a large number of small and medium-size enterprises all producers will have a remarkable degree of knowledge of most other domestic producers in the sector, their main domestic and foreign suppliers and the most important customers. In Austria all firms in a sector are usually organised in at least one association or guild with nation-wide coverage. Most of the actors share the same background and one can guess that most will have participated in some sort of joint activity at the local, the regional or the national level.

However, such a business climate of quite close relationships does not necessarily lead itself to intensive co-operation and interaction among firms. On the contrary, in most cases the opposite can be observed. This means, however, that if institutions are part of policy making on the macro- or mesoeconomic level their influence on the microeconomic level is quite limited. Especially small and medium firms often envision their fellow producer as their main competitor with a quite adverse attitude towards co-operation. Although local rivalry of this kind stimulates the entrepreneurial spirit and reinforces the productivity in the region, the *shared history*, values and culture make certain types of exchange and co-operation more easy. It is therefore a quite open question why in a country with such a specific form of corporatism on a macroeconomic level does not have a comparable form of co-operation on the microeconomic level?

Interactions between firms - especially at the local and the regional level - have an increasing importance as the use of knowledge gradually intensifies when developing new products and processes and when accessing new markets. As the development in the international competition increase the demand for knowledge exchange, new network relations between firms seem to become more important and seem to be built at a faster rate than ever before. It can thus be realised that since the 70's an increase of several forms of co-operation has changed the industrial environments which has at the same time challenged the existing economic literature of innovation, technology transfer, and diffusion. The phenomenon of co-operation itself has its roots in the theory of cartels in the 30's and international cross-licensing. However, the recent upsurge of collaborative alliances represents a qualitatively new stage, with a much greater number of agreements, an increased range of industrial sectors involved and far more international collaborations. In particular, the collaboration in the production of technological knowledge, with the partners' dependent on each other's complementary skills and assets, is a relatively new phenomenon (Coombs et al., 1996).

The following chapter will therefore give a short overview of the economic approaches to innovative behaviour of firms and analyse the role of co-operation in the innovation process.

3 Theories of the firm

Since Coase's seminal 1937 paper on "The Nature of the Firm", there has been an odd and unjustified separation between price theory and the economics of organisation. The following chapters link up with the literature on economic organisations but try to emphasis the knowledge-based premises. Rather than conceptualising the firm as an entity that is primarily kept together by transaction cost minimisation, new approaches extend the view of the firm as an entity whose primary role is to acquire, combine, utilise and upgrade knowledge. The following chapter does not only discuss the sources of the different approaches but also tries to elaborate possible points of contacts between the approaches.

3.1 Knowledge matters

As mentioned in the first chapter, the performance of national innovation systems should be reflected in the efficiency and effectiveness in the production, diffusion and exploitation of economically useful knowledge. Innovation, as a cumulative process, appears as a process in which interactive learning and collective entrepreneurship are fundamental. It is therefore a well known topic that inter-firm relationships are important in structuring the system of innovation.

Once the focus of the analysis moves from macro-economics to the micro-economic level, the need to examine closely the quality of co-operation and linkages between actors becomes all the more important. Moreover, it is necessary to shed light on existing theories of the firm and to proof whether the theoretical concepts allow us to fully understand the modern corporation in its complex entirety. In standard economics these relationships are assumed to be characterised by competition and pure market relationships. Focusing upon innovation makes it clear that co-operation between firms is a necessary supplement to competition.

The theoretical focus towards co-operation even marks a new qualitative standard which enhances the interactive character of innovation. In economics, knowledge and knowledge flows is the classic example of a public good which drive the wedge between private and social rates of return to innovation. Hence, the general presumption of most economists is that incentives to do R&D may often be seriously undermined as a consequence of the problem of appropriability. For a small country like Austria international R&D-spillovers therefore played a quite substantial role. But it becomes more interesting for a country moving from the analytical ground of "unplanned" spillovers and related externalities to that of linkages with the purpose of reaping partly predefined or *targeted* returns to technological activity through co-operation. The effects are even more intensive when these agreements are sufficiently numerous, dense, and frequent which imply the existence of a network. Recognising the importance of networking and co-operation thus leads to the further insight that co-operation, when properly recognised and valued by firms, then "represents a specific source of increasing returns" (Chesnais, 1996).

Another quite interesting aspect of a "new economic paradigm" lies in special features of today's production regime, which is increasingly information intensive and dominated by information technologies. Hence, the implication of the new modes of production do not only concern the vague expression of externalities, but the variety of specialisation and flexible mass-production. This regime makes inter-firm co-operation as a special form not only in technology creation and sharing, but also more broadly in the production and sourcing of specialised

inputs. Special forms of agreements depend on the surplus-creating attributes of the partner, which means that co-operation can not arise solely from the co-operative relationships alone. This implies necessarily that the firms linked together or involved in networks possess specific potentialities.

3.2 The neo-classical approach

A pure market is presented as the ideal norm in the neo-classical analysis of allocation. Through the price mechanism and symmetric information an efficient allocation of goods can be achieved. Neo-classical production theory is built on the idea that firms face a dual production decision. Firstly, they must decide what to produce. This decision is based on rates of return: potential product lines are known, and firms will allocate and reallocate capital among them in search of the highest returns. Then the problem is the choice of production technique: firms within an industry face a given and known array of production technologies and are assumed to have the competence to operate all available production methods. Armed with this knowledge, and with a knowledge also of present and future factor prices, firms can make a profit-maximising choice of technique. In this context technology is seen as knowledge, and firms are able to access knowledge in a relatively rapid and costless way. Due to these assumptions the technological dimension of production are unproblematic. Hence, neo-classical production theory is perhaps best understood as reflecting an economy, where innovation is a marginal and perhaps accidental phenomenon. And with the characteristics of innovation concerning uncertainty and risks pure markets would effectively block product innovations and would reinforce a more or less stationary character of the economy.

But an economy, characterised by a highly developed division of labour, one interesting aspect of innovation is that it give rise to the problem of assessing the utility-value of the information on which new products or agreements between actors are based. Central to this is the assumption of diversity of behaviour across individual agents and the continued development of technologies which (primarily) firms develop and spread through the economic system. Process and change, not equilibrium and state are central concerns. Hence, within an evolutionary approach imperfect information is an integral part of this process, indeed the possession of privileged information is the mainspring of profit opportunity. In paraphrasing Richardson, Metcalfe (1995) states that knowledge which is available to everybody provides a profit opportunity to nobody. If markets are pure and characterised by an anonymous relationship between economic actors, the information problem can not be solved. Innovative activities aiming at new products would be very risky to initiate and successful product innovation would be difficult to achieve. It is therefore, that while standard neo-classical economics is assumed to optimise one dimension (allocation), it produces inefficiency in another dimension (innovation).

The problem with information (and knowledge) is that it is difficult to determine a price for information that will satisfy both buyer and seller. The buyer wants to know, whether the information offered is worth the requested price, but "[...] its value (of the information) for the purchaser is not known until he has the information, but then he has in effect acquired it without cost" (Arrow, 1970). Because there exists no market for information and the costs of transmitting the information are quite low it will discourage the seller from offering the information.

3.2.1 Does asymmetric information means market failure?

This kind of market failure opened the tradition of the public good character of knowledge and how government should act concerning R&D. This market failure approach to knowledge production leads to a relatively simple set of policy proposals. In this set-up the basic policy task is to encourage discovery-oriented activities, and then to protect the use of the results. Thus, the public sector should either produce knowledge directly, or provide subsidies to knowledge-producing institutions. The appropriability problem implies the existence of strong property rights (via patents or other intellectual property protection). But the basic problem with the approach is that it does not give any secure guide to how to identify areas of market failure, or the appropriate levels of public support which might follow from it. There appears to be a rationale for public provision, but where, and how much (Metcalfe, 1994)?

The rationale for governmental intervention and hence technology policy has long been concerned with the market-failure-argument. Beside the imperfect markets for information, governments intervene in order to provide public goods, as well as to mitigate externalities, inefficient market structures or barriers to entry. While some of these arguments are still at the heart of technology policy, the general market failure argument has to be tempered by considering the risk of government failure. Governments cannot *a priori* be assumed to do better than markets, even when the latter have shortcomings. Moreover, some of the traditional market failure arguments turn out to be consequences of the innovation process *per se.* Due to the fact that every innovation process both generates and is influenced by uncertainty, this aspect of market failure is particularly damaging to the possibility of a Pareto efficient allocation of resources to invention and innovation. It is the uncertainty which comes from the anticipation that individuals and organisations will behave in a way which cannot be fully or even partially anticipated. But this difficulty is deeply embedded in the nature of technical knowledge, the creation of which depends upon the establishment of information asymmetries. "In a quite fundamental sense, innovations and information asymmetries are one and the same phenomena. Indeed, such asymmetries can scarcely be termed market imperfections when they are necessary conditions for any technical change to occur in a market economy" (Metcalfe, 1995).

To summarise, it has been shown that it is quite fundamental for policy as well as theoretical developments which assumptions are made with respect to knowledge. Although it may seem trivial but it makes a crucial difference if it is assumed that knowledge is symmetrically or asymmetrically distributed, whether the future is uncertain or not, etc. The basic propositions about the role of knowledge influenced the work on firms and determined the broad menu of contemporary theories of economic organisations. Moreover, different assumption of the distribution of knowledge is the *raison d'être* of the modern literature on the economics of organisations. The following chapters should thus give a short overview of the different approaches.

3.3 The contractual and competence perspective of the firm

In the last decade, the theory of the firm has become a rapidly expanding research area in economics.[16] The general economic expansion of interest in the firm in general is reflected in a broad menu of theoretical ap-

[16] This can to a certain extent be attributed to the winning of the Nobel prize 1991 of one of its pioneers, Ronald Coase.

proaches, all of them in many ways sprang from the highly influential work of R. Coase. Thus, there is the brand of transaction cost economics developed by O. Williamson (1985), the nexus of contract theories (Alchian and Demsetz, 1972), the incomplete contract approach pioneered by Grossman and Hart (1986) or the economics of organisations more broadly (Milgrom and Roberts, 1992).

In spite of some not inconsiderable varieties among these approaches, it is fair to say that they agree on some fundamentals. The basic insight is the following: In addition to production costs of the usual sort, one must also consider transaction costs in explaining institutions like firms. The Coasean literature of the last two decades has indeed focused precisely on the comparative transaction costs of alternative organisational structures, including, paradigmatically, the choice between firms and markets.[17] Moreover, the literature has seen the "nature" of the firm as fundamentally contractual. That is, firms and other institutions are alternative *bundles of contracts*, understood as mechanisms for creating and realigning incentives.

An alternative approach to the theory of firm was developed alongside a broad spectrum of theoretical (mainly evolutionary) approaches. But the main characteristic of the different approaches is that they place the primary emphasis on the firm's endowment of *capabilities.* This perspective on the firm's existence and boundaries is conceptually distinct from the contractual approaches. For understanding the sources of sustained competitive advantage, capabilities constitute the knowledge base of the firm. They are normally seen as productive bundles of routines of a highly tacit and social nature, and they are operated by teams of individuals for some strategic purposes. Firms are seen in this perspective as essentially heterogeneous - and this heterogeneity is created endogenously through the tacit and social components of knowledge as embodied in capabilities. The capability perspective includes contributions from somewhat different starting points.[18] But within this corpus of theories the common-sense is the recognition of the character and limitations of knowledge on the production side - which is neglected in the contractual theories.

The emerging capabilities view is even more heterogeneous than the post-Coase literature, partly because of its diverse backgrounds in business history and strategy, evolutionary economics, and technology studies. However, both approaches can be seen as instances of the broader problem of understanding how knowledge and the boundaries of the firm interact. In this sense it can be realised that there may be a need to combine propositions from capabilities and contractual theories. Yet, not to see them as alternatives but as a complementary area of research (Langlois and Foss, 1997). The following sections try to give an overview of the central concerns of the two approaches shortly described above but with view of the topic of the study - thus co-operative behaviour of innovative firms.

3.4 Contractual approach

The contractual approach to the firm begins with Coase (1937). The paradigm with which Coase was confronted in the 1930s was the conception of the firm as a production function. In this sense the firm operates at two mar-

17 They also agree upon some behavioural assumptions that extend the usual self-interest assumption such as opportunism or moral hazard.

18 See also: Nelson and Winter (1982); Langlois and Robertson (1995); Foss (1993); Dosi and Marengo (1993); Langlois (1992); Teece and Pisano (1994)

gins: price and quantity.[19] Yet, price theory was never intended to be a theory of the firm as an organisation or institution. Thus, using this sort of price theory to explain the existence, boundaries or internal structure of the firm can never be satisfactory. Coase realised this in observing that in the world of price theory firms have no reason to exist. According to neo-classical textbook economics, the decentralised price system is the ideal structure for carrying out economic co-ordination. Now the question emerges, why some transactions are removed from the price system to the interior organisations called firms? The answer Coase found, is, that there is a "cost to using the price mechanism". Thus, the idea of transaction costs was born: costs that stand separate from and in addition to ordinary production costs. Costs of discovering what the relevant prices are or market transactions that would be necessary to co-ordinate some complex production activities. These costs can be avoided by firm organisation.

Although the analysis of the origin of firms was quite important, it nevertheless has a very narrow view of the firm and thus neglects important aspects of firm behaviour. In the Coase' tradition the firm is no more than an alternative and indeed a second best instrument of resource allocation that persist as a result of market failure.

The explanation of the firm as an institution that lowers the costs of qualitative co-ordination in a world of uncertainty has initiated major subfields in this discipline. In order to make Coase's ideas more operational, the theoretical stream has both narrowed his explanation of the firm and moved its focus away from issues of co-ordination, especially qualitative co-ordination. However, from the perspective of real-world firm behaviour and the boundaries of the firm, the view of the firm only in the context of transactions ignores some of the most important factors that determine firm organisations and underpin the relationship between firms and markets. Hence, this approach essentially relegate to second place, or even assume away, the activities that the people working for the firm are actually engaged in. These include deciding what to produce and how to produce it and then actually producing it in the way that best rewards the firm's owners. Thus, success derives from the firm providing goods and services that meet the need of potential customers in a way that generates the highest possible returns. If so, then firms as organisations need to tackle a variety of goals which are interdependent (Langlois and Robertson, 1995).

3.4.1 Transaction costs and vertical integration

As was pointed out above, all transaction costs are basically information costs. But most theories of transaction costs and boundaries of the firm "[...] are static in an important sense" (Langlois and Robertson, 1995). They take the circumstances of production as given and investigate comparatively the properties of market-contract arrangements, internal organisations, and sometimes other modes of organisations. Although Oliver Williamson cannot be accused of having a narrow conception of transaction-cost economics, he also has upheld the partition between transaction costs and production costs. This he argues as a pragmatic methodological postulate: hold production costs constant and look only at transaction costs. "A useful strategy for explicating the decision to integrate is to hold technology constant across alternative modes of organisations and to neutralise obvious sources of differential economic benefit" (Williamson, 1985).

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[19] Axel Leijonhufvud (1986) mentioned, that the neo-classical conception of the firm *"... is more like a recipe for bouillabaisse where all the ingredients are dumped in a pot, (K, L), heated up, f(.), and the output, X, is ready.* Hence, this view provides no insight into organisational structure or the sequencing of tasks".

Assumptions

In Williamson's earlier work (Williamson, 1975) the framework of incomplete contracts dominated and thus issues of co-ordination figured quite prominently. He argued, that an internal organisation may be a superior mode of co-ordination versus the market whenever two behavioural assumptions are assumed: firstly, *bounded rationality*, "which relegates all forms of comprehensive contracting (with and without private information) to the infeasible set" (Williamson, 1993). The expression bounded rationality is a somewhat misleading. Thus it describes the limits to an agent's knowledge and decision making skills due to complexity and/or uncertainty of the world. Economists often object to it because limits on rationality are mistakenly interpreted in nonrationality or irrationality terms.[20] Yet contracts are incomplete because of the limitations of knowledge and in estimating all possible outcomes of an agreement.

The second behavioural assumption is that human agents are given to *opportunism*, "which is a deep condition of self-interest seeking that contemplates guile" (Williamson, 1993). Thus, promises to behave responsibly that are unsupported by credible commitments will not be reliably discharged.

Why vertical integration?

Given these behavioural assumptions, Williamson focuses on what has become perhaps the central concept in the economics of organisations: *asset specificity*.[21] "The main factor to which transaction-cost economics appeals to explain vertical integration is asset specificity" (Williamson, 1986). According to this logic, assets are highly specific when they have value within the context of a particular transaction but have relatively little value outside the transaction. This opens the door to opportunism. Once the arrangement is signed and the asset deployed, one of the parties may threaten to pull out of the arrangement - thereby reducing the value of the specific asset. Fear of such an ex post possibility will affect investment ex ante. In the absence of appropriate contractual safeguards, the transacting parties may choose less specific (and therefore less specialised and less productive) technology. If, by contrast, the transacting parties were to pool their capital into a single enterprise in whose profits they jointly share, the incentive for unproductive opportunism would be attenuated. And these vertical integrated organisations would choose the more productive, specialised technology. Hence, because unpredictable changes makes it costly to specify contractual provisions (costs of persuading, negotiating or co-ordinating), the effect of vertical integration would be greatest when there is a high degree of interdependence among the relevant stages of production. Or even more, as Langlois and Robertson (1995) suggest, than mere interdependence is necessary: the interdependence must be such that a change in one stage of production requires a corresponding change in one or more distinct stages. But nevertheless transactions can occur only across a "technologically separable interface" (Williamson, 1985). Only the movement from one stage to another does constitute a transaction that firms may either internalise or handle through market-based exchange.

Limits of the contractual approach

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[20] Williamson's understanding of bounded rationality is very much in line with the definition of Simon. In his view bounded rationality refers to human behaviour that is 'intendedly rational, but only limitedly so' (see Williamson, 1975).

[21] The main import of the condition of asset specificity is this: Whereas the identify of parties to a neo-classical transaction is irrelevant, the identity of parties to a transaction that is supported by nontrivial investments in durable, transaction-specific assets is critical. In effect, parties of the latter are *bilaterally dependent*. The inter-temporal governance of contractual relations is greatly complicated as a consequence of this condition (Williamson, 1993, emphasis in original).

The tendency to pursue more or less static analysis implies that the contractual perspective has difficulties understanding the firm as a distinct historical entity. Individual transactions are not the prime vehicles of historicity; it is the firm's competence endowment that is relevant. Yet, the following limits of the approach can be mentioned:

First, as was noted above, transaction cost theory takes the circumstances of production (i.e. production costs) as given and investigate comparatively the properties of market-contract arrangements or internal organisations (i.e. transaction costs). This approach operates with a "thin" (Foss, 1993) conception of technology. The underlying assumption is, that technology - as well as the menu of inputs and outputs more generally - is given through some process that is historically and logically prior to the issue of the organisation of the economic activities. Hence, the neglect of any firm-specific knowledge (or tacit knowledge) implicitly means that all profitable technological knowledge is shared among firms. Williamson finds no answer to circumstances in which the technologies of production - or perhaps other environmental factors - are changing. The economic problem centres around combining given inputs and outputs in a way that minimises transaction costs, given technology. In his view, the approach from asset specificity alone may then be less persuasive: "The introduction of innovation, plainly complicates the earlier-described assignment of transactions to markets or hierarchies based entirely on an examination of their asset specificity qualities. Indeed, the study of economic organisations in a regime of rapid innovation poses much more difficult issues than those addressed here" (Williamson, 1985). Hence, innovation, the creation of markets, learning within and between firms, etc. are either side-stepped or implicitly taken to be unimportant to economic organisations.

Second, transaction costs are essentially short-run phenomena. This does not mean that such costs are unimportant. On the contrary, one cannot explain ownership and contracting structures without transaction costs. But it is highly unlikely that firms through vertical integration get all capabilities necessary for all activities in the chain of production. Hence, firms must link up with other firms. This often takes place through contracts in inter-firm co-operations. In this sense the Williamson' market-hierarchy approach leaves little place to industrial co-operation. Often, and especially when innovation is involved, the links among firms are of complex nature. Knowledge, reputation or experience play a significant role. To put it in another way, all firms must rely on the capabilities owned by others, especially to the extent that such capabilities are dissimilar to those the firm possess. But in the long-run the environment of such relations between firms becomes more stable with diminished uncertainty. Thus, in the long-run contracts become *self-enforcing* because of reputation effects. Also moral-hazard or opportunism effects between firms are to be attenuated by the evolution of norms of reciprocity and co-operation. Another aspect of the argument is, that in an environment in which change is diminishing, then behaviour is also becoming increasingly routine. And routine behaviour is necessarily easier to monitor and foresee than non-routine behaviour. For these "environmental reasons" transaction costs play a smaller role in the long-run (Langlois and Robertson, 1995).

Concerning vertical integration as the consequence of the transaction cost approach Geroski (1992) raised two critics: first, vertically integrated firms often lose the efficiency benefits of competition, they can sacrifice scale advantages in the production of inputs that are only used in-house, and second, when vertical integration means that the producing firms deals only with one (in-house) buyer or supplier, it can result in a restriction of the flow of information from input or output markets to decision makers. "Attractive alternatives to vertical integration include more flexible arrangements that either enable information to be shared more effectively, or enable more information to be shared" (Geroski, 1992).

Another main critic on the transaction cost approach developed by Foray (1991) is that it requires the essential hypothesis of the perfect substitutability of internal and external resources or activities. This hypothesis is necessary so that the transaction costs remain the *cornerstone* of the firm boundaries. But according to Foray this hypothesis is based on the erroneous interpretation that the integration of external resources has no effect on the nature of the firm. Following the fact that the integration of resources tends to make this resource more and more specific there cannot be substitutability because a resource entering into a firm acquires new qualities and organisational restructuring in its nature, especially by improving its learning capability.

To conclude, a theory that emphasises the firm-specific knowledge may lead to insights in economic organisations that differ from standard transaction costs. Thus, the transaction cost approach may not capture all determinants of the boundaries of the firm with excluding the firm's endowments of capabilities as something that co-determine their boundaries. But no other than Ronald Coase himself has argued in this direction with now being much more sceptical towards contractual theories of economic organisations: "[...] while transaction cost considerations undoubtedly explain why firms come into existence, once most production is carried out within firms and most transactions are firm-firm transactions and not factor-factor transactions, the level of transaction costs will be greatly reduced and the dominant factor determining the institutional structure of production will in general no longer be transaction costs but the relative costs of different firms in organising particular activities" (Coase, 1990).

To put it in another way, in order to analyse firm behaviour, learning abilities and co-operation between firms the *black box* has to be opened and the mechanisms has to be studied in a deeper way. To develop it further, inter-firm co-operation and networking has to be studied not primarily in terms of *costs*, whether transaction costs or others, but should rather be examined in terms of strategic behaviour, appropriability, technological complementarity and other complementary assets. Networks as a "third form" (Freeman, 1991) intermediate between markets and hierarchies try to capture these effects of know-how trading and knowledge exchange.

3.5 Competence approach

The contractual approach described in the previous section seems to be within the framework of traditional microeconomic theory. One consequence of this is that its primary object of explanation is the efficient organisation of existing economic resources. Hence, it seems that it is outside this approach if the issue is how new resources are discovered by firms, how resources are accumulated or how firms interact with each other.[22]

For an elucidation of the competence perspective on the firm it is necessary to mention shortly the *competitive strategy* tradition in business economics. The systematic study of business strategy began with case-studies revealing that firms within the same industry differed in terms of policies regarding product quality, distribution channels, competitive positioning etc. These differences came to be identified as differences in strategies. Empirical work also demonstrated that profit rates were much more heavily dispersed within industries than across industries. The sources of profitability were clearly firm-specific rather than industry-specific (Foss, 1993).

[22] It should nevertheless be tried in the following section to show that it is a legitimate research strategy to see the two approaches as two sides of one coin. Yet, to align the key ideas of the two perspectives. See also Foss (1996).

One obvious implication of this observations is that performance, i.e. production is something extremely specific to individual firms (Langlois, 1992). This is because the underlining capabilities are specific with the well known result that two different firms simply will not have the same costs of carrying out the "same" productive operation. This is what specialisation and the division of labour is all about.

The root of the benefits of specialisation is accumulation of more or less tacit knowledge - in the form of individual skills as well as in the form of firm-specific knowledge capital represented by capabilities.[23] The emphasis of heterogeneous firm capabilities has been used in the literature to account for inter- and intra-industry dispersal of returns and for theorising the foundations of competitive advantage (Teece et al., 1994). Thus, heterogeneity is one of the crucial concepts of the capabilities perspective. However, the competence of the firm and consequently the competitive advantage depend on one important condition, namely the imitation of the capability in question. Teece (1986) used the term "appropriability regimes" to describe the ease of imitation. It is therefore the search for the characteristics that make assets non-imitable, i.e. identify tacitness, complexity and specificity as the crucial characteristics underlying imitation costs.[24] Hence, it is precisely because some firms may acquire resources that other firms are incapable of imitating that they can obtain sustainable competitive advantage. It is also the difficulties of trading capabilities that explains why capabilities determine the boundaries of the firm. Specifically, the social, tacit, and complexity aspects are also important for understanding the boundaries of the firm.[25] Thus, it can be well seen that in the competence view of the firms, the distinction between production and transaction costs loses much of its force and justification.

However, it was the British economist George Richardson (1972) who introduced the term "capabilities" to talk about the necessarily limited range of productive knowledge firms and individuals possess. It was well before Williamson's first book when Richardson stressed the fact "[...] firms are not islands of planned coordinations in a sea of market relations but are linked together in patterns of co-operation and affiliation" (Richardson, 1972). Taking issue with the representation of knowledge in the production process, Richardson writes:

"Of course I realise that production functions presume a certain level of managerial and material technology. The point is not that production is thus dependent on the state of the arts but that is has to be undertaken (as Mrs. Penrose has so very well explained) by human organisations embodying specifically appropriate experience and skill. [...] nevertheless, it seems to me that we cannot hope to construct an adequate theory of industrial organisation and in particular to answer our question about the division of labour between firm and market, unless the elements of organisation, knowledge, experience and skills are brought back to the foreground of our vision" (Richardson, 1972).

The key implication of his perspective as it relates to economic organisation is that the structure of complementarity and similarity among various capabilities in the economy affects the pattern of organisation in ways not fully

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23 It should be mentioned that the competence approach focuses more on knowledge capital assets which are firm-specific rather than agent-specific. Thus, firms come equipped with more knowledge than is embodied in the sum of individual agent's capital. This is precisely what Nelson and Winter (1982) mean by "routine", as they define it: "routines are the skills of an organisation".

24 The division between tangible and intangible assets of a firms is highly relevant in this context. While tangible assets may be the source of initial competitive advantage, it seems likely that intangible assets can be sources of long-lived (sustainable) advantage, since most tangible assets can be bought on factor markets, reverse-engineered, etc.

25 That capabilities influence the boundaries of the firm was already seen very clearly by the perhaps most important precursor of the capabilities perspective, Edith Penrose, when she observed that "[...] integration may appear profitable because the firm believes it can produce some of its requirements ... much more cheaply than it can obtain them on the market" (Penrose, 1959).

explicable in terms of the costs of transacting. Indeed, the ability to transact is itself a capability, which suggests a blurring of the boundary between production and exchange.

In Richardson's terminology, production can be broken down into various stages or activities. Some activities are similar, in that they draw on the same general capabilities. Activities can also be complementary (in both technical and economic sense) in that they are connected in the chain of production and therefore need to be co-ordinated with one another. Juxtaposing different degrees of similarity against different degrees of complementarity produces a matrix that maps different types of economic organisations.

Complementarity an increasingly important theme in today's economics of organisation (Milgrom and Roberts, 1990); indeed, there is a widespread recognition that "strongly complementary assets should be brought under common ownership" (Milgrom and Roberts, 1992). But the real force of Richardson's argument is in quite different direction. In Richardson, the import of the concept of capabilities was their limitations. Because of what are effectively cognitive constraints, all organisations must specialise; and, since the chain of production in an advanced economy requires a diversity of very different capabilities, the costs of integrating across many links in that chain are necessarily high, and firms must rely on various kinds of market and kinds of arrangements to co-ordinate their activities even in the context of contractual hazards. However, this opens the spectrum of co-operations in which firms see their activities in a dense network by which they are inter-related. The analysis denotes not only manufacturing processes but relates equally to research, development and marketing.

Richardson's insight is a simple but extremely profound one. For it suggests that - as a quite general matter - capabilities are determinants of the boundaries of the firm, since they determine the relative costs of different firms in organising particular activities. Problems of economic organisation may crucially reflect the possibility that a firm may control production knowledge that is, in important dimension, strongly different from what others control. Generally, the *competence view* is more conscious of the character and limitations of knowledge on the production side than is the mainstream post-Coase literature.

3.6 Points of contacts between the approaches

The previous section has shown that the capabilities perspective has reached a distinct theory of economic organisation, one that is based on a conceptualisation of the firm as a repository of productive knowledge with certain non-standard characteristics. Compared to this view the transaction cost approach is characterised through its overemphasis of transaction costs and incentive alignment with the exclusion of production costs and issues of co-operation. However, in recent work it has become increasingly realised that there may be a need to combine propositions from capabilities and contractual theories. Hence, some of the work has addressed the relation between firms' capabilities and their boundaries so that, for example, the role of both production costs and transaction costs determining the boundaries of the firm becomes more visible than it is in the post-Coase literature on the economics of organisation. [26]

[26] Some examples in which both incentive and capabilities considerations enter the picture can be found in Lewis, Sappington (1991); Aghion and Tirole (1995). But also the work of Teece (1982, 1987) demonstrates that issues such as diversification and the innovative boundaries of the firm are best approached in terms of a theory that combines capability and contractual theories. For a fuller discussion of the issues involved here, see Foss (1996) and Langlois and Foss (1997).

The majority of these studies implicitly or explicitly accept the proposition that efficient economic organisations are above all a matter of somehow aligning the incentives that co-operating input-owners face. But it is nevertheless possible in principle to add capabilities considerations to basic incentive ideas and *vice versa*. For example, one may argue that the full realisation of the rent-yielding potential of capabilities requires incentives that harmonise the actions of resource-owners, and provide stimuli to investment in the accumulation of human capital. Thus, contractual theories may help to understand the organisation and accumulation of capabilities which can be seen as a clear complementarity between the two theories. The further examples should show that there is no fundamental conflict between the two bodies of theories:

How well can knowledge be protected?

Teece (1982, 1986) in argues that there is a direct connection between the degree of appropriability a firm confronts and its efficient (innovation) boundaries. For example, to the extend that the firm produces valuable knowledge that is ill-protected by intellectual property rights, this may underlie expansion of vertical as well as horizontal scope. However, if the firm on the other hand develop knowledge that is hard to imitate, it may choose its boundaries much more narrowly. Generally, the more complex and/or tacit the firm's knowledge base is, the fewer activities it has to integrate in order to yield rents.

Diversification

Realistic analysis of the scope of firms confirm that almost no firm has integrated the entire value-chain, the common explanation being that the firm confronts increasing diseconomies of scope as it integrates activities that demand capabilities that are increasingly dissimilar relative to the firm's own capabilities (Richardson, 1972). A similar explanation applies to the explanation of diversification. This is a production oriented explanation, that may, however, be given an interpretation in terms of incentives: as the firm moves increasingly away from its core business, it confronts increasing adverse selection and moral hazard problems, since management becomes increasingly unable to efficiently monitor employees or evaluate their human capital. Agency costs rise correspondingly, producing the net profitability disadvantage associated with further integration.

Asset specificity and capabilities

An obvious similarity consists between the Williamsonian asset specificity and capabilities. As was argued above, the notion of specific assets is key to the modern economics of organisation. However, asset specificity developed by Williamson do not incorporate capabilities. Capabilities on the other hand would certainly seem to qualify as specific assets - they are specialised to firms: they have low (or no) values in alternative uses. But the modern economics of organisation does not normally view them that way. Part of the reason may be that capabilities are hard to treat in formal models. Another part may be that capabilities are distinct from an ordinary factor of production. However, these difficulties are not insurmountable in principle, and capabilities deserve a place on the short-list of empirically important specific assets (Langlois and Foss, 1997).

Complementary assets

Turning an innovation into a commercial success may require investments to stimulate the supply of specialised inputs, i.e. the success depends on "complementary assets" (Teece, 1986). In short, a successful innovation is the outcome of a number of inputs combined together. Complementary assets are generally related to the manufacturing or marketing of the output in which the innovation is embodied, but they are inputs typically supplied by firms upstream or downstream to the innovation producer. Appropriation strategies based on controlling complementary assets will therefore involve some forms of vertical relations between the producer of these assets and the innovator. Such relations can take many forms depending upon the structure of the transaction costs involved. Although there can be many forms of market failure be involved associated with bargaining costs or opportunistic behaviour, there are many analyses suggesting that establishing vertical relations may be an important element of a successful strategy.

Hence, in the light of these examples the relations of complementarity between the post-Coase literature and the capabilities view may appear even more striking. This concurs with one of the major scholars in today's economics of organisation when he observes that "[...] firm capabilities need to be understood not in terms of balance sheet items, but mainly in terms of the organisational structures and managerial processes which support productive activity" (Teece, Pisano, 1994). In order to understand the process of emergence and accumulation of capabilities, we need to pay attention also to the incentive structure of firms, since it influences investments in human capital.

Two examples

The previous sections have given an impression of the strong expansion of work on the firm, both from a capabilities perspective and from contractual perspective. Although these two bodies of theories are often thought to be fundamentally different, there are several attempts to integrate propositions from the capabilities perspective with ideas about economic organisation. But it is also questionable if a unified theory will allow to understand such issues as the dynamics of the modern corporation in its complex entirety. One can observe that the industrial dynamics nowadays is accompanied with an up and down of the theoretical approaches. For example, it was one of the *doyen* of the business historians, Alfred Chandler (1990), who argued at the beginning of the 90s, that being big and heavily vertically integrated is one condition for successful performance, at least on the global arena.

Arguably, vertical integration is currently out of fashion and Chandler's views are flatly contradicted by those who advocate the "virtual corporation", witnessing the relatively short-lived but extremely flexible partnering that develops in order to reap temporary technological opportunities. This was preached as the organisational form of the future, by the advocates of "networking" and "industrial districts".[27]

The problem is that the existing theoretical apparatus does not really allow to say much about when and under which circumstances Chandler-type firm organisations dominates "the virtual corporation" (or similar decentralised types of organisations) and vice versa. The examination of transaction properties can lead to neglect the more dynamic aspects. An organisational form, for example, that is burdened by heavy transaction costs can nevertheless be very much engaged in learning that lead to dynamic efficiencies. Alternatively, focusing only on dynamic efficiencies can lead to forget about static efficiencies.

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[27] See a rather sceptical assessment of the future of "the virtual corporation" in Leitner (1997).

Another example has to do with the current debate on outsourcing. Outsourcing simply means letting suppliers take over activities that were once undertaken in-house; thus, it is an instance of vertical disintegration. Because it allows the firm to get access to the high-powered incentives of market supply (rather than internal procurement) and because it allows the firm to eliminate some fixed cost, outsourcing may be an attractive strategy. However, the critics of this strategy (and advocates of a Chandler-type) argue that excessive outsourcing lead to a loss of ability to upgrade capabilities. Thus, retarding the learning capacity of the firm destroys the firm's ability to upgrade its capabilities, harming its long run competitive advantage. In other words, understanding the dynamics of outsourcing requires an understanding of the interplay between the development of the knowledge assets of the firm and its boundaries.

The new shape of knowledge

The two examples presented above indicates the broader problem of understanding how knowledge and the boundaries of the firm interact. It also indicates that learning plays a crucial part in economic organisations. The capabilities perspective shows that the conceptualisation of knowledge is crucially important and not completely covered by the standard asymmetric information paradigm. Starting from production rather than from transaction makes this clear. Specifically, the tacit and social components of knowledge as embodies in capabilities matter crucially to economic organisations. It furthermore makes clear that innovation processes can not be shaped as a linear process, but as highly influenced by many factors which indicates that the interaction between firms is something more than just access to an increasing amount of information. But emphasising the role of knowledge means that more attention should be paid to the issue of the distribution of knowledge between firms and in particular to the character of this knowledge.

Arrow (1994) has recently pointed out that the traditional dichotomy between public and private knowledge may be becoming less and less relevant. Hybrid forms of knowledge which are neither private nor public become increasingly important. More and more strategic know-how and competence is developed interactively and shared within subgroups and networks. But access and membership to such networks is far from free. This change in the character of knowledge may be regarded as the other side of the more generally recognised organisational developments where the dichotomy between market and hierarchy is challenged by hybrid forms which are known as industrial networks (Freeman, 1991). Several aspects are included in these new forms of knowledge based networks: some of them are local while others cross national boundaries and the access to such networks may be crucial for the success of firms as well as research teams. Even the founder of the modern neo-classical general equilibrium theory states "[...] that social variables, not attached to particular individuals, are essential in studying the economy or any other social system and that, in particular, knowledge and technical information have an irremovably social component, or increasing importance over time" (Arrow, 1994).

Although there is general agreement that innovation should be understood as an interactive process there is limited knowledge about the purpose and the nature of this interaction. It was with respect to these new forms of interactive knowledge flows that A. Marshall mentioned the industrial atmosphere by noting: "the secrets of industry are in the air". It is the aim of this survey to study the aspects and characteristics of the secrets in more detail.

4 Innovation and co-operation

The last chapters have shown that knowledge and knowledge flows play an crucial part in all theoretical approaches mentioned and, according to the NIS approach, is one of the main determinants of economic developments. However, the theoretical knowledge of some of the aspects of innovation is still incomplete, and an exhaustive quantification of all key dimensions of innovation activities is still lacking. Although it is now widely acknowledged that firms innovate through a variety of sources and that innovation patterns are industry-specific, a quantification of the different inputs and evaluation of interaction of firms are still needed.

Innovation as an interactive process

The intellectual framework of the new measurement tools developed over the last decade is defined by the notion that "the linear model of innovation is dead" (Rosenberg, 1994). The focus of the *post-mortem paradigm* is now placed on the fact that innovative activity is an interactive process in which different phases and sources of technological change are interdependent and not hierarchically structured. Hence, this new approach differs significantly from the earlier linear approach by stressing the central role of feedback loops between downstream (market-related) and upstream (technology-related) phases of innovation and by pointing to the varying interactions between science, technology and innovation related activities within and among firms.

Whereas in the past a great deal of attention was attached to R&D activities, regarded as the main source of innovations, recently the focus has shifted to the role played by other complementary sources. But with the changing view of firms, i.e. the view of firms contrary to quasi-markets, the focus of measuring innovative activities lies on characteristics quite harder to be measured. In stressing the competence/capability approach it was shown that what is distinctive about firms is that they are domains for organising activity in a non-market-like fashion. Yet, the organisation of firms takes place in a more multilateral fashion indicating that firms operate with some kinds of technological knowledge base not easily transferable or easy to acquire. However, there is no single source of technological knowledge and it seems reasonable to distinguish between different areas of production-relevant knowledge, with different levels of specificity (Smith, 1995).

Different knowledge bases

First there is the general scientific knowledge base which is generally shaped by policy or funding decisions. This is itself highly differentiated and of widely varying relevance for industrial production.

Secondly there are knowledge-bases at the industry or product level. At this level modern innovation analysis emphasis the fact that industries often share particular scientific and technological parameters; there are shared intellectual understanding concerning the technical functions, performance characteristics or use of materials. This notion tends to underpin what is generally known as "technological paradigm" or "technological regime". This part of the industrial knowledge base is highly structured and shapes the performance of all firms in an industry. Nevertheless, this knowledge base does not exist in an vacuum. It is developed , maintained and disseminated by institutions of various kinds, and it requires resources.

Thirdly, the knowledge bases of particular firms can be identified which are highly localised and which form the basis of their competitive position. The highly specific character of this knowledge is not simply technical: it is

also social, concerning the way in which technical progress can be integrated with skills, production routines, explicit or tacit training and so on. At this level, the relevant technological knowledge base may be informal and uncodified, taking the form of skills specific to individuals or to groups of co-operating individuals. The tacit and localised character of firm-level knowledge means that although individual firms may be highly competent in specific areas, their competence has definitive limits. This means that firms may easily run into problems in innovation which lie outside their area of competence. But firms can also find limitations in their ability to carry out search processes relevant to problems they are confronted with. Hence, firms must be able to access and use knowledge from outside the area of the firm when creating technologies.

These different types of knowledge bases are not separate but integrated with one another, often in complex ways. Moreover emphasising the complex and often unstable structure of knowledge bases, innovative activities of firms can not easily analysed in looking just at the firms' boundaries. A changing environment imposes the need for various and changing configurations of competencies and therefore the firm must co-operate with others. In particular, accelerating (technological) change and fiercer knowledge-based competition challenges the firm to connect to the knowledge infrastructure and to suppliers not only by price signals and information about quantities supplied and demanded.

Measuring innovative activities

It is due to the very nature of the phenomenon of innovation, characterised by the high heterogeneity and the multidimensional structure of knowledge flows. In particular, the characteristics of the knowledge bases of firms also hamper the measurement of technology and innovative activities:

- ◊ Technological knowledge may be formal or tacit. While only a portion of such knowledge may be written down in books, manuals or patents another part remains tacit.
- ◊ Sources of innovative activities may be internal or external to firms. Innovation often involves a heterogeneous range of activities, which must be integrated and co-ordinated by the innovative firm. Hence, the creation of technological knowledge at the level of firms is a multi-faceted process, involving the complementary development of very different types of knowledge. It is an interactive process with structured interactions between firms, involving processes of mutual learning and knowledge exchange.
- ◊ While some innovative activities may be easily identifiable in economic terms, through prices and costs, other technological activities occur outside the sphere of market transactions.
- ◊ Technological change consists both of identifiable tangible activities - for example, new machinery and equipment - and intangible activities., which include the generation of new ideas, inventions and innovations.

In addressing these problems, a more comprehensive approach to mapping national innovation systems is contained in firm-level innovation surveys, which question firms on their sources of knowledge relevant to innovation. These surveys also gather data on firm R&D expenditure and other innovation inputs as well as R&D-related performance and other innovation outputs. From the national innovation systems perspective, they are the most broad-based source of information on the general patterns of technological collaboration and information use of firms. Nonetheless, many of them provide helpful indications both for analysis and economic policy choices (Evangelista et al., 1997). The diversity of the various surveys has enhanced the knowledge of the "innovative

phenomenon" but it has still not been possible to obtain comparative statistical data over time and across countries. In recent years, great efforts have been made to harmonise surveys on innovation at international level.

Two innovation surveys are most well-known: the "Community Innovation Survey" (CIS) and the "Policies, Appropriability and Competitiveness for European Enterprises" (PACE) Project. The CIS survey was developed between 1991 and 1993 as a joint initiative between DG XIII of the European Commission and EUROSTAT and collected firm-level data for 40.000 manufacturing enterprises in Europe. Yet, this survey was not launched in Austria. A second CIS survey, building on the methodological and analytical lessons learned in the first phase, is being launched in 1997. In the second phase a survey was launched in Austria as well. Regarding knowledge flows, no comprehensive analysis of the results of the first CIS survey has been made; rather, studies have been made done for specific countries and industrial sectors using CIS data.

The PACE survey was designed to study the opinions of R&D managers from the European Union's largest manufacturing firms concerning the types and goals of innovation, external sources of technical knowledge, public research, methods to protect innovations (e.g. patents), government support to innovation and obstacles to profiting from innovation. Findings show the most important external source of knowledge for firms is the interaction between the firm and its suppliers and customers and the technical analysis of competitors' products (MERIT, 1995).

Joint industry activities

However, other aspect should be mentioned here concerning the innovation surveys undertaken in most countries. Since the 1980s an increase in the importance of inter-firm co-operation in most advanced countries can be observed. These co-operations can take a variety of forms including informal partnerships, formal technological alliances and joint ventures as well as more informal interactions. In most countries, R&D collaborations between firms and strategic technical alliances are growing rapidly. This is especially evident in new fields such as biotechnology and information technologies, where development costs are particularly high (e.g. Hagedoorn, Schakenraad, 1991). Firms co-operate to pool technical resources, achieve economies of scale and gain synergies from complementary human and technical assets.

Also important, but more difficult to measure, are the informal linkages and contacts among firms whereby knowledge and know-how are transferred, including relationships among users and producers and the role of competitors as both a source for and stimulus to innovations. This increase in inter-firm co-operation can be explained in part by the inability of any single organisation to stay abreast of an increasingly rapid pace of innovation involving the development of new products integrating diverse technologies. Firms in both high and traditional technological sectors have been led to seek partners with competencies that are complimentary to their own.

However, the SAPPHO Project was one of the first and most comprehensive empirical studies of innovations and representative of a whole generation of research (Freeman, 1991; Rothwell, 1974). This study demonstrated the significance of both internal (functional integration of in-house activities) and external networks of the firm for innovation success. Successful innovations were characterised by making considerable use of other sources of

technology. Furthermore, later research confirmed the central importance of external co-operation with users and external sources of technical expertise. [28]

Other parallel empirical studies have stressed the significance of both formal and informal networking (Freeman, 1991). Although rarely measured systematically, it has been argued that behind every formal network, usually various informal networks are to be found. The significance of informal networks is a reflection of the fact that some knowledge cannot be codified in formal specifications and is difficult to communicate both within firms and between firms and other knowledge institutions. In consequence, in recent years, an appreciation of sociological factors such as personal relationships of trust and confidence along with the importance of cultural and geographical proximity in both formal and informal networks have been put forward. These are necessary complements to more narrow economic explanations (Lundvall, 1992).

The aim of the study

The proponents of the NIS approach argue, that the learning resulting from interaction between producers and users of technology is a critical factor in the capacity of a national innovation system to bring new products and processes to the market place. In this view, innovation is not the fruit of the activity of an isolated firm, but rather depends on the creation of technical-economic networks which link universities, research institutions and firms. Thus, most surveys on innovation indicate that firms do benefit from the knowledge of other firms and institutions in the innovation process and provide a detailed description of the firms involved according to firm size and sector of activity. But they do not provide information on key dimensions of inter-firm relations such as contractual forms used by partners, the nature of the information exchanged and the new knowledge produced. Issues such as the importance of trust among firms or the way they are confronted with problems during the co-operation are not addressed and in any case cannot be adequately studied through survey methods alone. Hence, there does not exist a study at the national level in Austria focusing on the nature and determinants of inter-firm co-operation.

This study has the objective to provide detailed information on these critical dimensions of innovative activity. It is widely believed that the relatively poor development of inter-firm relations in Austria constitutes a weakness of the innovation system. With the concentration on the public sector which performs more than half of R&D the links between this level and the level of production is weak. Moreover, confronted with an increasingly competitive environment firms may be tempted to seek advantage in a way that undermines trust and longer term co-operation. These factors help to account for the limited development of inter-firm co-operation. The systematic

[28] Lundvall (1988) introduced the concept of "organised markets" by arguing that most markets involve an element of mutual exchange of qualitative information, and sometimes by direct co-operation in the process of innovation. In order to overcome the "information impactedness" - an uneven distribution of information - a closer user-producer relationship can be seen as the most basic function to communicate information about technological opportunities and user needs. This kind of interactive learning involves mutual benefits for the parties involved, and such benefits may compensate for higher production and transaction costs. Hence, the *organised market approach* stresses the fact that a broad framework of feedbacks and discourses between users and producers are crucial. One of the implications of organised markets is that there exist no optimal or even satisfactory network of user - producer relations at any point in time, given the development of user needs and technological opportunities (Lundvall, 1993). Especially after a period with a radical change in the technological base of the economy, the existing institutional set-up might be assumed to be badly adapted to the new opportunities. That is why agencies outside the network of firms - government or financial institutions - might have an important role to play in the restructuring of the economy.

observation of the current state of inter-firm co-operation for product development will therefore allow to provide responses to the, amongst other, following types of questions:

- ◊ Is innovative and co-operative behaviour of Austrian firms related to the size of firm?
- ◊ Are there significant differences in the frequency by type of partner?
- ◊ Do firms in Austria face obstacles in their effort to establish co-operative inter-firm relations?
- ◊ What role does trust play in inter-firm relations?
- ◊ What kind of knowledge are the results of the co-operation?
- ◊ Is there a significant difference between firms with an R&D department and firms which do not have a department?

There is a real need to understand the nature of inter-firm relations in Austria and to draw on international comparison in order to identify the strengths and weaknesses of the Austrian system. Yet, the international comparative dimension of the project is not incompatible with undertaking a detailed analysis of the Austrian system at national level. The study has its basic objectives to identify those factors which determine the success of inter firm co-operation and to further the understanding of the role of inter-organisational co-operation in the innovation process and to give a more solid base for public policies aiming at supporting the creation and renewal of co-operation as an element in innovation policy strategies.

5 The Survey

The survey carried out in Austria is largely compatible with the Danish questionnaire (DISKO)[29] although some additional modifications have been made. The project was planned to analyse co-operation at two levels: the firm level and the project level. Accordingly, the DISKO project consists of two phases: the first one is already finished, the second phase with questions going deeper into co-operation on the project level will follow.

In Austria the project consists of two phases as well: in the first phase, which is documented in the report at hand, only firm-specific characteristics of co-operation were analysed with all project-specific questions or open questions kept out from the questionnaire. This implies that the second phase with project-specific questions and analysis currently is neither implemented nor submitted as a project proposal.[30]

Method

The main methodological characteristic of this project was the use of a guided telephone interview with supporting software, i.e. Computer Aided Telephone Interview (CATI). Data collection using CATI involves the combination of computers and telephone interviewing. Telephone interviewing as compared to the other two main types of data collection, personal interviewing and postal surveys, has advantages and drawbacks. There were several reasons to adopt this approach:

- ◊ The primary advantage are low costs and ease to establish contact with respondents.
- ◊ This method is quite new and compared with traditional methods of surveying it is a rather economical method.
- ◊ It appears to be a tool flexible enough to be adopted to additional questions and national specifications.
- ◊ There need to be core questions included in each country study which should provide the basis for inter-country comparisons.

However, in the phase of the test interviews some of the disadvantages or sensibilities of this method became apparent:

- ◊ The time limit: a CATI-interview must not take longer than 20 minutes. If the interview takes more than 20 minutes the answers are given very rapidly in order to complete the interview or it is finished untimely.
- ◊ It is therefore quite challenging to find a balance between the time restriction and all those questions essential for the topic.
- ◊ In a CATI interview the questions have to be well designed for a telephone interview. Hence, the language used has to be quite distinct and understandable and has to convey the same basic meaning to the respondent.

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29 Det Danske InnovationsSystem: Komparativ analyse af udfordringer, styrkepunkter og flaskehalse (DISKO). In English: The Danish Innovation System: Comparative analysis of challenges, strenghts and bottlenecks.

30 At the time when Euro-DISKO was developed Austria has already finished its survey.

Field work

As this method of surveying is quite resource intensive an external partner who is used and experienced in CATI-interviews was contracted to carry out the interviews. The testing phase required quite intensive communication effort with the institute due to the length of the questionnaire and other improvements suggested by the CATI partner.

5.1 Questionnaire

As already mentioned, the **tip**-questionnaire also contained a large number of questions of the Danish DISKO questionnaire. However, Austria decided to work out a questionnaire with some modifications from the DISKO approach. The reasoning for choosing the themes and formulating specific questions as well as issues is presented and discussed in the analysis of the data in the following sections. The focus of this section is to give an overview of the formal design of the questionnaire.

In the **tip**-questionnaire some sub-modules were added in order to analyse some *soft factors* of co-operation and hence to analyse in a more specific sense the co-operative behaviour of Austrian firms and companies. Table 2 provides an overview of the tip-questionnaire. It shows the modules with indications of the content of the specific questions.

Table 2: The modules of the Austrian questionnaire

Modules	Purpose
Module 1	*Contact.*
Contact	The questionnaire incorporates a series of questions through which a competent person in the company was located and asked to participate.
Product development	In trying to establish a common understanding of the concept of product development the company was asked whether it had developed products within the last 2 years.
Module 2	*Co-operation in product development.*
Collaboration in product development	We asked the company whether it had collaborated in the product development. In a series of questions the company was further asked whether it has co-operated with different types of Austrian and foreign partners during the development process. Additionally, we asked whether the co-operation was for the first time or repeated. This procedure is time consuming. However, it was considered being important to search systematically for this information and not to rely on information about partners spontaneously coming to the informants mind. Furthermore, all these kinds of answer categories were asked in random order in order to avoid a bias that could arise if all informants were asked about potential partners in the same order.
Module 3	*Motives and other aspects of co-operation*.
Motives	To establish the importance of several motivations in co-operation. We developed 11 categories of motivations for co-operation which were asked in a random order.
Management of co-operation	The objective was to determine whether the firm has signed a formal contract or has defined an explicit structure considering the costs and risks of a co-operation project.
Trust	The objective was to judge the level of trust in the relationship along following critical areas: the sharing of unanticipated product development costs, the respect for agreed principles of confidentiality, the importance of reputation in the decision to co-operate with a partner, and

	whether the firm considered it being necessary to pass through a trial period together with the partner before committing substantial resources to the relationship. This corresponds to the idea that trust is something which is built up in an interactive learning process.
Problems	This question will allow us to document the relative importance of different problems in co-operative product developments. The 11 answer categories were asked in a random order as well.
Results	The objective is to determine whether the new knowledge or ideas resulting from the project were codified in some manner or have been remained in the form of tacit knowledge. We further asked to which extent the knowledge is transferable to other potential partners.
Exchange of employees	The objective is to judge the importance of personal contacts in a co-operative project. Because tacit knowledge is difficult to communicate, the movement of people is usually essential for the knowledge transfer. Hence, it indicates informal contacts behind every formal co-operation.
R&D department	We asked whether the firm has an R&D department or not.
R&D co-operation	This indicates, whether co-operation in product development was accompanied by co-operation in R&D.
Impact of R&D co-operation on the R&D expenditure.	These firms which had co-operated in R&D were asked for the impact on the R&D expenditure.
Module 4	*Augmented Products*
Development of augmented products	This question was directed towards the development of augmented products (e.g. services). In order to make sure that the interview partner understood the concept of service in the augmented product correctly, it was explained to him/her.
Co-operation in the development of augmented products	Analogous to the previous question, the company was asked whether it co-operated with others in the development of the service and if so: which collaboration partners participated and whether they were national or foreign partners. However, even the firms which have not developed products and hence have not gone through the whole interview were asked the questions of collaboration on the augmented products.
Module 5	*General questions*
Assessment of the co-operative culture in Austria	We asked the interview partner if in his or her view the co-operative behaviour among Austrian firms has improved within the last three years or not. The same question was asked concerning the co-operative behaviour between domestic and foreign firms.
Assessment of competition	At the end of the questionnaire we posed a question of a general assessment whether the competition in his or her sector has increased within the last years or not.
Module 6	*Willingness to participate in phase II*
Willingness for further participation	Finally, the informant was asked whether the company was willing to be contacted for a more detailed interview.

There was a general agreement between the participating countries, that a core set of questions should be included in each survey. The core questions on firm level compatible and hence comparable with the Danish DISKO questionnaire are shown in

Table 3.

Table 3: Core set of questions compatible with DISKO

Firm level on product development	• Development of a tangible product which in its design, its construction, its productive capacity or in any other way is new for the company. • Development of augmented products, i.e. new services, related to the development of new physical product(s).
Firm level on co-operation	• Collaborative links ⇒ list of collaborators from the DISKO survey, ⇒ distinction between foreign and domestic partners, ⇒ distinction between collaboration for the first time or in repetition. • Exchange of employees with the collaboration partner.

5.2 Sample

Two databases (*Creditreform* and *Herold*)[31] were used in order to identify the firm sample. The *Creditreform* database comprises over 55,000 companies and the *Herold* database over 40,000 companies. There were only those companies selected which are registered in both databases in order to ensure that the companies have a trade register number. All the selected companies were listed under the heading *Manufacturing* (NACE codes 15 to 36). Another selection criterion was the number of employees. According to the DISKO project we selected only companies with more than 10 employees because we also assumed that only a minor fraction of the small companies would be engaged in developing products and hence co-operate in the process of product development. With these selection criteria the sample space was built and consists of 3,026 companies.

From this sample space a randomly selected sample of 1,816 companies was built and handed out to the institute which was contracted to carry out the field work. The following information about the companies was taken from the databases:

◊ Name of the firm (including telephone number and address),

◊ Organisational status,

◊ Year of foundation,

◊ NACE code (including the five-digit sector code),

◊ Number of employees,

◊ Turnover,

◊ Import-, Export share.

31 *Creditreform* database: Creditreform Wirtschaftsauskunftei, Kubicki & Zemen KG. *Herold* Database: Herold Business Data AG.

Because the allocation of the companies within the NACE codes would be highly disaggregate, some sectors were pooled together to aggregates. The pooling of industries to aggregates was taken from the DISKO because of comparability. The following Table 4 exhibits the aggregates with the NACE codes grouped together, the sample space and the randomly selected sample. In order to indicate that the randomly selected sample represents the sample space, the distribution of the sample across the aggregates is shown as well.

Table 4: Aggregates with the sample space and the randomly selected sample

Aggregate	NACE-codes	sample space	in %	sample	in %
1	food (15), tobacco (16)	340	11	212	12
2	textiles (17), wearing apparel (18), leather (19)	288	10	182	10
3	wood and wood products (20)	208	7	125	7
4	pulp, paper (21), publishing, printing (22)	348	12	220	12
5	refined petroleum (23)	6	0	4	0
6	chemicals and made fibres (24)	105	3	60	3
7	rubber and plastic products (25)	163	5	108	6
8	non-metallic mineral products (26)	240	8	140	8
9	basic metals (27), fabricated metal products (28)	578	19	330	18
10	machinery and equipment (29)	270	9	142	8
11	office machinery and computers (30), electrical machinery and apparatus (31), radio, tv, communication (32), optical instruments, watches, clocks (33)	200	7	113	6
12	motor vehicles (34), other transport equipment (35)	59	2	39	2
13	furniture, manufacturing n.e.c. (36)	221	7	141	8
		3,026	100	1,816	100

Source: tip Innovative Firm Networks Survey

5.3 General description of the data

Out of the sample of 1,816 companies due to the budget of the survey 1,006 were contacted by phone. The overall results are as follows:

- ◊ 79 companies did not answer.
- ◊ 484 companies had no product development within the last two years.
- ◊ 443 companies had developed one or more products within the last two years.
- ◊ 202 companies had an intensive co-operation in product development.
- ◊ 72 companies had co-operated but with emphasis on internal development.

Hence, 44% of all contacted firms had developed one or more products; beside the 7.9% which did not answer, 48.1% had no product development.

Beside Austria, Denmark and Spain have already finished their surveys with the following results: in Denmark 1,022 firms were interviewed of which 548 (54%) had introduced one or more products within the last two years. 398 firms were interviewed in Spain of which 310 (78%) had developed one or more products within the last three years. Hence, the rate of product innovating firms is low in Austria.

As product development and co-operation in product development was the prerequisite, finally the interviews was pursued with 274 companies. Table 5 shows how the 927 firms which reported they had or had no product development within the last two years were distributed according to the industrial sector using the pools of aggregates. The table mainly indicates the survey as highly representative due to the distribution of the firms in the sample (see Table 4).

Table 5: Aggregates with the number of innovative and not innovative firms

Aggregate	product development	no product development	total	as % of the total (N=927)
1	56	50	106	11.4
2	39	51	90	9.7
3	22	40	62	6.7
4	35	76	111	12.0
5	2	-	2	0.2
6	21	9	30	3.2
7	42	19	61	6.6
8	42	35	77	8.3
9	62	100	162	17.5
10	45	34	79	8.5
11	39	15	54	5.8
12	8	14	22	2.4
13	30	41	71	7.7
	443	484	927	100

Source: tip Innovative Firm Networks Survey

The following Table 6 takes the information from Table 5 and shows how those companies which co-operated during product development are distributed amongst the groups of the 13 aggregates.

Table 6: Number of companies with product development and co-operation distributed among the 13 aggregates

Aggregate	product development	[%]	co-operation in product development	in % of product developer/agg.
1	56	12.6	28	50.0
2	39	8.8	25	64.1
3	22	5.0	8	36.4
4	35	7.9	22	62.9
5	2	0.5	0	0
6	21	4.7	17	81.0
7	42	9.5	28	66.7
8	42	9.5	26	61.9
9	62	14.0	39	62.9
10	45	10.2	31	68.9
11	39	8.8	26	66.7
12	8	1.8	6	75.0
13	30	6.8	18	60.0
	443	100	274	62

Source: tip Innovative Firm Networks Survey

Table 6 also shows the percentage of co-operative firms related to the number of firms per aggregate which reported product development. Due to the fact that in aggregate 6 and aggregate 12 many foreign firms are located in Austria their co-operation intensity is high. The industry sectors of aggregate 6 and 12 can also be characterised by mostly big firms.

As was noted above, the firm had to report one or more product innovations for participating in the survey. The questionnaire was launched to examine co-operative behaviour of innovative firms and to explore motives and specific aspects of collaboration. Hence, the purpose of the survey was not to analyse innovative firms and companies in general.

In the following sections the results of the survey will be analysed in a rather descriptive way for following reasons: First, we know several independent factors such as firm size and turnover (unfortunately not all firms) but no performance indicator. In every survey analysing firm specific behaviour it is a difficult task to get firms revealing firm related performance data like cash-flow or profit rates. This is even more difficult in an direct but nevertheless anonymous way like a telephone interview. Second, it is even more difficult to estimate output related performance without being able to consider time series.

All sections are structured in the same way: At the beginning of each section the question of the questionnaire including the items is given in an exact translation.[32] The second part provides an analysis of the data.

[32] The questionnaire was originally written in German.

6 Results of the survey

6.1 Module 1 - Product innovation

The survey starts with a question about product development. Questions concerning process development were kept out of the questionnaire. Eventually with this kind of restriction on product development a certain bias towards bigger firms can be expected.

The interviewer tried to establish a common understanding of the concept of product development by explaining the exact meaning in the introduction to the question.

Introduction	In this survey product innovation means the development of a tangible product which in its design, its construction, its productive capacity or in any other way is new for the company. We are not thinking of small modifications which only affect the appearance of the product. Nor are we thinking of cases where the company's products are adapted to each individual customer as a matter of routine. Nor does the survey cover development of new processes in the company's production, such as introducing machinery with new technology or a new organisation of the production process.
Question (2)	Has your company - alone or in conjunction with others - developed one or more products within the last two years?
Answer items	– yes, one product – yes, several products – no – don't know

Innovation plays a crucial role in the performance of companies. Therefore there has been a huge interest in the measurement of innovative activity in recent years. However, this increased attention has also revealed limitations in the data available to analyse these processes. In particular, there are worries that the statistical sources generally used - R&D data on the input side, and the patent data on the output side - are rather narrow in scope, both conceptually and practically. More recently there have been attempts to develop more direct output indicators of various kinds. In the case of product development, especially with the method of an telephone interview, the basic point of departure is that firms usually know whether their product mix has changed or not. Certainly, they are able to identify a new product within that mix. This leads to the idea that firms can be asked to identify the number of new products, thus providing a potential indicator of innovative output. In the case of process innovation it would be rather difficult to ask a firm by phone and to compare these kinds of innovations across industries.

Some general remarks

The debate on the roles of large and small firms in industrial innovation has been going on for decades: Some economists such as Galbraith (1957) argue in the tradition of Schumpeter for the importance of large size and monopolistic power while others strongly argue in favour of small enterprises. However, it seems clear that the restriction of innovation to product development derives from a single theoretical tradition, namely the Schumpeterian approach. Schumpeter argued that price competition was a secondary phenomenon in market economies; the basic driving force of economic dynamics was attempts by firms to open up new markets by changing their products.

Nowadays it is a well known fact that the role played by small and medium-sized enterprises in innovation differs both across sectors as well as over the stage of the industry lifecycle. The advantages of large firms in innovation are primarily associated with their relative bigger financial and technological resources, and thus with *material* advantages. For example, a product innovation may include several incremental innovations relating to different components of the product. Product innovations may be based on R&D activities or on technology acquired by other means. Whereas small firms' advantages are those of entrepreneurial dynamism, internal flexibility and the high responsiveness to changing circumstances, they thus exhibit *behavioural* advantages (Rothwell and Dodgson, 1994). Large firms which combine both material and behavioural advantages are, of course, in an extremely strong position.

Apart from the size of firms, innovative activities do not occur by chance. The innovation process (and especially the process of product innovation) is an activity that requires inputs, which are typically of specialised and non-routine nature. The essence of product innovation is that it involves doing something new. Therefore innovation is, by its very nature, a risky activity - often the inputs and costs cannot estimated with certainty and the outputs can only be predicted imprecisely. With such a risky activity one can expect that there will be failures as well as successes and in many cases it may not even be possible to precisely state the probability of success.[33]

Regarding the fact that an innovative firm does not live in a vacuum the prime inputs to the innovative process are: skilled labour, machines or capital, finance, and managerial efforts (Bosworth and Stoneman, 1996). It follows that the innovative activity of a firm is likely to be constrained if it is unable to access such inputs properly. There is a large and vast literature addressing the problems of access to these inputs. Yet anyway, one can see that the size of innovative firms matters insofar as small firms have to rely on a limited scope of activities or suffer from a lack of resources for innovative activities (funding or managerial capabilities).

To state a rather theoretical argument which applies to every innovative firm independent of size: an innovative firm has an incentive to innovate if there is a net gain in profits that arise from its innovative activities. This gain is equal to the profits that arise after innovation relative to what profits would have arisen if that innovation had not occurred. The crucial point is that such counter factual profits are not the same as current profits if other firms are innovating as well. The firm is surrounded by other organisations that are undertaking innovation and, thus, are changing the firm's opportunity set. Innovation by competitors reduce the profits of the firm. In a competitive

[33] There may be many innovations that do not succeed - for example it is often quoted that 95% of new product launches fail (Bosworth and Stoneman, 1996).

environment, where other firms are innovating, the firm must therefore innovate in order to remain relatively on its level. Only achieving a level of innovative activity puts a firm ahead of its rivals, allows it to grow and to be more successful.

According to Bosworth and Stoneman (1996) the firm has to make three interrelated innovation decisions: whether, when and how much innovation. For the first decision, one would expect that the firm would innovate if such innovation yielded a return higher than the risk adjusted cost of capital. Since there is usually a high degree of uncertainty associated with innovation, the returns expected from successful innovations will, of course, have to be large enough to compensate for the losses incurred on failures. For the second one, the firm would need to take into account the expected innovative behaviour of rivals and the impact of early or late innovation upon early or late adoption revenues. For the third decision, the firm would need to consider its ability to undertake innovation, the problems of market acceptance of innovation and again the behaviour of rivals. Such decisions are complex in nature and even more difficult to model. But this economic approach focuses on the point that innovation is an investment activity and states that reduced profits for the firm today means increased profits in the future. Such a time profile of returns indicates that expected profitability, problems of financing or risks of innovation are the key limiting factors. These are serious obstacles for small and medium sized companies to invest in new product development or to adopt some risky behaviour.

Another theoretical approach (Dosi, 1997) stresses that inter-sectoral and inter-temporal differences in the propensity of innovating are better accounted for, in a first approximation, by differences in opportunities and firm-specific capabilities rather than by fine variations in profitability incentives. But nevertheless it is straightforward that a certain expected differential profitability is a necessary condition for firms to undertake expensive and risky innovations.

Hence, as stated above, the innovative firm does not live in a vacuum and requires a lot of inputs. These inputs are either internal or external to the firm. As already stated with regard to inputs to innovation or access to specific resources, firms operate within national, international and even global innovation systems. One mechanism of achieving new information or knowledge produced elsewhere is via collaborative behaviour.

What does the data show?

One of the first aims of the survey is to establish how widespread innovation is within the Austrian manufacturing sector. Generally, one can assume that in a competitive economic system, all firms are forced to innovate in the one or the other way, although it is reasonable to reveal how frequently firms innovate and to determine the fraction of firms which is affected by the introduction of new products. For illustrating the distribution of innovative firms across size classes two methods were used.

The first method of illustration is in the tradition of the well known analysis of the CIS[34] data or other innovation surveys. This method tries in a rather simple and statistically questionable way to exhibit the relationship between firm size and propensity to innovate. According to this method main firm size classes were built consisting of different numbers of firms. Within every size class the percentage of innovative firms are estimated. The breakdown of the existence of product innovation by firm size is shown in Table 7. The method of building size

[34] Community Innovation Survey (CIS)

classes and calculating the share of innovative firms was also used in analysing CIS data (see e.g. STEP, 1997; Evangelista et al., 1997).

Table 7: Innovating and non-innovating firms by firm size

Firm size by no. of employees	# of innovating firms	# of non-innovating firms	innovative firms as % of total by size class
10-19	68	152	30.9
20-99	197	256	43.5
≥100	178	76	70.1
	443	484	

Source: tip Innovative Firm Networks Survey

Table 7 reveals that there are significant differences in the percentage of innovating firms across different size classes. The table clearly indicates that the probability of a firm having developed one or more products within the last two years and firm size exhibit a positive correlation and increases more or less linearly. 30.9% of firms with less than 20 employees have developed one or more products within the last 2 years. This percentage increases to 43.5% in the size class with 20-99 employees and goes up to 70.1% in the size class consisting of firms with more than 100 employees. This relationship holds also for the countries participating in the CIS. Evangelista et al. (1997) show that at the European level a clear positive relationship between firms size and the percentage of innovating firms exists as well.

The second method emerged from the problem of comparability in order to represent the differences of innovating firms across different size classes. The problem with building different size classes is due to the fact that the classes consist of different numbers of firms. Hence, it can be misleading to compare the share of innovative firms across different size classes consisting of different numbers of firms. An alternative, yet more advanced method for illustrating the dependency of product innovation and firm size is described in the following section.

Testing the propensity to innovate

Two samples of firms were built: One sample consists of all innovative firms and the second sample includes all non-innovative firms. Within every sample the size of the firms provide us with the information necessary to calculate the mean value and the variance, respectively. The objective of the following analysis is to estimate a stochastic model representing the characteristics of the two groups of firms to point out if there is any difference. Hence, we are looking for a distribution with a mean value equal to the mean value of the data and with a variance equal to the variance of the data, respectively. Yet, the coincidence of a distribution with the data depends very much on the type of distribution as well as on the calculated estimates of the parameters. Since the data are neither normal nor equal distributed we have to use a family of distributions that is most flexible in representing the characteristics of the observations and hence is most suitable for pointing out the difference between the two groups of firms significant.[35]

Therefore we used the family of beta-distributions which consists of all density functions of the form:

[35] I am indebted to Alexander Kopcsa for his helpful ideas and comments. See also Kopcsa (1991).

$$f_x(\alpha,\beta)_{(a,b)} = \frac{(b-a)^{1-\alpha-\beta}}{B(\alpha,\beta)} \cdot (x-a)^{\alpha-1} \cdot (b-x)^{\beta-1} \quad , \forall\, a < x < b$$

where α and β are parameters and all observations lie in the interval (*a, b*).

The expected value of a beta-distribution is

$$EX = a + (b-a) \cdot \frac{\alpha}{\alpha+\beta}$$

and the variance is

$$VarX = \frac{(b-a)^2 \cdot \alpha \cdot \beta}{(\alpha+\beta)^2 \cdot (\alpha+\beta+1)}$$

Within both samples we can calculate the mean value of the size of firms, hence we have *n* observations $x_1,\ldots,x_n$ of a stochastic item. For each sample we have to find that distribution out of the family of the beta distributions which describes the observations of the two groups in the best manner.

The mean value of the sample is given by

$$\bar{x}_n = \frac{1}{n} \cdot \sum_{i=1}^{n} x_i$$

and the variance is given by

$$s_n^2 = \frac{1}{n} \cdot \sum_{i=1}^{n} (x_i - \bar{x}_n)^2$$

For calculating the parameters α and β we applied the moment-estimator. By applying the moment-estimator we have to find that distribution (in this case out of the family of beta-distributions) with its mean and variance equalising the mean and variance of the sample. Hence, following from the equations above we had to solve a system of two equations with the two unknown parameters α and β. This system is given by

$$\bar{x}_n = a + (b-a) \cdot \frac{\alpha}{\alpha+\beta}$$

and

$$s_n^2 = \frac{(b-a)^2 \cdot \alpha \cdot \beta}{(\alpha+\beta)^2 \cdot (\alpha+\beta+1)}$$

The boundaries *a* and *b* can be defined as the size of the smallest firm and the size of the largest firm per sample, respectively

$$a = \min\{x_1, \ldots, x_n\}$$

$$b = \max\{x_1, \ldots, x_n\}$$

The samples of the firms are not equal distributed, thus we have many more small than large firms. We therefore decided to choose the range with the highest density of observations to illustrate the difference between the two groups. Hence, we took $b = 551$ for the sample of the innovative firms and $b = 380$ for the sample of non-innovative firms.

The moment-estimator $\hat{\alpha}$ for the parameter α exhibits

$$\hat{\alpha} = \frac{\bar{x}_n - a}{b - a} \cdot \left[\frac{(\bar{x}_n - a) \cdot (b - \bar{x}_n)}{s_n^2} - 1 \right]$$

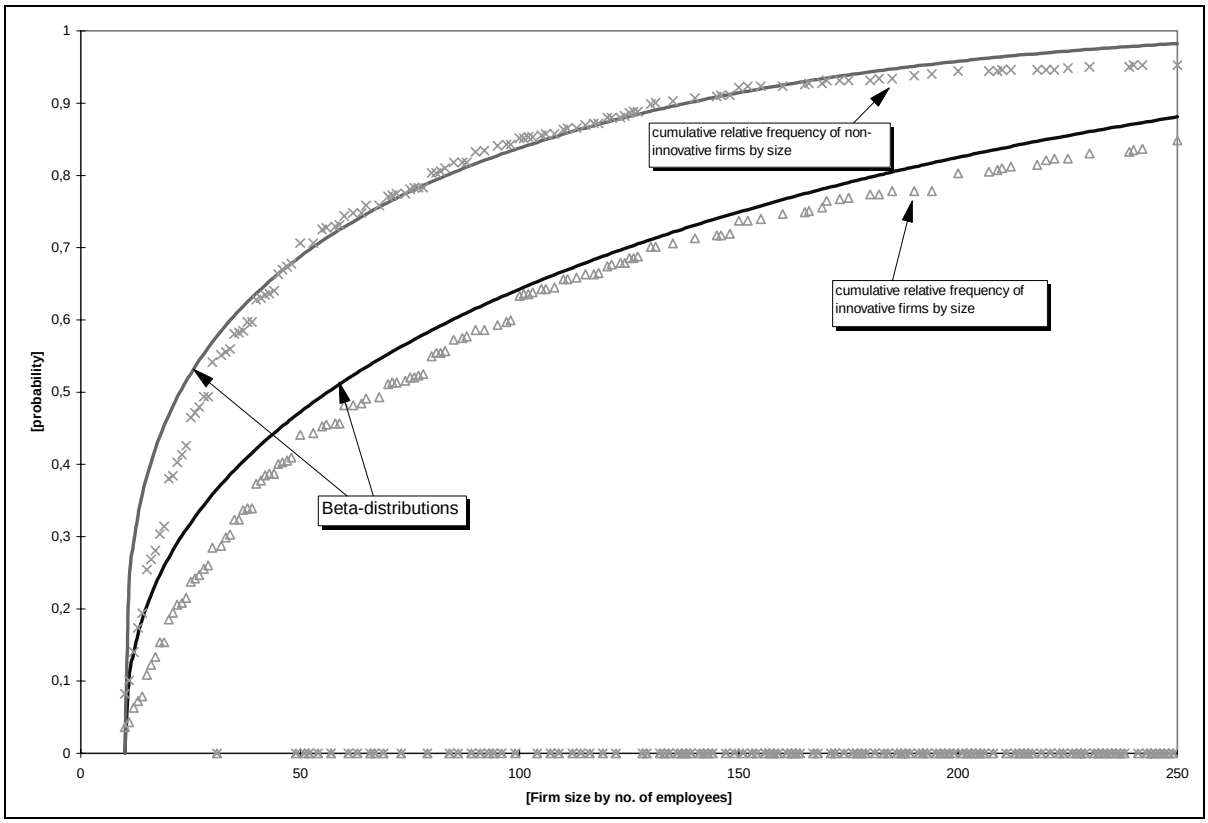
The moment-estimator $\hat{\beta}$ for the parameter β exhibits

$$\hat{\beta} = \frac{b - \bar{x}_n}{b - a} \cdot \left[\frac{(\bar{x}_n - a) \cdot (b - \bar{x}_n)}{s_n^2} - 1 \right]$$

Both the cumulative relative frequency of the firm sizes per sample with the estimated beta-distributions are illustrated in Figure 1. On the first view the figure shows the two distributions as very well suited to represent the data and to exhibit the difference between the two groups of firms.

Hence the main difference to the first method of building different size classes lies in the *direction* of the analysis. Thus we do not take the firm size and try to relate the propensity to innovate like in the well known method described before but to look first if the firm is innovative or not. In a second step we estimated the distribution of firms according to their size within these two groups of innovative and non-innovative firms. As Figure 1 reveals, every firm size is taken as a class by its own and hence the problem comparing different groups consisting of different numbers of firms can be avoided. The two beta-distributions reveals the probability of a firm up to x employees related to the two samples. If we take for example the firms up to 100 employees the beta-distributions of Figure 1 reveal, that the probability of drawing a firm up to 100 employees out of the sample of innovative firms is 0.62 and the probability of drawing a firm up to 100 employees out of the sample of non-innovative firms is 0.83. If we increase the firm size up to 250 employees the beta-distribution of the non-innovative firms reveals nearly unity which means that all non-innovative firms are covered within this range.

Figure 1: Beta-distributions over the samples of innovative and non-innovative firms



Source: tip Innovative Firm Networks Survey

In more detail the following results can be drawn from Figure 1:

- ◊ Over the range of firm size from 10 to 250 employees the estimated beta-distribution of the non-innovative firms lies above the beta-distribution of the innovative firms.
- ◊ Up to a firm size of 250 employees the estimated beta-distribution of the non-innovative firm exhibits a probability of nearly unity. Hence, within this range almost all non-innovative firms are covered.
- ◊ At the boundary of 250 employees the beta-distribution of innovative firms has not reached unit which means that bigger firms lie in the sample of innovative firms.
- ◊ The gap between the two estimated distributions is highest at a firm size of about 100 employees.

To summarise, the method of estimating beta-distributions shows no distinct result contrary to the findings presented in Table 7. Hence, the share of innovative firms becomes higher the higher the size class. Yet, the estimation of beta-distributions are more interesting from a methodological point of view. It seems statistically questionable to compare the share of innovative firms from different size classes with every size class consisting of a different number of firms. We therefore decided to built two classes of firms: one sample consists of all innovative firms and an other sample consists of all non-innovative firms. Within the two samples every firm size is taken as a class by its own and we can show the significant differences between these two samples. Hence, the advan-

tage of this alternative method can be seen in the fact that no arbitrary boundaries of size classes are drawn. Although we use the traditional estimation of calculating the percentage in the following sections we just tried to give a hint for further discussions with respect to the methodological framework for the analysis of data in innovation surveys.[36]

6.2 Module 2 - Co-operation in product development

With the following question the core of the survey starts. The companies which had developed one or more products within the last two years were asked whether they had collaborated with different types of Austrian or foreign partners during the development process. The existence of such relationships would be yet another indication that innovation is a *networking* as opposed to a *localised* activity.

Question (4)	During the product development, has your company co-operated with any institute, customer or competitor or has the development taken place internally?
Answer categories	– yes, there was an intensive co-operation. – no, the development took place mainly internal [but there was a certain co-operation]. – no, the development was exclusively internal.

The results show that co-operative arrangements are widespread within innovative firms. Nearly 62% of all firms with one or more product innovations (Σ=443) had co-operated while 38% did not report any co-operation. Table 8 shows the result in absolute as well as relative numbers.

Table 8: Number of co-operative and non-co-operative firms

Firm size by no. of employees	# of co-operating firms	# of non-co-operating firms	co-operating firms as % of the total by size class
10-19	33	35	48.5
20-99	115	81	58.4
≥100	126	53	70.4
	274	169	61.7

Source: tip Innovative Firm Networks Survey

The breakdown of the existence of a collaborative arrangement by firm size is shown in Table 9. The results clearly show that the probability for a firm having a collaborative agreement increases with firm size. An astonishing result is that the difference between the lowest class and the highest class in percentage of cases is only about 22%; 48.5% of the smallest firms and 70.4% of the larger firms have co-operative arrangements. However, one might note that while there are significant hindrances to product innovation concerning firm size, the difficulty of making co-operative arrangements does not vary with firm size. This result clearly shows that co-operative arrangements are important for innovative firms independent of their size.

[36] A comparison of country or regional data can be interesting in this respect. We only differentiated between innovative and non-innovative firms in our sample but a comparison of the data dependent on regional specificities would be interesting as well.

Table 9: Innovation and co-operative agreements of innovative firms by firm size [in %]

Firm size by no. of employees	product innovation	co-operation
10-19	30.9	48.5
20-99	43.5	58.4
≥100	70.1	70.4

Source: tip Innovative Firm Networks Survey

Although it is difficult for small firms to get access to all resources required for product innovation - finding arrangements or partners for co-operation does not seem to be difficult. Although there is a positive correlation between co-operation and firm size[37], this relationship is overshadowed by the fact that nearly half of the very small firms (10-19 employees) co-operated during the product development. The percentage increases to more than 58% of firms with 20-99 employees and reaches 70% for firms with more than 100 employees. Compared with the share of innovative firms the problem seems to lay more in the low number of innovative firms than in co-operative arrangements.

Propensity of innovative firms to co-operate

To illustrate the difference between the two samples of co-operating and non-co-operating firms we tried to apply the method developed in section 6.1. Hence, we estimated beta-distributions over the two samples of innovative firms. According to the idea developed above, the sample of innovative firms were divided into two groups: one sample includes all firms reporting co-operation during the product development and another group including all non-co-operating (although innovative) firms.

The boundaries *a* and *b* are defined as the size of the smallest firm and the size of the largest firm per sample, respectively

$$a = \min\{x_1,\ldots,x_n\}$$

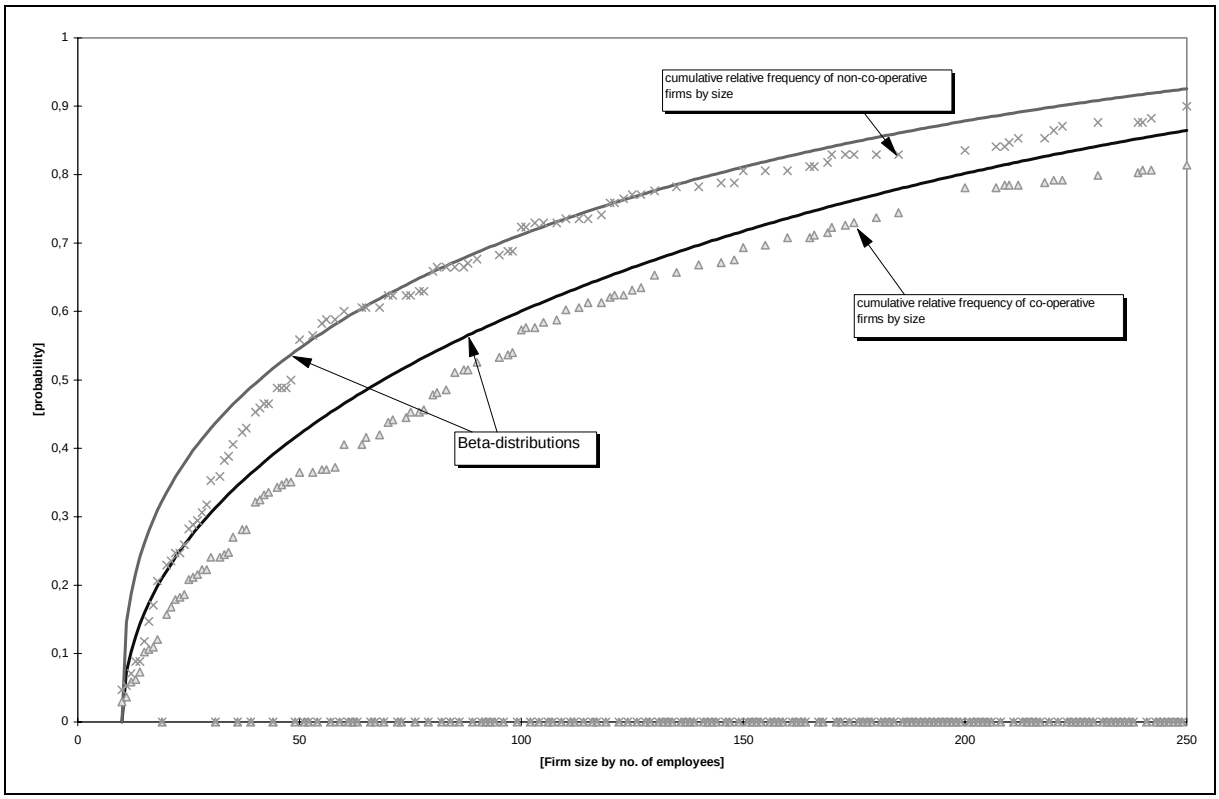
$$b = \max\{x_1,\ldots,x_n\}$$

with *n* observations $x_1,\ldots,x_n$ of the firm size.

Like in the samples in section 6.1 the two samples of co-operating and non-co-operating firms are not equal distributed as well, thus we have much more small than large firms. Hence, for analysing the range with the highest density we took $b = 550$ for the sample of the co-operating firms and $b = 470$ for the sample of non-co-operating firms. Figure 2 shows the results of the calculations which is mainly interesting in comparison with Figure 1.

[37] The analysis of co-operation with specific partners by firm size will show a rather different result (see below).

Figure 2: Beta-distributions over the samples of co-operating and non-co-operating firms



Source: tip Innovative Firm Networks Survey

Some striking results can be seen in Figure 2:

- ◊ Compared with the two distributions in Figure 1, the beta-distributions of Figure 2 are closer to each other. Hence, estimating the difference between co-operation and non-co-operating firms within the sample of innovative firms is less significant as it was with the difference between innovative and non-innovative firms.
- ◊ But the figure also exhibits that over the range of firm sizes the probability a firm has x employees within the sample of non-co-operative firm is higher than within the sample of co-operative firm. Hence, the figure clearly indicates a coherence between propensity to co-operate and firm size.
- ◊ The shape of the two Beta-distributions are flatter which can be interpreted as the fact that co-operating and non-co-operating firms, respectively, are distributed over a wider range compared with the distributions of non-innovative firms.

Some sector specific remarks

Looking at the distribution across NACE-aggregates it is difficult to find clear pattern as there are only a few observations. Yet, regarding this restriction it can be stated that the probability of a firm having a collaborative arrangement appears to be highest in aggregate 6 (chemicals) with 81% of the firms reporting co-operation. This

observation can be explained by the fact that many Austrian chemical firms are subsidiaries of foreign firms. Intensive co-operative behaviour can be observed in aggregate 12 (motor vehicles) and aggregate 10 (machinery) as well.

By far the lowest co-operation rate is found in low-tech sectors such as wood (only 36% co-operate), furniture (58%) and food (50%). Due to this findings one might suggest that collaborative agreements are more common in sectors of advanced technology and less common in others. The reasons for this are not entirely clear, although there may be a tendency of firms to look for collaboration in new and mainly riskier areas with more technological changes involved.

6.2.1 Co-operation with specific partners

Another important issue in the survey was to investigate the patterns of collaboration regarding the partners by organisational type. Innovative firms use a variety of external sources of information which include a range of different types of actors, as listed below. Thus it is a central question with whom do which kinds of firm co-operate. It is interesting to know whether certain types of partners are more likely to be domestic or foreign owned. It was also asked whether the co-operation was for the first time or in repetition.

Question (5)	Now I list some partners who are suitable for co-operation. Please indicate if you have co-operated with the partner within the last two years in the development of the new product.
Answer categories	– private customers – government customers – supplier of materials and components – suppliers of equipment for producing the product – your own parent company or one of your subsidiaries – competitors – marketing, management, legal or other private consultants – suppliers of technical services, testing, controlling, standardisation or equivalent – universities – contract research organisations (e.g. ARCS, JR)
Remarks	To each category a question was added, asking if the co-operation was with a domestic or foreign organisation and if the co-operation was for the first time or in repetition.

Firms which responded positively to the question of co-operation were now asked to give more detailed answers concerning the organisational type of the partner and if the partner was domestic or foreign.

However, as firms may have more than one agreement of any type, multiple indications were possible. Therefore the figures are based upon the total number of indications. The percentages may thus be best considered as relative to the numbers of the other types. The percentages are related to the total number of co-operating firms (N=274). The results are presented in Table 10.

Table 10: Co-operation with different partners (multiple indications possible)

	All co-operation partners	Foreign partners
Partners	# of firms (% of all co-operating firms)	# of firms (% of all co-operating firms)
suppliers of materials and components	169 (62.1)	115 (42.0)
private customers	154 (56.4)	100 (36.5)
suppliers of technical services, testing, controlling, standardisation or equivalent	114 (41.8)	48 (17.5)
your own parent company or one of your subsidiaries	106 (38.7)	65 (23.7)
government customers	90 (33.0)	37 (13.5)
universities	89 (32.7)	30 (10.9)
suppliers of equipment for producing the product	78 (28.7)	61 (22.3)
contract research organisations (e.g. ARCS, JR)	65 (23.8)	22 (8.0)
competitors	54 (19.7)	28 (10.2)
marketing, management, legal or other private consultants	48 (17.6)	19 (6.9)

Source: tip Innovative Firm Networks Survey

A view on the data shown in Table 10 provides a first impression of the differences between domestic and international innovation relationships.

With the discussion of the dynamics of globalisation and national innovation systems in the background, it is interesting to investigate the patterns of co-operation, namely to which extent innovation systems are national or international, respectively. Although it is empirically difficult to measure, the existing data seem to indicate a growing frequency of international relationships - especially for innovative firms. The data show that a quite intensive domestic network goes hand in hand with, on average, a high co-operation intensity with foreign partners.

The results also indicate that the most common co-operation partners are suppliers of materials and components both in the total and with foreign partners. As Austria is an open economy with a high share of foreign enterprises or subsidiaries there is often a rather close co-operation with parent companies or with one of the subsidiaries of the firm. Similar to Denmark, a country which has already finished its survey, the most common co-operation partners are suppliers of materials and components and private customers as well. This result emphasises the well known fact that supplier-buyer chains are extremely important mechanisms for the transmission of information and know-how. The willingness to provide information and to interact in a close relationship is high in order to stimulate demand for the products. Hence, some types of partners are by their very nature extremely important and therefore highly ranked as co-operation partners.

Another surprising result is the fact that about one third of the firms co-operate with universities. In general universities can be powerful motors for the technological and economical development of industrial branches. Many examples, mainly from overseas, demonstrate the major impact a university can have if its potentials for technology transfer to industry are fully exploited. In recent years in some countries there has been an increasing interaction between universities and commercial firms due to the fact that universities have become more entrepreneurially and commercially oriented in their own right. With respect to the well known fact that in Austria more

than 70% of government R&D funding are devoted to the higher education sector (the highest percentage in the OECD), it is quite difficult to interpret the high co-operation rate as a consequence of cuts in funding. However, some pressure might exist towards a more commercially oriented university system. According to Jörg et al. (1996) there are some strong co-operation links between specific university institutes and commercial firms in Austria originated mostly in personal relationships and on the initiatives of the firms. Nevertheless there exists a desire of the university sector for more co-operation and closer relationships. But seen from the industry sector the university sector is an important source of knowledge and an interesting co-operation partner.

Many studies emphasise that the quality of the public research infrastructure and its links to industry are one of the most important national assets for supporting innovation. Government-supported research institutes and universities are main performers of generic research and produce a body of basic knowledge for use and further development by industry. Increasingly, the research conducted at these institutions is supported by enterprises who are collaborating with the public sector in joint technology projects. The general ability of industry to access knowledge developed by the (public) university sector is considered as important, although it is assumed that the usefulness of public knowledge differs greatly by industrial sectors.

Since it is rather difficult to draw sector-specific conclusions with the existing sample-space the following Table 11 shows the co-operation intensities concerning the size of the firms. One will expect that some sources of information embedded in potential co-operation partners become more important with size. Table 11 shows the percentage of co-operating firms within each category of co-operation partner depending on the size of the firm. To illustrate the table: 48.5% of all co-operating firms with less than 20 employees co-operate with private customers, 54.4% of all co-operating firms with 20-99 employees co-operate with private customer etc.

Table 11: Co-operation intensities by size of the firm [in % of cases]

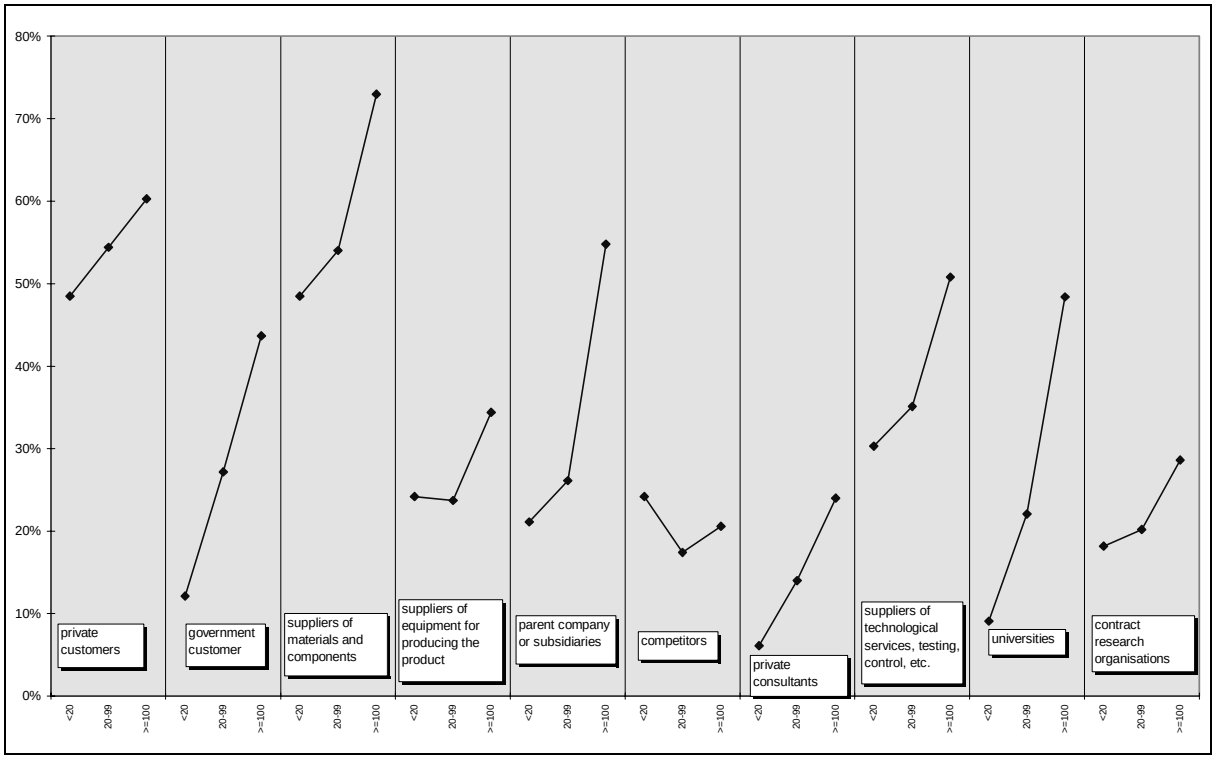
	Firm size by no. of employees		
Collaborating partners	10-19	20-99	≥100
private customers	48.5	54.4	60.3
government customers	12.1	27.2	43.7
suppliers of materials and components	48.5	54.0	73.0
suppliers of equipment for producing the product	24.2	23.7	34.4
your own parent company or one of your subsidiaries	21.1	26.1	54.8
competitors	24.2	17.4	20.6
marketing, management legal or other private consultants	6.1	14.0	24.0
suppliers of technological services, testing, control, standardisation or similar	30.3	35.1	50.8
universities	9.1	22.1	48.4
contract research organisations (e.g. ARCS, JR)	18.2	20.2	28.6

Source: tip Innovative Firm Networks Survey

A comparison of the co-operation intensities regarding the firm size reveals some interesting results. One of the main results is that most of the sources which firms have indicated do not vary monotonically with size. It is

therefore interesting to see whether some potential partners increase or decline with size. Figure 3 visualises the results of Table 11.

Figure 3: Co-operation intensities with partner categories by size of the firm [in %]



Source: tip Innovative Firm Networks Survey

There are three criteria through which Figure 3 can be analysed: first, the level of co-operation intensities, second the correlation between firm size and co-operation intensities and third, the range of co-operation intensities between the size categories. Concerning all three criteria a rather heterogeneous picture of co-operative behaviour can be seen.

For firms it is generally essential to co-operate with private customers. However, there is no *a priori* reason to expect that there is a difference in the degree of dependence upon knowledge from the private customers related to the size of firm. Moreover, this category of co-operation partner shows one of the smallest range in the data. Yet it might be argued that small firms are more responsive to their clients, whereas larger enterprises have more systematic and formally developed links with their customers.

Suppliers are also seen as important knowledge sources and co-operation partners. Again, there is no *a priori* reason for believing that there should be a relationship between the importance of these sources and the firm size. It might be that larger enterprises glean information from a wider range of suppliers, but the smaller ones might be more dependent on suppliers for information. The data show that within the small range there is no monotonic relationship between the importance of suppliers of equipment and firm size. Although there is a positive relationship between co-operation intensity with suppliers of materials and components and firm size the

level co-operation intensity is rather high. However, the data indicate that manufacturing firms interact with knowledge-intensive service organisations which in turn implies that service sectors play an important role in the innovation process.

Elsewhere there is a strong positive relation between the rated importance of the co-operation partners and the size of the enterprise. These positive relationships apply to the following partners: government customers and universities. Within these partner categories a strong correlation with size of the firm as well as a wide range can be found. Although there is a positive correlation between firm size and co-operation with private consultants and contract research organisations, the range of dispersion is rather small. Compared with universities the co-operation intensity with contract research organisations is higher for small firms. Yet, bigger firms do have an stronger contact to universities.

The strong relationship between size and co-operation with universities seems to be a sensitive result given that larger enterprises tend to employ highly qualified personnel more likely to have in-house R&D facilities. Large science-based firms might be well prepared to communicate with universities knowing their codes and their cultures, while smaller firms may have greater difficulties in this respect. In addition small firms often do not have the personnel and financial resources in order to co-operate with universities. However, due to the fact that it is important for industry to have access to universities, co-operation with universities could be an important source of information also for small enterprises. If there are bridging problems, agents mediating between knowledge producers and knowledge users may be established by the government. Public and semi-public technological service institutions are important in this respect (Dalum et al., 1992).[38]

Another result is worth to be mentioned. Small enterprises rank the importance of competitors as co-operation partners somewhat higher than bigger firms. However, the ranking especially of small firms is surprisingly high. It appears that small firms are more attentive towards their competitors. For small firms the activities, practices and products of competitors may be easier to observe and to access.

To conclude, the empirical data show that the overall willingness to co-operate, i.e. the information requirements rise with firm size. Yet the relative importance of co-operation partners vary significantly across firms sizes. The strength and direction of this relationship depend very much upon the partner as the source of knowledge or transfer of technological know-how.

These results clearly support that policy has to take under consideration the *network* aspect of knowledge flows between different partners. External sources are significant for innovation. Co-operation is for most of the innovative firms an essential part of the innovation process. Thus, the efficiency and competitiveness of an economy depends very much on how economies adapt to these changing economic environments. Due to the fact that innovation is by far more than a stand alone activity, policies have to be directed towards the systemic aspect of innovation rather than targeted towards isolated actors. Hence, as systems characteristics are important, policies that improve the system would be more important. Policies concerned with innovation has to take the co-operative aspect of innovation into consideration.

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[38] The European Commission commissioned a study (Schaettgen et al., 1996) in which independent technology transfer organisations are suggested, which do not belong to the university but merely work closely with it, develop an even more explicit business culture. This means that these organisations have the opportunity to design structures freely, which are fully supportive of industry-oriented research and of technology transfer. However, in Austria such organisation exist already although they do not play an important role for technology transfer to the industry (Jörg et al., 1996).

Looking at the co-operative behaviour with partners from abroad it can be expected that large firms are more internationally oriented than smaller ones. Yet most of the co-operations are purely domestically oriented. As was already shown in Table 10 the majority of partners from abroad are suppliers of materials and components as well as private customers. In comparison to the suppliers of equipment or products, the suppliers of know-how, private consultants as well as suppliers of technological services, are less frequently mentioned as a foreign partner. The lower rate of foreign relationships probably occurs both because the historical development of the industrial structure of a country depends more or less on the types of knowledge and skills within the country and because individuals might find it easier to develop contacts and co-operate with people from the same cultural and linguistic background. The following Table 12 is structured like Table 11. Hence, it shows the percentage of firms by size which co-operate with foreign partners. The table has to be read as follows: 18.2% of all co-operating firms with less than 20 employees co-operate with foreign private customers, 32.2% of all co-operating firms with 20-99 employees co-operate with foreign private customer etc.

Table 12: Co-operation intensities with foreign partners by size of the firm [in %]

	Firm size by no. of employees		
Collaborating partners (foreign)	10-19	20-99	≥100
private customers	18.2	32.2	45.2
government customers	6.1	9.6	19.0
suppliers of materials and components	24.2	31.3	56.3
suppliers of equipment for producing the product	6.1	18.3	30.2
your own parent company or one of your subsidiaries	12.1	13.9	35.7
competitors	6.1	8.7	12.7
marketing, management legal or other private consultants	3.0	4.3	10.3
suppliers of technological services, testing, control, standardisation or similar	15.2	13.9	21.4
universities	-	5.2	19.0
contract research organisations (e.g. ARCS, JR)	3.0	6.1	11.1

Source: tip Innovative Firm Networks Survey

Although bigger firms co-operate to a greater extent with foreign partners compared with smaller firms there does not exist an increasing linear relationship between co-operation intensities and size of the firms. Compared with Table 11 some of the insights in the co-operation with foreign partner may be self-evident, but some are surprising.

- ◊ The linkages of very small firms (10-19 employees) to foreign partners is rather low. Only 18.2% of the firms in this size class co-operated with foreign customers. More than 45% of the firms with more than 100 employees have linkages to foreign customers.
- ◊ As with the overall co-operation intensity, the most often cited foreign co-operation partners for every size class are suppliers of materials and components. While one quarter of the small firms co-operated with this category of partner more than half of the bigger firms indicated this item (56.3%).

- ◊ The co-operation intensity with foreign competitors is lower for small firms. Compared with the overall assessment of co-operating with competitors the co-operation intensity with foreign competitors declined for small firms to 6%.
- ◊ The lowest rate for all size classes exhibit co-operation with foreign marketing, management, legal or other private consultants. Only 10.3% of the bigger firms indicated this item.
- ◊ There is not one small firm co-operating with foreign universities. The co-operation of big firms with foreign universities has diminished as well. Hence, Austrian firms are not very much linked to foreign universities.

6.3 Module 3 - Motives, trust, and barriers to co-operation

The previous chapters have demonstrated that innovation in product development is typically performed in co-operation. The innovative outcome emerges mostly from collaboration. Each partner contributes some complementary elements. The final achievements are something more than a single firm could attain. The systemic character of innovation brings us to the questions addressing the motives for co-operation, i.e. what are the motives of firms if they want to co-operate with partners in product development. Other interesting factors in the analysis of co-operation are: management of co-operation, role of trust in the relationships, and barriers to co-operation.

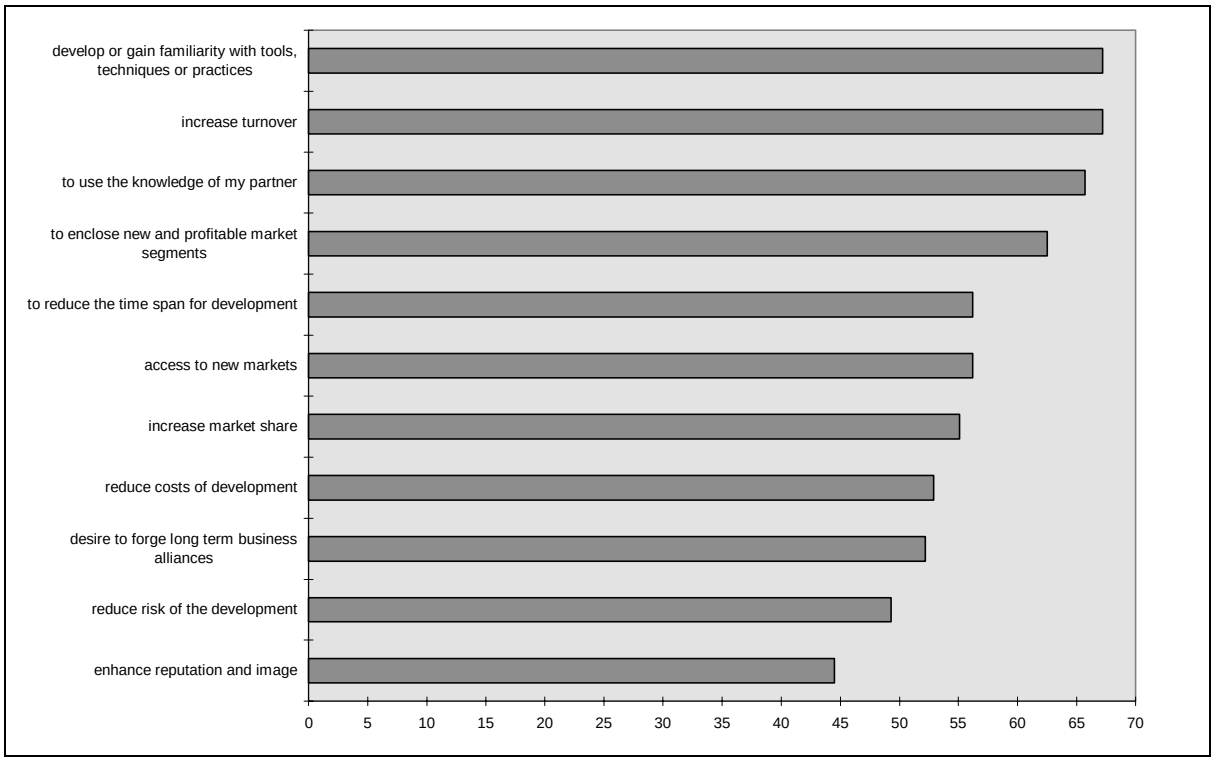
6.3.1 Motives

Question (6)	There are several possible motives for co-operation. Please indicate which of the listed motives were important for you in the co-operative product development.
Answer categories	– to use the know-how of my partner. – desire to forge long term business alliances – access to new markets – increase market share – to reduce the time span for development – increase the turnover – reduce the risk of the development – reduce the costs of development – enhance reputation and image – develop or gain familiarity with tools, techniques or practices – to enclose new and profitable market segments

To some extent each of the listed motives plays a certain role in collaboration as Figure 4 exhibits. Although the motives are overlapping and it is therefore difficult to discriminate very clear between them, they give a quite clear impression of the motives the firms have if they start a co-operation for product development. Figure 4 gives an overview of how many firms indicate each motive with quite interesting results. As the figure points out, the four most often mentioned motives pursue both economic goals in a narrow sense which are in fact expansionistic (such as *increase turnover* and *enclose new and profitable market segments*) and learning goals (as *develop or gain familiarity with tools, techniques or practices* and *use the knowledge of my partner*). More than 62% of all co-operating firms have mentioned these four motives which means that general expectations most of

firms put to co-operation are rather high. On the other hand Figure 4 also shows that reputation and image play a minor role as a motive for co-operation. 44.5% of the firms had indicated this motive as important for co-operation. Hence, reductionistic motives such as risk reduction or cost reduction exhibit a rather low priority.

Figure 4: Motives for co-operation [% of all firms agreeing to the item]



Source: tip Innovative Firm Networks Survey

As most of the firms have indicated more than only one or two motives, it is quite interesting to look at not only how often the single motives were mentioned but also which of the motives were indicated jointly.[39] With regard to this aspect the analysis reveals that the motives most often mentioned together are more focused on market related goals. These motives are:

- ◊ *Increase turnover* with *increase market share* are those two motives which were indicated most often together.
- ◊ The combination ranked next is *access to new markets - increase turnover - increase market share*. At the next level the motives *use the knowledge of may partner* and *enclose new and profitable market segments* are mentioned together. Hence, the first non-market-related motive in this ranking is mentioned in relation with a rather market-related motive.

[39] For this analysis we used our system of network mapping developed by Kopcsa et al. (1996).

◊ At the lower levels there are different combinations of motives all mentioned above. The first pure learning motives in combination are *use the knowledge of may partner* with *reduce the time span for development.*

A more detailed insight into the motives can be attained by relating the assessment of the motives to the size of the firms. Table 13 shows the percentage of all co-operating firms distributed over the size classes which indicated the motive. A range of interesting patterns regarding the motives can be observed.

Table 13: Motives for co-operation by firm size [% of firms by size class agreeing to the item]

	Firm size by no. of employees		
Motives	10-19	20-99	≥100
develop or gain familiarity with tools, techniques or practices	60.6	67.0	69.0
increase turnover	66.7	65.2	69.0
to use the know-how of my partner	48.5	61.7	73.8
to enclose new and profitable market segments	54.5	60.0	67.5
to reduce the time span for development	51.5	49.6	63.5
access to new markets	45.5	55.7	59.5
increase market share	42.4	50.4	62.7
reduce costs of development	45.5	47.0	60.3
desire to forge long term business alliances	42.4	47.8	58.7
reduce risk of the development	45.5	47.0	52.4
enhance reputation and image	42.4	43.5	46.0

Source: tip Innovative Firm Networks Survey

◊ It is self-evident that the overall goal *increase turnover* is relevant independent of the size of the firm. Hence, the difference of percentage between smaller and larger firms is not significant. 66.7% of the small firms and 69% of the bigger firms mentioned this motive.

◊ Another motive with a small difference of the share between small and bigger firms exhibits the motive *develop or gain familiarity with tool, techniques or practices.* In both size classes more than 60% indicated this motive.

◊ Concerning the motive *use the know-how of my partner* the data show the highest difference between small and bigger firms. While less than half of the small firms (48.5%) mentioned this motive the share within bigger firms has risen to 73.8%.

◊ Due to the fact that it is in general easier for small firms to *enclose new and profitable market segments* than to *increase market share* the difference is shown by the data. 54.5% of the small firms mentioned the motive *enclose new and profitable market segments* while 42.4 % pursued the goal of *increase of market share.*

◊ The motive *enhance reputation and image* does not exhibit a significant difference between smaller and larger firms. 42.4% of the small firms and 46% of the larger firms indicated this motive.

6.3.2 Organising co-operations

Another feature concerns the handling of co-operation especially if there exists a well defined structure of communication between the partners. The definition of common goals and a clear division of competencies between the partners are of interest in this context, too. Moreover it gives insight to the significance of organisational versus competence related activities during the co-operation.

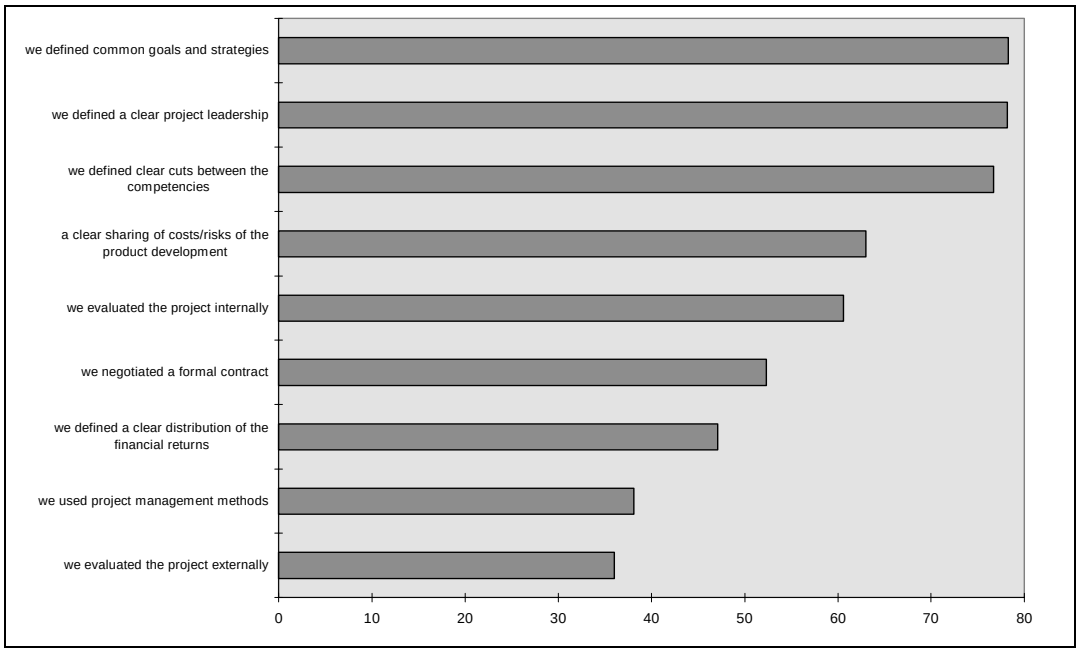
Question (7) Answer categories	I will now list a number of activities that may take place in the course of co-operation. Please indicate if you have undertaken one or more of the following activities. – we negotiated a formal contract – we defined common goals and strategies – we defined clear cuts between the competencies – we had a clear sharing of costs/risks of the product development – we defined a clear distribution of the financial returns – we defined a clear project leadership – we used project management methods – we evaluated the project internally – we evaluated the project externally

Figure 5 lists the activities in descending order of frequencies with the *definition of common aims and strategies,* a *clear project leadership* and *clear cuts between the competencies* on the top of the ranking.[40] Nearly 80% of the answering firms indicated these activities undertaken in the course of the co-operation. However, the ranking of some activities are quite surprising:

- ◊ Only half of the firms indicated that they negotiated a formal contract with their partners. This finding justifies the notion of co-operative arrangement instead of co-operative agreements.
- ◊ More than 60% of all co-operating firms evaluated the project internally.
- ◊ Probably due to the fact that it is rather difficult to estimate the financial returns, less than half of the firms indicated that they defined a clear distribution of the financial returns in advance.

[40] Figure 5 has to be read as follows: hundred per cent comprise those firms who indicated either yes or no for each of the answer categories, i.e. those who didn't give any answer are not included.

Figure 5: Organising co-operation [% of all firms agreeing to the item]



Source: tip Innovative Firm Networks Survey

When analysing the motives it was easy to group some of them under the heading of more market-oriented, others to learning-oriented motives. Analysing the activities a focus on defined competencies and goals rather than on formal contracts or financial returns became obvious. The activities which most of the firms indicated together were:

- ◊ *We defined clear cuts between the competencies* together with *we defined a clear project leadership.*
- ◊ At the next level the activity *common aims and strategies* is added. Looking at the four strongest activities mentioned together *clear sharing of cost/risks* is included.

Table 14 provides a detailed insight into the activities during the co-operation undertaken by small and large firms. It shows the percentage of all co-operating firms distributed over the size classes which indicated the relevant activities. The data reveal the importance of some of the activities during the co-operation related to the size of the firm.

Table 14: Organising co-operation by firm size [% of firms by size class agreeing to the item]

	Firm size by no. of employees		
Activities	10-19	20-99	≥100
we defined common goals and strategies	71.0	75.5	82.8
we defined a clear project leadership	77.4	70.9	85.1
we defined clear cuts between the competencies	71.0	69.1	85.1
clear sharing of costs/risks of the product development	67.7	57.8	66.7
we evaluated the project internally	54.8	50.9	71.3
we negotiated a formal contract	58.1	38.5	63.3
we defined a clear distribution of the financial returns	54.8	43.6	48.3
we used project management methods	48.4	35.5	37.8
we evaluated the project externally	29.0	31.5	42.1

Source: tip Innovative Firm Networks Survey

The following observations can be made:

- ◊ The awareness of the first three activities (*common goals and strategies*, *project leadership* and *clear cut between the competencies*) is high across firm sizes. More than 80% of the large firms and more than 70% of the small firms have undertaken these activities.
- ◊ A not very significant difference between small and large firms show the data with regard to *sharing of costs/risks of the product development*. Moreover, compared with the larger firms a higher percentage of the small firms (67.7%) indicated this activity which can be interpreted as a high awareness of the costs and risks of co-operative projects within smaller firms. But the most surprising result is concerned with the *use of project management methods*: while 48.4% of the small firms use project management methods less than half of the large firms (37.8%) are aware of these kinds of methods.
- ◊ The culture of evaluating the project is highly developed even in small firms: more than half of the small firms (54.8%) evaluated the project internally and 29% evaluated the project externally.

To summarise, if we look at the activities related we only find combinations of the four activities ranking on the top in Figure 5. Most of the firms are aware of a clear strategy, the definition of common aims as well as a clear definition of the competencies between the partners.

6.3.3 Reputation and trust

An important aspect of the qualitative links between firms is the existence of trust. Co-operation must have a *social basis* (Dodgson, 1996), involving affinity and loyalty. Given the social basis of inter-firm co-operation, the quality of the relationships between partners has obvious implications for the outcomes. It is a well known fact that the most important determinants of these relationships are trust or confidentiality, reputation of the partner and fairness. A wide range of studies has shown how intensive inter-firm links and learning between partners depend on high levels of trust. Lundvall (1988), for example, argues that in order to overcome the inevitable

uncertainties in jointly developed product innovations, "[...] mutual trust and mutually respected codes of behaviour will normally be necessary".

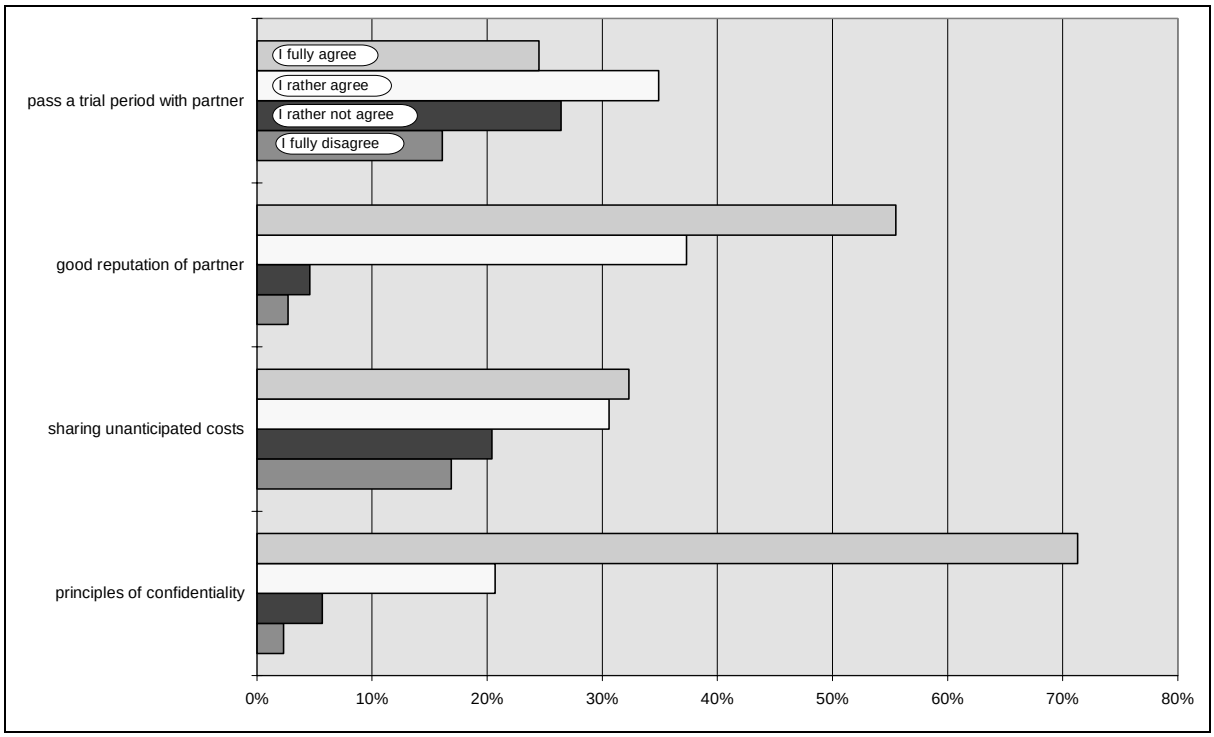
Question (8A)	I will now list some statements concerning co-operation in product development. Please indicate on a scale from 1 to 4 if you agree with the statement or not (1=I fully agree ... 4=I fully disagree).
Statements	A) It is necessary to pass through a trial period with our partner before committing substantial resources to collaborative development. B) To commit ourselves to collaboration a good reputation of the partner is essential C) We can depend on our partner to act fairly in sharing unanticipated product development costs. D) We have confidence that our partner will always respect the agreed principles of confidentiality.

The following Figure 6 shows quite interesting results: more than 70% of all co-operating firms fully agree that trust and confidentiality is a very important requirement for co-operation. Compared with this result only 24% of all co-operating firms consider the necessity of passing a trial period with the partner before committing substantial resources to collaborative development being important. Hence, a high level of trust (or mistrust) between the contracting partners is perceived *ex ante.* If the partners have confidence in each other from the outset, trust prevails in their mutual commitment. It is clear that the attitude of *ex ante* trust is more or less a matter of history, of past experience and of the reputation of the partners. As a consequence, Figure 6 also shows that 55% of the firms indicated that reputation of the partner is very important. The analysis of the activities in the previous chapter shows that most of the firms do have a rather clear picture of the aims and strategies as well as of the competencies of the co-operating partners. It seems that mistrust is less the more definable and well structured the co-operation is established. Figure 5 also shows that only half of the firms negotiated a formal contract. This can be interpreted as a certain extend of mutual trust and confidentiality.

Inherently co-operations are highly dominated by cultural affinities and social settings. The importance of the background is strongly emphasised in the literature. Freeman (1991) argues: "Personal relationships of trust and confidence (and sometimes of fear and obligation) are important both at the formal and informal level [...] For this reason cultural factors such as language, educational background, regional loyalties, shared ideologies and experiences and even common leisure interests continue to play an important role in networking. "

A number of reasons can be suggested to explain why high trust facilitates effective inter-firm co-operation (Dodgson, 1996). The first relates to the sort of knowledge being transferred, which is often tacit, uncodified, firm-specific and more or less commercially sensitive. It is therefore not immediately transferable and requires some dense and reliable communication paths. Partners are expected to share trust in each other's ability to provide valid and helpful responses to uncertainty. Furthermore they are trusted not to use this information in ways which may prove disadvantageous to partners.

Figure 6: Reputation and trust [% of all firms]



Source: tip Innovative Firm Networks Survey

A second reason relates to time scale of successful inter-firm links. Trust facilitates continuing relationships between firms. Continuity is highly valuable because the objective of inter-firm co-operation may change over time, for example, when entering new markets or new technological opportunities. Furthermore, it is only within a long-term horizon that reciprocity in collaboration can occur - trust militates against opportunistic behaviour. In underlining these theoretical findings the analysis of the data exhibit that within every group of co-operation partners the co-operations in repetition outweigh those which are for the first time.

The third reason for high trust in co-operation reflects the high management costs of such linkages. Selecting a suitable partner and building the dense communication paths through which information can be transferred requires considerable management costs, both real and opportunity costs. Trust between firms has to exist on a general as well as on a personal level. It has to be engrained in organisational routines, norms and values. Such features are not costless, and having made the effort to build a strong relation to a partner, jeopardising them through a lack of trust is not a sensible option.

6.3.4 Problems within co-operations

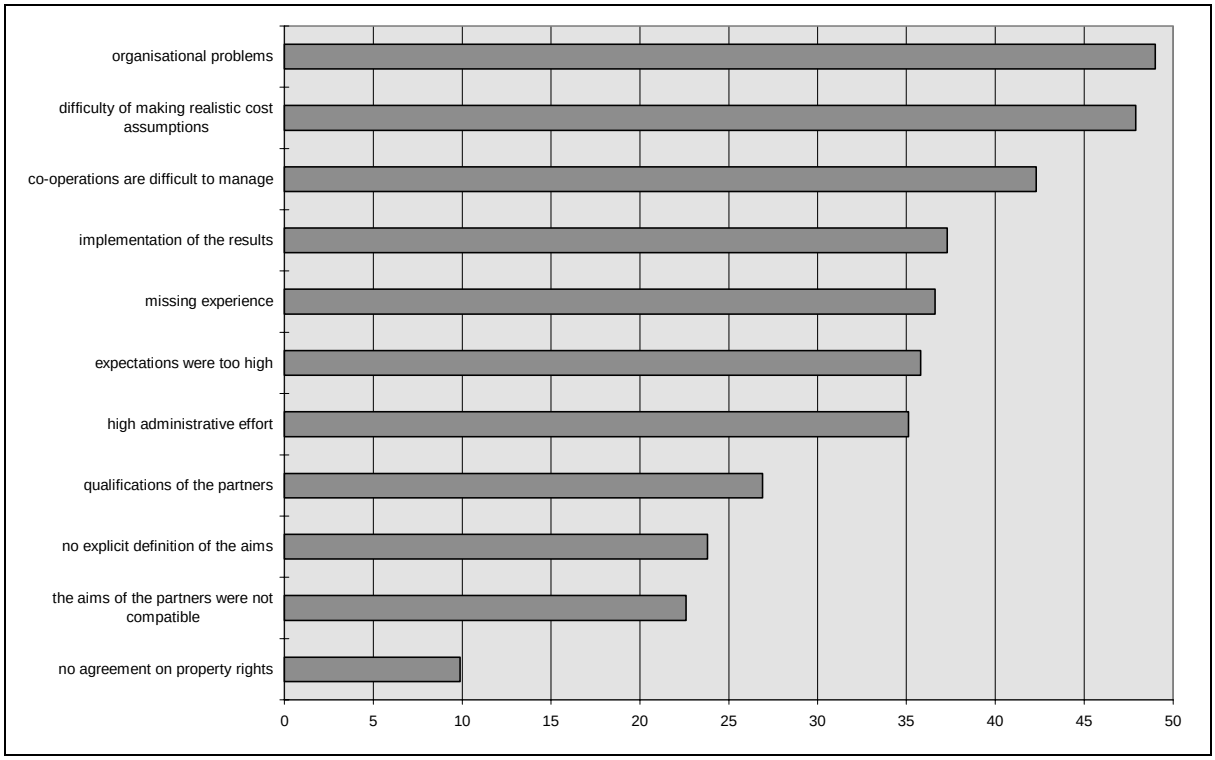
An important *soft factor* which turns into being rather a hard factor in *real life* are problems emerging in inter-firm co-operation. It was therefore asked which of the listed problems occurred during the collaboration.

Question (8B)	I will now list some possible problems concerning co-operation. Please indicate which of the

Answer categories	problems occurred in your co-operation. – organisational problems – qualifications of the partners – co-operations are difficult to manage – high administrative effort – missing experience – expectations were too high – no explicit definition of the aims – the aims of the partners were not compatible – difficulty of making realistic cost assumptions – implementation of the results – no agreement on property rights

In analogy with the previous analysis, Figure 7 shows that most of the firms perceive organisational issues rather than structural problems (e.g. *no explicit definition of the aims* or *incompatibility of aims between the partners)* as the main problems. This means that as soon as firms become clear about their own aims and strategies and the utility of co-operation in achieving the aims these rather basic problems - compared with other problems - do not matter any more. It is self-evident that organisational problems or difficulties of how to manage the co-operation can not be foreseen to the whole extent. Another interesting result is - contrary to common expectations - that only 10% of the firms have indicated that agreement on property rights were problems in the collaboration.

Figure 7: Problems within co-operations [% of all firms agreeing to the item]



Source: tip Innovative Firm Networks Survey

A different result emerges from analysing the indicated problems in relation: the problems indicated together are *difficulties to manage the co-operation* with *difficulties in making realistic cost assumptions*. Another problem indicated in combination with the first two is *implementation of the results*.

A central question in this context is how the listed problems are related to firms with different sizes. Hence one can expect that organisational problems are mainly problems of small firms while large firms have more experience with co-operation or are better equipped in order to avoid most of the problems. The following Table 15 provide detailed information about the assessment of different problems due to firm size.

Table 15: Problems within co-operations by firm size [% of firms by size class agreeing to the item]

	Firm size by no. of employees		
Problems	10-19	20-99	≥100
organisational problems	51.6	48.6	48.8
difficulty of making realistic cost assumptions	25.8	46.7	54.5
co-operations are difficult to manage	32.3	37.0	49.6
implementation of the results	32.3	37.3	38.5
missing experience	35.5	36.7	36.9
expectations were too high	29.0	35.5	37.7
high administrative effort	22.6	34.4	39.0
qualifications of the partners	25.8	26.6	27.4
no explicit definition of the aims	29.0	19.6	26.0
the aims of the partners were not compatible	32.3	18.5	23.8
no agreements on property rights	16.1	4.7	12.9

Source: tip Innovative Firm Networks Survey

- ◊ As one can expect the item with the highest agreement of small firms are *organisational problems* (51.6%), although the percentage does not differ very much to the percentage of larger firms (48.8%). Related to this rating 32.3% of the small firms indicated that co-operations were *difficult to manage*. Yet, half of the large firms had difficulties with the management of co-operations.
- ◊ An astonishing result can be seen that only one third of the small firms agree to *missing experience* as a problem. Compared with this result the problem seems to be more relevant for firms of the two higher size classes. Hence, the argument that small firms are very often confronted with missing experience in co-operation does not seem valid.
- ◊ The difficulty of making *realistic cost assumptions* are for 25.8% of the small firms seen as a problem. However, the number of percentage increases to 54.5% of the large firms which possibly is due to the fact that large firms are more involved in bigger and riskier co-operation projects where to make realistic cost assumptions are rather difficult.
- ◊ Only 25.8% of the small firms have problems with the *qualifications of the partner* whereas 27.4% of the large firms indicated this problem.
- ◊ Related to the management of co-operation the problem of a *high administrative effort* is seen as rather low by small firms. 22.6% of the small firms indicated this problem while nearly 40% of the larger firms have problems with the administrative effort.

To summarise, problems accompanying co-operation are not focused mainly on the partner (such as qualification) or expectation not fulfilled by the partner, but rather affect organisational issues and characteristics inherent to collaboration. The analysis of the data concerning firm size does not show any significant problem for small firms, beside the 51.6% of small firms facing organisational problems as the main problem of co-operation. Hence, on the average all firms are making realistic assumption of the adventure of co-operative product development projects. There are no significant differences between small and large firms.

6.3.5 Results and by-products of co-operation

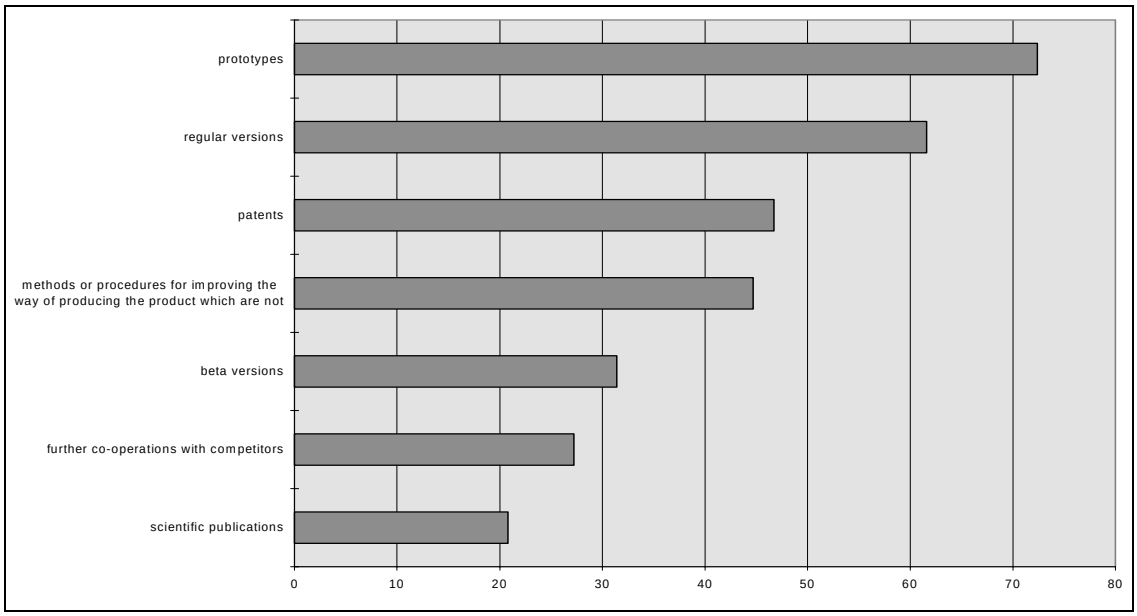
Product development was the pre-condition for carrying out the interviews. At the beginning of the survey it was therefore asked if the firms had developed one or more products and if the firm had co-operated in the development. Beside the product development there can be other by-products such as scientific publications or patents. The following question of the survey asked for these by-products.

Question (9A)	I will list now some consequences and by-products resulting from co-operation in product development. Please indicate, which of these occurred in your co-operation.
Answer categories	– further co-operation with competitors – beta versions – regular versions – prototypes – patents – scientific publications – methods or procedures for improving the way of producing the product which are not documented in blueprints, patents or other means

The following Figure 8 shows a clear-cut result.[41] More than 72% of all firms indicate that prototypes were one of the results, surprisingly 46% of firms indicated a patent application as a by-product of their collaboration.

[41] The figure has to be read as follows: hundred per cent comprise those firms who indicated either yes or no for each of the items, i.e. those who didn't give any answer are not included.

Figure 8: By-products of co-operation [% of all firms agreeing to the item]



Source: tip Innovative Firm Networks Survey

A high percentage of firms (44%) indicate that the collaboration resulted in *new methods and procedures not easily transferable*. This result can be understood as a hint that knowledge which is not easily transferable, i.e. tacit knowledge, matters in co-operation. However, the role of tacit knowledge as a well known but also hard to measure fact will be analysed in more detail in the following section.

From these aggregated results it is interesting to look if there are significant differences between small and larger firms. Hence one can expect that scientific publications or patents are mainly the results of the co-operation of larger firms. The following Table 16 provides detailed information about the assessment of different problems due to firm size.

Table 16: By-products of co-operation by firms size [% of firms by size class agreeing to the item]

	Firm size by no. of employees		
By-products	10-19	20-99	≥100
prototypes	67.7	70.8	75.2
regular versions	53.6	59.3	65.7
patents	25.8	47.2	51.7
methods or procedures for improving the way of producing the product which are not documented in blueprints, patents or other means.	40.0	38.1	51.7
beta versions	29.6	33.3	30.3
further co-operations with competitors	29.0	28.3	25.8
scientific publications	3.3	16.3	28.9

Source: tip Innovative Firm Networks Survey

- ◊ The most significant difference of size classes exhibit the item *patents* and *scientific publications*. Although one quarter of the small firm have a *patent* application as a result of the co-operative product development more than 50% of the bigger firms indicated this item.
- ◊ *Scientific publications* can not be seen as a common by-product of small firms. Only one firm mentioned that a scientific publication was one of the results of the co-operation.
- ◊ Another interesting result can be seen in the item *further co-operation with competitors*: Table 11 has already shown that a higher percentage of small firms co-operated with competitors. Due to this finding some of the small firms are interested in further co-operation with competitors.
- ◊ If the item *methods or procedures for improving ...* is taken as a hint for the role of tacit knowledge as an important knowledge transfer during co-operation, this kind of knowledge is more or less equally important for all size classes.

6.3.6 Tacit knowledge

The last sections showed that innovative activities involve a great deal of interaction with external sources of knowledge and experience. As a consequence of the change in the process firms organise innovation, the understanding of innovation also changes. Compared with the understanding of innovation as a linear process with a series of sequential steps, the systems approach focuses on the interactive links between different stages and the composition of these linkages. In this approach innovation depends on knowledge and the assimilation of information through learning and co-operation. Tacit knowledge is thus an important element in this process.

A central issue in any discussion about tacit knowledge is how it is defined and what are its key dimensions and attributes. This is due to the very reason that tacit knowledge is so difficult to define and quantify. It is generally accepted that tacit knowledge is non-codified, disembodied know-how that is acquired via the informal take-up of learned behaviour and procedures. Learning in an unstructured or semi-structured way is a key element within tacit knowledge acquisition and transfer (Howells, 1994).

It has become increasingly acknowledged that the contribution of innovation to growth and economic performance is not just simply associated with embodied technologies, such as new plants and equipment, but is also highly depended on disembodied, intangible assets and working practices. In co-operations not only formally codified knowledge but also skills, experience and know-how, embodied in persons, are transferred. Given that tacit knowledge is largely person-embodied, personal relationships are vital elements of the innovation process. Due to the fact that tacit knowledge is informal and non-tangible in character it still has been largely neglected in the context of research and policy formulation. Yet a major reason why this has been the case is that tacit knowledge still remains a rather vague concept and extremely difficult to measure and evaluate.

For these reasons, the following three questions of the survey try to tackle this phenomenon by asking about the appropriate method to transfer the knowledge and if an exchange of employees during the co-operation took place.

Question (9B)	In your opinion, what is the most useful way to transfer the relevant know-how to other possible co-operation partners.
Answer categories	– exchange of personnel – internal training – workshops – others:... – Don't know/No answer

Question (10)	During the course of the collaboration did one or more of your employees spend time and work in the company of your collaboration partner?
Answer categories	– Yes – No – Don't know/No answer

Question (11)	During the course of the collaboration did one or more employees from the collaboration partners spend time and work in your company?
Answer categories	– Yes – No – Don't know/No answer

Know-how transfer requires personal interaction through exchange, training, seminars, etc. Since by its very nature tacit knowledge cannot be written down, it must be acquired by learning and experience, it is thus person-embodied or organisation-embodied. Hence it is very delicate to communicate it to others. One way to benefit from this kind of knowledge is through human mobility and the exchange of personnel during co-operations. This is an important instrument for dissemination of knowledge. Yet, despite the contribution to the competitive edge of companies the assumption exists that this kind of exchange is not very much part of the Austrian culture. The results of the survey put light on this assumption.

Table 17 shows that 45.2% of the firms answered that the relevant know-how is transferable to other possible co-operation partners through workshops. On the other hand 19.4% answered that exchange of personnel is the best method for transferring knowledge. To be able to estimate this results as rather high or low the findings have to be compared with the surveys of the other participating countries which are not yet available.

Table 17: Knowledge transfer

Knowledge transfer through...	per cent of firms
exchange of personnel	19.4
internal training	16.0
workshops	45.2
others	8.4
don't know/no answer	11.0

Source: tip Innovative Firm Networks Survey

The results show that the knowledge built-up through co-operation is not really tacit by its very nature. Answering that the knowledge is best transferable by workshops means that aspects of it can be codified and hence one

has to take a broader view of tacit knowledge. However, 19,4% of firms answering that the knowledge is best transferable through personal exchange give a hint to pure tacit knowledge which does not have the potential to be codified.

Since in most cases knowledge cannot be obtained from codified information alone, the most effective means of linking different activities in the innovation process is often through direct contacts between knowledgeable individuals. In this context the person-to-person contact is a crucial element in the dissemination and acquisition of tacit knowledge. The following Table 18 and Table 19 show the percentage of firms which exchanged personnel during the co-operation.

Table 18: Exchange of personnel

Personnel working in the firm of the partner.	per cent of firms
Yes	28.9
No	70.3
Don't know/No answer	0.8

Source: tip Innovative Firm Networks Survey

Table 19: Exchange of personnel

Personnel from the partner working in the own firm.	per cent of firms
Yes	35.9
No	62.9
Don't know/No answer	1.2

Source: tip Innovative Firm Networks Survey

It is not an easy task to position and evaluate the share of firms dealing with exchange of personnel. Hence, the data have to be compared with the results of the survey of the other countries.

Anyway, the results of the tables above indicate that the distinction between tacit and codified (or articulated) knowledge must be treated with great caution (Senker et al., 1996). Polanyi (1966), whose work has influenced and still drives the discussion about tacit knowledge to a large extent, has pointed out that these two cannot be sharply distinguished. While tacit knowledge can be possessed for its own, explicit and codified knowledge must rely on being tacitly understood and applied. Hence, all knowledge is either tacit or rooted in tacit knowledge.

Therefore it does not lead to a well defined result thinking about to which degree the assimilated knowledge through co-operation consists of tacit or codified knowledge. In the context of knowledge transfer it is more interesting to look at the ability of firms to apply assimilated knowledge to productive uses and to analyse the aspects to be taken into account concerning co-operative behaviour. Thus for innovative firms it is very important to have the ability to recognise the value of new information, to assimilate, it and to apply it to a commercial end. This leads to the concept of *absorptive capacity* which will be analysed in more detail in the following section.

6.3.7 The impact of R&D

The following three questions of the survey are related to the idea that each firm open for co-operation has the ability to recognise the value of new, external knowledge, to assimilate it and apply it to get an innovative output. This ability has to be shaped and created and is closely related to the already existing stock of knowledge. The ability to evaluate the utility of outside knowledge and hence the capabilities of a partner are largely dependent on specific capabilities of the firm. At the most fundamental level this comprises basic skills or even a shared language but it may also include knowledge of the most recent scientific or technological developments in a given field. These abilities collectively constitute what Cohen and Levinthal (1989, 1990) have called *absorptive capacity*. They have shown that firms conducting their own R&D are more capable to use external available information and thus are more open for co-operation. This implies that absorptive capacity may be created as a by-product of a firm's R&D investment. Another by-product is this approach itself: while economists conventionally think of R&D as generating a product of one single kind, namely knowledge, this approach suggests that R&D not only generates new information, but also enhances the firm's ability to assimilate and exploit existing information.

The following questions were asked in the survey:

Question (12) Answer categories	Has your company a R&D department or not? – Yes, our company has a R&D department. – No, it has not. – Don't know/No answer.

Question (13) Answer categories	Did co-operation in product development included any co-operation in R&D or not? – Yes, it included some co-operation in R&D. – No, it didn't. – Don't know/No answer.

Question (14) (only relevant if the previous question was answered 'yes') Answer categories	What was the impact of the co-operation in R&D? Did the expenditure of R&D increase, diminish or remain unchanged? – R&D expenditure increased – Remained unchanged – R&D expenditure diminished – Don't know/No answer

The following tables show some highly confirming results which lead to the assumption that investing in R&D has an impact not only on innovative but also on co-operative behaviour. It is shown that a huge percentage of innovating and co-operating firms do have a R&D department which leads us to the assumption that R&D does not only generate new knowledge but also contributes to the firm's absorptive capacity, i.e. to its incentives to learn and to its ability to exploit related external knowledge. Looking at the distribution of firms with a R&D department across the size classes exhibit that a quite high percentage of the small firms (28.1%) have an R&D department. Moreover, more than three quarters of the larger firms confirmed the existence of a R&D department.

Table 20: R&D department [#, % of the total by size class]

R&D department	no. of firms	% of total	10-19 (#, %)	20-99 (#, %)	≥100 (#, %)
Yes	153	57.1	9 (28.1)	50 (44.6)	94 (75.8)
No	114	42.5	23 (71.9)	61 (54.5)	30 (24.2)
Don't know/No answer	1	0.4	-	1	-

Source: tip Innovative Firm Networks Survey

Table 21: R&D co-operations [#, %]

R&D co-operation	no. of firms	per cent
Yes	87	33.0
No	172	65.2
Don't know/No answer	5	1.9

Source: tip Innovative Firm Networks Survey

Table 22: Impact on R&D expenditure [#, %]

R&D expenditure	no. of firms	per cent
increased	33	37.9
remained unchanged	33	37.9
diminished	8	9.2
Don't know/No answer	13	14.9

Source: tip Innovative Firm Networks Survey

Before going into detail, the fact that a high percentage of co-operating firms do have a R&D department should be discussed in more detail. This is even more interesting when put into the context of theoretical findings.

As already indicated in the theoretical chapter, economists (e.g. Nelson, 1959, Arrow, 1962) have argued that research spillovers diminish firms' incentives to invest in R&D by undermining the appropriability of returns of inventive activities. It has been argued that technological knowledge is a public good and its effects are thought to be costlessly realised by all firms. Whenever in this tradition the costs of knowledge transfer is mentioned, it is typically identified with imitation costs. In suggesting that technological knowledge is a public good, Arrow did not deny the existence of such costs, but argues that typically they are small relative to the costs of creating new knowledge.

Cohen and Levinthal (1989) picked up this argument by asking the question of what determines these imitation costs of assimilating technological knowledge. Thus, they argue, that rather than receiving new knowledge as a free gift firms must invest resources in the *absorptive capacity* necessary to understand the results of the external spillovers. Hence, the long-run costs of learning may be substantial. Most of these costs are borne via the development of a stock of prior knowledge that constitutes the firm's *absorptive capacity*. They further argue that a significant benefit of R&D is its contribution to this knowledge base. Therefore, the incentives to learn should also influence R&D spending.

Hence, the firm's own R&D plays a twofold role: First, the firm generates new knowledge directly through its own R&D, and second, external knowledge, obtained from competitors or other co-operation partners (as well as extraindustry sources such as universities or contract research organisations), also contributes to the firm's

knowledge base. A central feature is that the firm's *absorptive capacity* determines the extend to which external knowledge is utilised whereas this *absorptive capacity* itself depends on the firm's own R&D.

It should therefore be analysed if firms that conduct R&D do have an increased ability to exploit external knowledge, i.e. to observe that firms with a R&D department have more external linkages than firms that do not conduct R&D systematically. The survey provides further evidence: while firms without a R&D department indicated 2.8 co-operation partners on the average, firms with a R&D department indicated 4.2 partners.

This interaction signifies that a firm is less able to adopt external knowledge passively as long as there is little attempt to carry out R&D systematically. In most of the cases firms invest in their *absorptive capacity* by conducting R&D in order to utilise knowledge and know-how of co-operation partners.

Another interesting result is shown in Table 21 by indicating that a high percentage of co-operating firms were co-operating in R&D as well. Table 21 shows that 87 firms, which are 56% of the firms which have a R&D department, carried out co-operation in R&D during the product development. Even one cannot say to what extent co-operation in product development is induced by the existence of a R&D department or by co-operation in R&D, the result sheds light on co-operation in general. It is often said that spillovers have a deterrent effect on R&D. A firm's incentive to invest in R&D is diminished to the extent that any findings from such activities are exploited by competitors and thereby diminish the innovators own profit. However, in analysing the data and looking at the close relationship between co-operation in product development and R&D, respectively, spillovers are far less a problem. Knowledge, characterised by its tacit, sticky or whatever nature, becomes far more a private good. Thus, the negative appropriability incentive associated with spillovers is counterbalanced by a positive absorptive-capacity-building incentive. The more useful external knowledge, i.e. the more possible partners with "co-specialised assets" (Cohen, 1995) exists, the more incentive the firm has to invest in its own R&D, which permits it to exploit those spillovers.

Hence, it is quite difficult to see spillovers *per se.* Spillovers should be understood in their strategic nature. If it is assumed that firms purposefully invest in R&D or co-operate in product development in order to generate profits, it can be considered that it is not the amount of return that others get but the amount that the innovator receives. As long as there are good reasons to expect that the return received by the innovator will satisfy opportunity costs criteria, the benefits that flow to others are irrelevant to the decision to invest in R&D, to co-operate in R&D or to co-operate in product development, respectively.

Another interesting issue is that an *episodic view* on product innovation can be misleading. Although the launch of a new product may well identify an innovative activity, it is probably more realistic to consider that firms continuously innovate, launching a continuos flow of new products. A clear distinction can be found between firms with a R&D department and firms without such department. As Table 23 shows, 83% of the firms with a R&D department introduced more than one product during the last two years. Whereas only 62% of firms without a R&D department indicated the introduction of more products. Firms then primarily differ in terms of the rate of flow of innovations generated and introduced.

Table 23: Product development related to R&D [in %]

Development of...	R&D department	no R&D department
one product	17	38
more products	83	62

Source: tip Innovative Firm Networks Survey

6.4 Module 4 - Collaboration in development of additional services

Analogous to the question concerning product development, the companies were asked whether they had developed alone or in collaboration with others additional intangible services supplied in connection with tangible products. If so, the company was asked which collaboration partners had participated. However, this question was also asked to firms who have answered earlier that they had not developed products at all and who therefore had not been asked for collaboration partners earlier. In order to make sure that the interview partner understood the concept of service in the augmented product, it was explained to him or her.

The following questions were asked:

Question (15)	When an industrial company sells a product, it also often supplies the customer with a range of more intangible services, such as free service checks, user training and so on. Within the last two years has your company - alone or in conjunction with others - developed one or more new services which are supplied in connection with new products?
Answer categories	– Yes – No – Don't know/No answer

Question (16)	Where there instances where this service development took place in collaboration with others?
Answer categories	– Yes – No – Don't know/No answer

Question (17)	Which collaboration partners were involved in this development project?
Answer categories	– private customers – government customers – supplier of materials and components – suppliers of equipment – your own parent company or one of your subsidiaries – technical institutes – other private laboratories – marketing, management, legal or other private consultants – suppliers of technical services, testing, controlling, standardisation or equivalent – universities or other research institutes – others...

Table 24 and Table 25 show that 25% of the 1,006 contacted companies had developed this kind of service and among these 41% had collaborated with others during this development. This result is quite similar to the results from the Danish DISKO project: in their survey 22% of the companies had developed augmented products and among these 47% had co-operated.

Table 24: Development of additional services [#, %]

augmented products	no. of firms	% of total (N=1006)
Yes	252	25.0
No	617	61.4
Don't know/No answer	137	13.6

Source: tip Innovative Firm Networks Survey

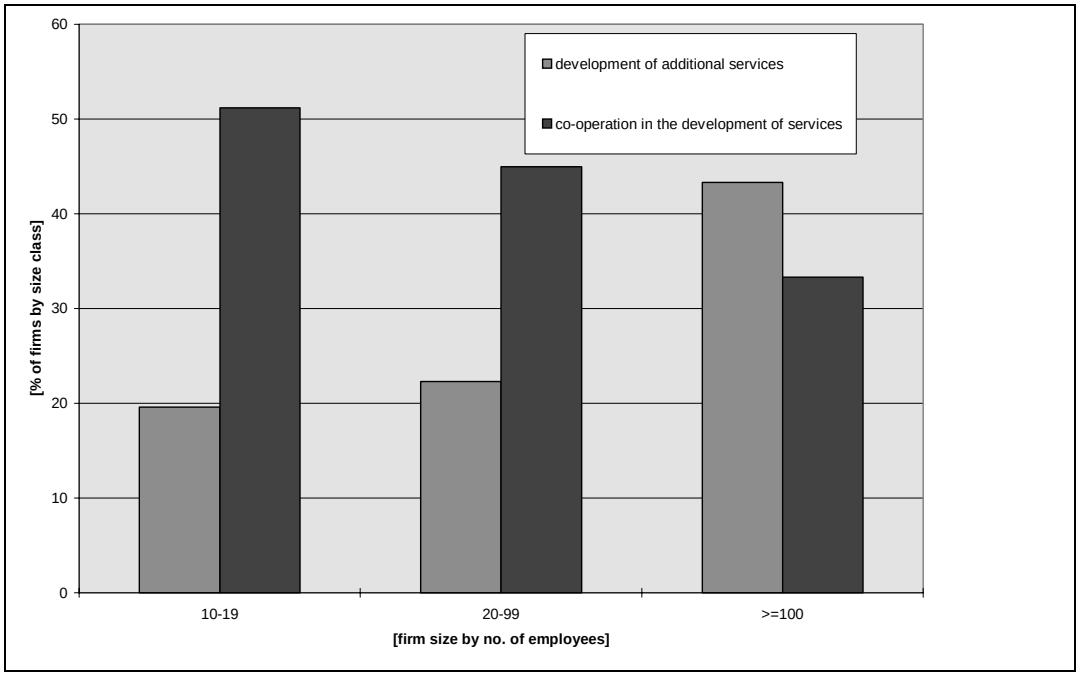
Table 25: Co-operation in the development of additional services [#, %]

co-operation	no. of firms	% of total (N=252)
Yes	103	41.0
No	145	57.8
Don't know/No answer	4	1.2

Source: tip Innovative Firm Networks Survey

In analysing the result in more detail the following conclusion can be drawn (without being documented in a table): 42% of the firms which had product innovation had developed additional services as well, whereas 14% of the firms which had not developed one or more products indicated the development of additional services.

Figure 9: Development of additional services and co-operative behaviour by size of firms [in %]



Source: tip Innovative Firm Networks Survey

Similar to the analysis of product development, Figure 9 shows the distribution of firms across size classes. The figure exhibits the distribution of firms across size classes according to innovation as well as to collaboration intensities.

The development of additional services related to the size classes looks similar to the distribution of firms which developed products, i.e. a positive relationship between development and size of firms can be estimated. However, an analysis of the collaboration intensities shows that co-operative behaviour is negative related to the distribution of innovative firms. While 20% of the small firms indicated the development of services the number increases to 43% related to larger firms. Concerning service development in co-operation with others the relationship is inverted. Thus, more than half of the smaller firms co-operated and only 33% of the larger firms. The following Table 26 provides an overview of the indications of co-operation partners. As multiple indications were possible the figures are based upon the total numbers of reports and may thus be best considered relative to the other types of co-operation partners.

Table 26: Co-operation with different partner categories [#, %]

	All co-operation partners	Foreign partners
Partners	# of firms (% of all innovative firms N=252)	# of firms (% of all innovative firms N=252)
private customer	37 (14.7)	20 (7.9)
supplier of materials and components	22 (8.7)	15 (6.0)
your own parent company or one of your subsidiaries	21 (8.3)	15 (6.0)
government customers	20 (7.9)	5 (2.0)
universities or other research institutes	19 (7.5)	6 (2.4)
suppliers of equipment	17 (6.7)	9 (3.6)
technical institutes	14 (5.6)	9 (3.6)
suppliers of technical services, testing, controlling, standardisation or equivalent	14 (5.6)	6 (2.4)
other private institutes	10 (4.0)	4 (1.6)
marketing, management, legal or other private consultants	9 (3.6)	4 (1.6)
others	19 (7.5)	-

Source: tip Innovative Firm Networks Survey

Table 26 shows that co-operation with *private customers* are ranked first followed by *suppliers of materials and components*. The result is quite similar to the co-operative behaviour in product development with co-operations mostly along the value-chain. The high percentage of *others* is due to the fact that the question was asked as an open question.

6.5 Module 5 - General questions

Three questions of a more general nature were posed at the end of the questionnaire. In the first question the interview partner was asked to what extent the relation to other Austrian firms has changed within the last three years. The same questions was asked concerning the relation to foreign firms. Further the company was asked to estimate to what extent the "climate of competition" has changed within the last years. Like the questions

about the development of augmented products the general questions were posed to all firms, independent if they have developed one or more products or not. This will show different estimations of the co-operative behaviour of the firms.

Question (18) Answer categories	To what extent has your company developed closer relations with Austrian companies within the past 3 years? – collaboration intensity has become more intensive – collaboration intensity has not changed – collaboration intensity has declined – don't know/no answer

Question (19) Answer categories	To what extend has your company developed closer relations with foreign companies within the past 3 years? – collaboration intensity has become more intensive – collaboration intensity has not changed – collaboration intensity has declined – don't know/no answer

Question (20): Answer categories	In your opinion, in what way has competition from other companies changed over recent years? – competition has become much sharper – unchanged – competition has declined – don't know/no answer

The following Table 27 summarises the result of the first two questions with a rough estimate of the co-operation intensities. It reveals that about one third of the firms (N=1,006) assess the co-operation intensity with Austrian firms as having become more intensive while over half of the interviewed firms answered that collaboration intensity has remained unchanged. Even more interesting is the result with regard to foreign partners: nearly 42% of the firms answered that the co-operation intensity with foreign firms has become more intensive. The same percentage of firms answered that the co-operation intensity with foreign partners has not changed during the last three years.

Table 27: Assessment of co-operation intensities [in per cent]

collaboration intensity	with Austrian firms	with foreign firms
more intensive	31.6	41.9
has not changed	53.7	41.1
has declined	8.1	6.3
don't know/no answer	6.7	10.7

Source: tip Innovative Firm Networks Survey

The distribution of the answers concerning the last question is shown in Table 28.

Table 28: Assessment of competition [in per cent]

competition	per cent of firms
much sharper	81.8
not changed	13.1
declined	3.2
don't know/no answer	2.0

Source: tip Innovative Firm Networks Survey

It is interesting to look if there is a divergence in the general estimation of co-operative behaviour between innovative and non-innovative firms. The results confirm the assumption that there is a divergence as is shown in Table 29.

Table 29: Assessment of co-operation intensity by innovative and non-innovative firms [in %].

	Co-operation intensity has become more intensive...		Competition has become much sharper
	with domestic firms.	with foreign firms.	
innovative firms	37.8	54.4	87
non innovative firms	25.9	30.7	77

Source: tip Innovative Firm Networks Survey

- ◊ While 38% of innovative firms assess that the co-operative behaviour of their firm with Austrian companies has increased over the last 3 years, 26% of the non-innovative firms declared that co-operation has increased.
- ◊ Concerning co-operation with foreign firms the divergence is even higher: 54% of the innovative firms vs. 30% of the non-innovative firms assessed an increase of co-operation with foreign firms.
- ◊ The distinction between innovative and non-innovative firms can also be estimated concerning the question of competition: 87% of innovative firms vs. 77% of the non-innovative firms estimate that competition has increased in the last three years.

Table 30 shows the results of the questions related to the size of firms. The answers of the firms are distributed across the used firm-size-classes.

Table 30: Assessment of increased collaborative behaviour by size of firm [in per cent]

	collaborative behaviour has increased	
size of firm by no. of employees	with Austrian firms	with foreign firms
10-19	28.8	30.1
20-99	33.3	40.6
>=100	31.1	54.4

Source: tip Innovative Firm Networks Survey

The distribution shows quite clearly that the estimation of increased co-operation with Austrian firms is more or less equally distributed across firm-size-classes. Hence, there is no significant bias towards larger firms. A different results is related to the question of the assessment of collaborative behaviour with foreign firms: there is a clear bias towards larger firms. More than 54% of the large firms think that co-operation with foreign firms has increased within the last three years. However, the results have to be considered with caution: they do not regard

the fact that many Austrian firms are subsidiaries of large foreign firms and hence do have a given relation to their parent company.

7 Main findings

The prime objectives of this report were to give a short overview over the existing NIS-literature and approaches to the theory of firm and to analyse the data contained in the Austrian survey. Due to the fact that the report is the contribution to the OECD project most of the results have to be compared with the survey of the other participating countries in order to locate the findings, i.e. to estimate if some results can be seen as rather low or high. But the scope of this study is limited primarily by time and resources available. It is clear that much more can be undertaken with the data in the future.

The report touches a number of debates which have occurred in the literature and which are intensively discussed on a national as well as on international policy level. Insofar the study can make a small contribution to these discussions although the aspects of innovation and co-operations are not discussed to the extent they deserve.

In most countries, governments believe that the rate of technological change in their economy is sub-optimal and they are concerned with improving innovative performance. The EU, on the other hand, is interested in increasing the rate of innovation in Europe as a whole. The first major policy issue that arise, therefore, concerns what is currently limiting or constraining the level of innovative activity in individual countries and in Europe as a whole. This points out that the economic context can not described as static with stable technology, stable consumer preferences, and a stable *arena* of competition. In this context inter-firm co-operation solve a paradox faced by firms in a changing environment. On the one hand, in order to become more competitive or even to survive, firms must focus on their specific areas of competence and this limits the width of perception and interpretation. On the other hand, they must remain receptive to changes in the environment that might create new opportunities and threats. To resolve this, firms focus on their core activities while using relations with suppliers, customers, competitors and others as sources of competencies when the need for them arise. This *strength of weak ties* may well be as important for the producer as for the user.

The EU Green Paper on Innovation (European Commission, 1995) stresses the policy relevance of collaborative agreements by its expressed view that fostering co-operation can be seen as a way of promoting European competitiveness. It goes right in the view that innovation "[...] is the driving force which point firms toward ambitious long-term objectives" (EC, 1995). But emphasising the role of co-operation in the process of innovation has by no means to appeal on the "natural solidarity" (EC, 1995) of economic agents. As a general result, the present report holds the view that agreements between economic actors does not stimulate innovative activity *per se.* "Inter-firm collaboration for innovation is motivated by gain" (Smith et al., 1991). Although the data show that co-operative agreements are an integral part of the innovation process co-operation itself is not costless. It has to be managed with a clear view of the outcome. Collaboration depends very much on factors like trust and past experience as well as knowledge of the competencies of the partner.

It has to be point out from the outset that it is not possible to throw light on all of the wide ranging policy debate concerning the information flows between firms and co-operation partners. But the survey has provided considerable insights about the role of co-operation in the innovation process related to some firm specific aspects.

The rate of product innovation is comparatively low in Austria

44% of all contacted Austrian firms had developed one or more products within the last two years. Beside the 7.9% which did not answer, 48.1% had no product development. Compared with Denmark (54%) the rate of product innovating firms is lower in Austria.

Propensity to product innovation increases with firm size

One of the first specific results of the survey show the percentage of innovative firms across the different firm size classes. The data show a positive correlation between firm size and percentage of innovative firms. 31% of firms with less than 20 employees have introduced a product within the last two years, while this percentage increases to 70% for firms with over 100 employees.

Beside these results we tried to find a new form of analysis which is interesting from a methodological point of view. Hence, for illustrating the relation of the propensity to innovate to firms size we were confronted with the tradition of building arbitrary firm size classes. It can thus be statistically questionable to compare the share of innovative firms from different size classes with every size class consisting of a different number of firms. We therefore decided to find an alternative method although the results do not differ very much. With the method of beta-distributions we could show that over the range of firm size from 10 to 250 employees the probability of drawing a non-innovative firm is higher than the probability of drawing an innovative firm. Up to a firm size of 250 employees the estimated beta-distribution of the non-innovative firms exhibits a probability of unity. Hence, within this range all non-innovative firms are covered. Innovative firms therefore mainly lie in the sample with more than 250 employees.

Innovation is rarely a stand alone activity

The results of the survey bear evidence to the fact that firms rarely innovate alone. 62% of the product innovating firms in the survey had co-operated with one or more partners during the development. There is a discernible tendency pointing to the fact that (product) innovating firms are interacting with other organisations and with a multitude rather than with a single external partner. Hence, innovative firms use a variety of external sources of information and knowledge transfer. From these results it can be argued that innovations increasingly integrate several distinct technologies and depend on complementary knowledge sources. In consequence, more and more strategic know-how and competence is developed interactively which in turn challenges the firm to take the interactive character of innovation into account.

The data provides strong evidence in favour that the co-operation intensity rises with firms size although the dispersion of co-operative behaviour of the smallest size class and the highest size class is not as large as concerned with product innovation. 49% of the smallest firms (10-19 employees) and 70% of the larger firms (over 100 employees) do have co-operative arrangements. Thus, on the first view overall co-operative behaviour rises with firm size. This was also illustrated by estimating beta-distributions for these two sub-groups of innovative firms although the data also show that co-operative arrangements are important for small innovative firms.

But the relative importance of different partners also differ across firm sizes. This raises a number of interesting empirical questions. One is whether the overall level of co-operation differs between small and large companies. A second relates to whether the relative importance of different co-operation partners changes with company size. The data show with regard of some types of partners a rather monotonic relationship between co-operation intensity and firm size (universities, government customers). Other types of co-operation partners show no such relationship (competitors, private customers, contract research organisations). The analysis of the data also exhibit that co-operations within the country are most important. Nevertheless, there are significant information flows through co-operations with foreign partners. 42% of the firms indicated co-operation with foreign suppliers of materials and components and 36.5% indicated a relation with foreign private customers. The data show that a quite intensive domestic network goes hand in hand with, on average, a high co-operation intensity with foreign partners. Thus, it is important to see co-operation in an international context.

The majority of co-operating firms are aware of a clear strategy and are more oriented towards market-related goals

Due to the fact that firms have more than only one or two motives for co-operation it is rather difficult to draw a significant profile of co-operating firms. A division of the several motives in two groups (more market related motives and motives more focused on learning) show that motives indicated in combination are rather market-related than learning-related. Generally spoken, co-operation in product development is less motivated by learning from the partner but more straightforward oriented (in the last instance) towards market-related goals. Moreover most firms are aware of a clear strategy, the definition of common aims as well as a clear definition of the competencies between the partners. Whereas using management methods are not very common in the co-operations.

Reputation and trust play a crucial role for co-operative arrangements

More than 70% of the co-operating firms fully agree that trust and confidentiality is a very important basis for co-operation. Yet this kind of basis has to be built *ex ante*, before substantial resources are allocated to the common development project. As a rather logical consequence 55% of the firms indicate that the reputation of the partner is very important. This result leads to another finding in the survey: most of the problems within co-operations are not focused mainly on the partner (like qualifications) or expectations not fulfilled by the partner, but rather affect organisational aspects inherent to collaboration.

Additionalities in the co-operation for product development: prototypes, patents, and scientific publications

More than 72% of all answering firms indicate that prototypes were one of the results whereas 46% of firms indicated a patent application as a by-product of the collaboration (beside the product development as the main result of the co-operation). 22% of the firms indicated scientific publications as a by-product of the co-operation. However, a high percentage of firms (44%) indicate that the collaboration resulted in knowledge not easily transferable which can be understood as a hint that tacit knowledge matters in co-operation.

Dissemination of knowledge: Workshops, internal training, and exchange of personnel

Concerning knowledge transfer 45% of the firms answered that the relevant know-how is transferable to other possible co-operation partners through workshops. On the other hand 19% answered that exchange of personnel is the best method for the transfer of knowledge. Since by its very nature tacit knowledge cannot be written down, it must be acquired by learning and experience, it is thus person-embodied or organisation-embodied. Hence, one way to benefit from this kind of knowledge is through human mobility and the exchange of personnel during co-operations. This is therefore an important instrument for the dissemination of knowledge.

A high share of co-operating firms have a R&D department

57% of the innovative firms have a R&D department. This result indicates that investing in R&D has a considerable impact on innovation and co-operative behaviour. Moreover, one third of these firms had a R&D co-operation during the product development. The survey provides further evidence that firms with a R&D department have more external linkages than firms that do not conduct R&D regularly: while firms without a R&D department indicate 2,8 co-operation partners on average, firms with a R&D department indicate 4,2 partners. The data further show that R&D leads to a more continuously innovation behaviour: 83% of the firms which conduct R&D introduced more than only one product during the last two years, compared with 62% of the firms which do not conduct R&D.

Nearly half of all firms: co-operation intensity with foreign firms has increased

The data reveal that about one third of all contacted firms (N=1006) assess the co-operation intensity with Austrian firms as having become more intensive while over half of the firms (54%) answered that co-operation intensity has remained unchanged. Even more interesting is the result with regard to foreign partners: nearly 42% of the firms answered that the co-operation intensity with foreign firms has become more intensive. There is an interesting divergence between innovative and non-innovative firms concerning this question. While 38% of innovative firms assess that the co-operative behaviour of their firm with Austrian companies has increased over the last three years, 26% of the non-innovative firms declared that co-operation has increased. Concerning co-operation with foreign firms the divergence is even higher: 54% of the innovative firms vs. 30% of the non-innovative firms assessed an increase of co-operation with foreign firms.

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9 List of figures

10 List of tables

11 Questionnaire

tip questionnaire for the focus group **Networks of innovative firms**

P.F102.9708	**Version A** Fragebogen-Nr.: .....

Kontakterstellung:

Guten Tag mein Name ist ....., ich bin ein Interviewer des Marktforschungsinstitutes market. Könnten Sie mich bitte mit jemandem, der für die Produktentwicklung in Ihrem Unternehmen zuständig ist, verbinden? Danke.

ja 1

nein, der Kollege ist derzeit außer Haus/Besprechung ..... 2 Termin: .....

weiß nicht wer zuständig ist 3

---

1. Guten Tag, mein Name ist ..... Ich bin ein Interviewer des Linzer Marktforschungsinstitutes market und wir führen derzeit im Auftrag des Wirtschaftsforschungsinstitutes und des österreichischen Forschungszentrums Seibersdorf eine internationale wissenschaftliche Studie durch. Dabei geht es um Kooperationen von österreichischen Firmen, genauer gesagt um Kooperationen bei der Entwicklung neuer Produkte. Zu diesem Thema würden wir gerne auch jemanden von Ihrer Firma befragen. Das Interview dauert etwa 12 bis 14 Minuten. Ihre Daten bleiben dabei selbstverständlich geheim und werden streng vertraulich behandelt. Würden Sie mir bitte das Interview gewähren?

ja, jetzt gleich 1

ja, aber zu einem anderen Termin..... ..... 2 Termin: .....

nein, da ist jemand anderer zuständig..... ..... 3 Verbinden lassen und zu Fr. 1

nein, bin zwar zuständig aber zu keinem Interview bereit..... 4

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2. In dieser Untersuchung interessieren wir uns für Produktentwicklungen bei denen ein für Ihr Unternehmen in irgendeiner Weise neues Produkt entwickelt wurde. Dabei kann die Neuheit im Design, in der Konstruktion, in seiner Anwendbarkeit oder in sonst einer Art und Weise für das Unternehmen neu sein. Ich denke aber dabei nicht an lediglich kleine Produktänderungen oder kleine routinemäßige Anpassungen an Kundenwünsche. Auch die Entwicklung neuer Produktionsprozesse oder die Einführung neuer Produktionstechnologien oder Organisationsformen sind dabei nicht gemeint, sondern tatsächliche Innovationen von Produkten oder an Produkten. Hat Ihr Unternehmen - alleine oder in Zusammenarbeit mit anderen - innerhalb der letzten 2 Jahre ein oder mehrere neue Produkte entwickelt oder war das nicht der Fall? (**ACHTUNG INTERVIEWER:** Wenn das Unternehmen lediglich bei der Produktentwicklung anderer Unternehmen integriert war, also keine eigene Produktentwicklung durchgeführt hat, lautet die Antwort NEIN!)

ja, ein Produkt.....1

ja, mehrere Produkte 2

nein3.....zu Fr. 15 (Modul 4)

weiß nicht / keine Angaben.....4 * zu Fr. 3

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*3. Gibt es in Ihrem Unternehmen einen Kollegen oder eine Kollegin, die oder der uns diese Fragen beantworten kann? Könnten Sie mich bitte mit dieser Person verbinden? Danke.

ja ..... 1 zu Fr. 1

nein2..... zu Fr. 15 (Modul 4)

Modul 2: Zusammenarbeit bei der Produktentwicklung

4. Hat Ihr Unternehmen bei der Produktentwicklung der vergangenen zwei Jahre mit irgendeiner Institution, mit einem Kunden oder Konkurrenten oder ähnlichen zusammengearbeitet oder waren die Produktentwicklungen hauptsächlich oder ausschließlich das Ergebnis firmeninterner Abläufe?

Ja, es gab intensive Zusammenarbeit	1	weiter mit Fr. 5
nein, die Entwicklung geschah hauptsächlich intern	2	weiter mit Fr. 5
nein, die Entwicklung geschah ausschließlich intern	3	zu Fr. 15 (Modul 4)

5. Ich lese Ihnen jetzt ein paar mögliche Partner vor, die für eine Zusammenarbeit bei der Entwicklung neuer Produkte in Frage kommen. Sagen Sie mir bitte jedesmal, ob Sie mit diesem Partner in den vergangenen zwei Jahren bei der Entwicklung neuer Produkte zusammengearbeitet haben oder nicht.
ACHTUNG INTERVIEWER: Lesen Sie die möglichen Antworten vor: Wenn der Befragte einen als Partner nennt, dann fragen Sie nach:

Und waren das österreichische und/oder ausländische Partner?

Und haben Sie mit diesen zum ersten Mal zusammengearbeitet oder fand die Zusammenarbeit zum wiederholten Mal statt? In einer Zeile sind auch mehrere Angaben möglich!

	nein, kein Partner	ja, österreichischer Partner		ja, ausländischer Partner	
		Zusammenarbeit		Zusammenarbeit	
		erst-malig	wieder-holt	erst-malig	wieder-holt
private Kunden	1	2	3	4	5
öffentliche Institutionen	1	2	3	4	5
Zulieferer von Material und Komponenten	1	2	3	4	5
Zulieferer von Maschinen zur Produktentwicklung	1	2	3	4	5
Tochter- oder Mutterunternehmen Ihres Unternehmens	1	2	3	4	5
Kooperation mit Konkurrenten	1	2	3	4	5
Consulting-Unternehmen im Marketing-, Management-, oder Rechtsbereich	1	2	3	4	5
Anbieter technischer Dienstleistungen wie zum Beispiel Designbüros, Softwareentwicklung oder ähnlichen Universitäten	1	2	3	4	5
außeruniversitäre Forschungseinrichtungen (zB Forschungszentrum Seibersdorf, Joanneum Research)	1	2	3	4	5

Modul 3: Die Motivation zur Kooperation:

6. Ich nenne Ihnen jetzt ein paar Gründe, die ein Unternehmen zum Eingehen von Kooperationen bei der Entwicklung neuer Produkte haben kann. Welche dieser Gründe waren für Ihr Unternehmen bei den Produktentwicklungs-Kooperationen der letzten zwei Jahre besonders wichtig? Beginnen wir mit .....

um das Know-How des Partners zu nutzen.....1

um langfristige Zusammenarbeit zu schaffen und zu stärken 2

um den Zugang zu neuen Märkten zu ermöglichen oder zu erleichtern..... 3

zur Erhöhung des Marktanteils..... 4

zur Verkürzung der Entwicklungszeit..... 5

zur Steigerung des Umsatzes..... 6

um das Risiko bei der Entwicklung zu reduzieren 7

um die Kosten bei der Entwicklung zu reduzieren..... 8

um das Ansehen und Image verbessern.....9

um neue Methoden, Techniken und Praktiken zu gewinnen..... 10

um ein neues gewinnbringendes Marktsegment zu erschließen..... 11

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7. Um die Art und Weise der Kooperationen näher zu definieren lese ich Ihnen jetzt ein paar Dinge vor, die im Rahmen einer Kooperation erfolgen können. Bitte sagen Sie mir jeweils, ob Sie diese Sache im Rahmen der Zusammenarbeit getätigt haben oder nicht.

	wurde getätigt	wurde nicht getätigt
einen formalen Vertrag ausverhandeln.....	1	2
gemeinsame Ziele und Strategien definieren	1	2
klare Abgrenzungen zwischen den Kompetenzen definieren.....	1	2
eine klare Teilung der Kosten und Risiken der Produktentwicklung.....	1	2
Definition einer exakten Aufteilung der finanziellen Erträge	1	2
Definition einer klaren Projektleitung	1	2
Definition der verwendeten Projektmanagementmethoden.....	1	2
gemeinsame, interne Evaluierung des Projektes	1	2
gemeinsame, externe Evaluierung des Projektes	1	2

8A Ich lese Ihnen nun noch ein paar Aussagen zur Kooperation bei Produktentwicklungen vor. Bitte sagen Sie mir jeweils auf einer Skala von 1 bis 4 wie stark Sie diesen Aussagen zustimmen. Wobei 1 bedeutet, dem stimme ich voll und ganz zu, 2 bedeutet dem stimme ich eher zu, 3 bedeutet dem stimme ich eher weniger zu und 4 bedeutet dem stimme ich gar nicht zu.

Bevor substantielle Ressourcen für eine Kooperation im Rahmen einer Produktentwicklung eingesetzt werden, ist es notwendig eine Probezeit mit potentiellen Partnern einzugehen.....1/2/3/4

Die gute Reputation des Partners ist eine wesentliche Voraussetzung für eine Kooperation.....1/2/3/4

Wir können uns darauf verlassen, daß unvorhergesehene Produktentwicklungskosten mit unserem Kooperationspartner geteilt werden. 1/2/3/4

Wir können darauf vertrauen, daß unsere Partner die vereinbarten Prinzipien der Vertraulichkeit jederzeit einhalten.....1/2/3/4

8B Ich lese Ihnen nun mögliche Probleme im Rahmen einer kooperativen Produktentwicklung vor. Welche dieser Probleme sind bei Ihrer Produktentwicklungskooperation aufgetreten?

Beginnen wir mit .....

organisatorische Probleme..... 1

Qualifikation der Beteiligten..... 2

Kooperationen sind schwierig zu managen..... 3

hoher administrativer Aufwand..... 4

fehlende Erfahrung bei Produktionsentwicklungsprojekten..... 5

die Erwartungen waren zu hoch..... 6

keine explizite Definition der Ziele..... 7

Ziele der Partner waren nicht vereinbart..... 8

Schwierigkeiten die Kosten richtig einzuschätzen..... 9

Schwierigkeiten bei der Umsetzung der Ergebnisse..... 10

Einigung über Eigentumsrechte 11

9A Ich lese Ihnen jetzt mögliche Konsequenzen und Folgen vor, die sich aus einer Kooperation im Rahmen von Produktentwicklungen ergeben können. Bitte sagen Sie mir, ob diese Konsequenzen und Folgen vor, die sich aus einer Kooperation im Rahmen von Produktentwicklungen ergeben können. Bitte sagen Sie mir, ob diese Konsequenzen bei Ihren Produktentwicklungkooperationen in den vergangenen zwei Jahren eingetreten ist oder nicht.

	ja	nein
weitere Kooperationen mit Konkurrenten auf den Absatzmärkten.....	1	2
Betaversionen.....	1	2
reguläre Versionen	1	2
Prototypen	1	2
Patente	1	2
wissenschaftliche Veröffentlichungen.....	1	2
Methoden und Prozeduren für eine verbesserte Produktentwicklung, die nicht in Blaupausen, Patenten etc. dokumentiert sind.....	1	2

9B Was glauben Sie ist die beste Methode, um das relevante Know-How zu anderen Kooperationspartnern zu transferieren?

durch Austausch von Personal.....1

durch internes Training.....2

durch Workshops.....3

keine dieser Methoden ist die beste sondern.....4

weiß nicht/keine Angaben 5

10. Arbeiten im Rahmen der Produktionsentwicklungs-Kooperationen der vergangenen zwei Jahre ein oder mehrere Angestellte Ihres Unternehmens bei Ihrem Kooperationspartner oder war das nicht der Fall?

ja 1

nein2

weiß nicht, keine Angaben.....3

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11. Arbeiteten im Rahmen der Produktentwicklung-Kooperation der vergangenen zwei Jahre ein oder mehrere Angestellte des Kooperationspartners in Ihrem Unternehmen oder war das nicht der Fall?

ja 1

nein2

weiß nicht, keine Angaben.....3

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12. Hat Ihr Unternehmen eine Forschungs- und Entwicklungsabteilung oder gibt es eine solche Abteilung in Ihrem Unternehmen nicht?

ja, unser Unternehmen hat eine F&E-Abteilung.....1

nein, unser Unternehmen hat keine F&E-Abteilung.....2

weiß nicht/keine Angaben.....3

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13. Beinhalteten die eingegangenen Kooperationen bei Produktentwicklung auch Forschungs-Kooperationen oder war das nicht der Fall?

ja, beinhaltete auch Forschungskooperationen.....1 *Fr. 14

nein, beinhaltete keine Forschungskooperationen.....2

weiß nicht/keine Angaben.....3

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*14. Und wie hat sich diese Forschungskooperation auf die Forschungs- und Entwicklungsausgaben ausgewirkt? Würden Sie sagen, dadurch haben sich die Ausgaben für Forschung und Entwicklung erhöht, sind die Ausgaben für Forschung und Entwicklung so alles in allem in etwa gleichgeblieben oder sind dadurch die Ausgaben für Forschung und Entwicklung eher gesunken?

hat zur Erhöhung der F&E-Ausgaben geführt.....1

die F&E-Ausgaben sind etwa gleichgeblieben.....2

hat zu einer Senkung der F&E-Ausgaben geführt.....1

weiß nicht/keine Angaben.....4

Modul 4: Kooperation bei der Entwicklung zusätzlicher Dienstleistungen

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15. Beim Verkauf industrieller Produkte bietet das produzierende Unternehmen oft zusätzliche Dienstleistungen an, wie zB Mitarbeitereinschulung und Serviceleistungen etc. Hat Ihr Unternehmen in den letzten zwei Jahren - alleine oder in Verbindung mit anderen - eine oder mehrere neue Dienstleistungen entwickelt, die in Verbindung mit neuen Produkten stehen oder war das nicht der Fall?

ja 1

nein2.....zu Fr. 18

weiß nicht/keine Angaben.....3 zu Fr. 18

16. Gab es bei der Entwicklung dieser Dienstleistungen Kooperationen mit anderen Unternehmen oder Institutionen oder war das nicht der Fall?

ja, es gab Kooperationen.....1

nein, es gab keine Kooperationen.....2 zu Fr. 18

weiß nicht/keine Angaben.....3 zu Fr. 18

17. Und welche Kooperationen waren daran beteiligt? Achtung Interviewer: Antworten nicht vorlesen! Wenn der Befragte einen als Partner nennt, dann fragen Sie nach: Und waren das österreichische oder ausländische Partner? In einer Zeile sind auch mehrere Angaben möglich!

	nein, kein Partner	ja, österreichischer Partner	ja, ausländischer Partner
private Kunden	1	2	3
öffentliche Institutionen	1	2	3
Zulieferer von Material und Komponenten	1	2	3
Zulieferer von Maschinen	1	2	3
Tochter- oder Mutterunternehmen Ihres Unternehmens	1	2	3
Prüfinstitute oder ähnliche	1	2	3
andere private Institute	1	2	3
Consulting-Unternehmen im Marketing-, Management-, oder Rechtsbereich	1	2	3
Anbieter technischer Dienstleistungen wie zum Beispiel	1	2	3
Designbüros, Softwareentwicklern oder ähnlichen	1	2	3
Universitäten oder andere Forschungseinrichtungen	1	2	3
anderes, und zwar:			

Modul 5: Allgemeine Kooperation und Wettbewerb

18. So alles in allem, glauben Sie, daß Ihr Unternehmen heut mit anderen österreichischen Unternehmen intensiver zusammenarbeitet als in den letzten 3 Jahren, oder ist die Intensität der Zusammenarbeit gleich geblieben oder arbeitet Ihr Unternehmen heute weniger intensiv mit anderen österreichischen Unternehmen zusammen als in den letzten Jahren?

Zusammenarbeit ist intensiver geworden.....1

Intensität ist gleich geblieben.....2

Intensität der Zusammenarbeit ist gesunken.....3

weiß nicht/keine Angaben.....4

19. Und mit ausländischen Unternehmen? Glauben Sie, daß Ihr Unternehmen heute mit anderen ausländischen Unternehmen intensiver zusammenarbeitet als in den letzten 3 Jahren, oder ist die Intensität der Zusammenarbeit gleich geblieben oder arbeitet Ihr Unternehmen heute weniger intensiv mit anderen ausländischen Unternehmen zusammen als in den letzten 3 Jahren?

Zusammenarbeit ist intensiver geworden.....1

Intensität der Zusammenarbeit ist gleich geblieben.....2

Intensität der Zusammenarbeit ist gesunken.....3

weiß nicht/keine Angaben.....4

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20. Das ist sicherlich schwer zu sagen, aber was denken Sie, wie hat sich in den letzten Jahren der Wettbewerb in Ihrer Branche entwikkelt? Würden Sie sagen, der Wettbewerb hat in Ihrer Branche in den letzten Jahren zugenommen, der Wettbewerb ist in den letzten Jahren gleichgeblieben oder hat sich der Wettbewerb in den letzten Jahren in Ihrer Branche eher verringert?

Wettbewerb hat zugenommen.....1

Wettbewerb ist gleichgeblieben.....2

Wettbewerb hat sich verringert.....3

weiß nicht/keine Angaben.....4

Modul 6: Teilnahmebereitschaft an Phase II

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21. Ihre Antworten sind Basis für eine erste Forschungsphase. Zu einem späteren Zeitpunkt werden wir noch einmal Daten für die zweite Forschungsphase erheben. Dürfen wir Ihren Namen und Ihre Durchwahl notieren, damit wir Sie zu einem späteren Zeitpunkt noch einmal um ein Interview bitten können?

Achtung Interviewer: Wenn der Befragte im Zweifel darüber ist, ob er für sein Unternehmen diese Entscheidung tätigen kann, dann sagen Sie: "Sie müssen keine sofortige Entscheidung diesbezüglich treffen, wir möchten nur wissen, ob unsere Forschungsgruppe Sie zu einem späteren Zeitpunkt kontaktieren könnte, um Ihnen mehr Information über unser Projekt darzulegen. Sie können daher warten bis Sie entscheiden, ob Sie bei der detaillierten Befragung teilnehmen wollen!")

Name: .....

Funktion: .....

Telefonnummer:.....

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22. Haben Sie Interesse an den Ergebnissen der Forschungsaufgabe?

ja 1

nein2

Ich möchte mich sehr herzlich für Ihre Bereitschaft zur Teilnahme an dieser Umfrage bedanken. Achtung Interviewer: Notieren Sie bitte, wenn der Befragte an einem Bericht der Studie interessiert ist.

Das Unternehmen möchte eine Zusammen-

fassung der Resultate des Projektes haben.....1

kein Interesse 2

Bei Fragen melden Sich bitte bei folgenden Mitgliedern unserer Forschungsgruppe:

Mag. Gernot Hutschenreiter (WIFO) - (01) 7982601/238

MMag. Andreas Schibany (ÖFZS) - (02254) 7803823

Ich möchte Ihnen für Ihre Zusammenarbeit danken.

Gleichzeitig möchte ich mich bei Ihnen entschuldigen, daß wir Ihre Zeit beansprucht haben und wünsche Ihnen noch einen schönen Tag.
Auf Wiederhören.