Innovation Systems in Regions of Europe – A Comparative Perspective

by

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Abstract:

The understanding of the innovation process has changed considerably in the past years. Models have shifted from linear and firm based conceptions towards interdependent and systemic approaches. Both national and regional innovation systems have been discussed in recent literature. The present paper investigates on the basis of data for several European regions, collected in the course of a European project, to which extent companies engage into networks in their innovation process. Also, the types of partners, their respective locations as well as differences between the regions are explored. First results show that for many firms innovation is still a rather internal process. Reliance on internal competence and lack of trust to other firms are among the reasons. Nevertheless, for another group of companies networks are much more relevant. They draw on ideas, know-how and complementary assets from customers, suppliers, consultants, universities, funding and training institutions. These networks can be observed from regional to global levels. There are considerable differences between company types and regions, however.

1. Introduction

Many regions in advanced countries have been challenged in the past years by the processes of globalization and industrial restructuring. There is a strong imperative for firms to innovate, i.e. to renew their product structure, technology and organizational practices. However, the innovation process of firms has changed considerably in the past years. There has been a move observed from a linear innovation model towards an interdependent and evolutionary model where many actors are involved. Innovation, thus, is carried out interactively between firms and knowledge suppliers, and it is increasingly supported by policy institutions, technology transfer agencies and education. These actors are forming „systems" at various spatial levels. Up to now a systemic view to innovation has been applied mainly to national economies („national innovation systems") and to selected cases of innovative or high tech regions („innovative milieux"). It rarely has been applied to a broader set of regions in a comparative perspective, however.

The present paper investigates to which extent elements of „innovation systems" can be identified in different regions in Europe and how these support the innovation process of firms. Both, „model regions" such as Baden Württemberg and less successful (reconversion and less developed) regions are investigated. The paper is related to a larger European project on these questions (REGIS, see acknowledgement) whose aim it was to identify key elements of regional innovation systems and their interaction by way of a comparative analysis of 11 regions in Europe (Cooke et al 1998)[1]. In the following, I briefly introduce the concept of the „regional innovation system" (2). Then, results of the firm survey of the REGIS project will be reported (based on answers from 833 companies) dealing with the companies' innovation activities (3) as well as their partners and networks in the innovation process (4). Conclusions are presented in section (5).

[1] Regions investigated in the REGIS project included high performance regions such as Baden Württemberg and Brabant, reconversion regions such as Styria, Tampere, Wales, the Basque country and Wallonia, „district"-types such as Aveiro and Friuli, as well as regions of Eastern Europe undergoing transformation such as Féjer region in Hungary and Lower Silesia in Poland. There were several steps in the REGIS project: First, on the basis of existing studies and secondary data, the regions were characterised with respect to their socio-economic characteristics, their policy approach and institutions („regional profiles"). In a second step, firm surveys were undertaken, studying the innovation behaviour in selected industries as well as the linkages between different firms and institutions. In a third step a selection of companies and organizations were interviewed in order to get a deeper view on the respective interactions.

2. Systems of innovation - conceptual background

The understanding of the innovation process has changed considerably in recent years. According to the traditional linear innovation model individual firms and their R&D activities are the main driving forces for innovation and the process unfolds in a strict sequence from research to development, production and to the market. More recent approaches, such as the systems view of innovation, are based on evolutionary and institutional theory (Dosi et al. 1988, Dodgson and Rothwell 1994, Edquist 1997). They have challenged the linear model on several grounds. The following propositions have been brought forward serving as theoretical background for the systems approach:

1) Innovation is considered as a non-linear and interdependent process (Kline and Rosenberg 1986). Besides R&D it may have various starting points and often these are clients or marketing and distribution functions. Then there are interdependencies and feed back loops to be observed. There is increasing interdependence within firms (e.g. between distribution, marketing, R&D, production) as well as between firms (e.g. relations to customers and suppliers) and with other organisations. To a high degree these interdependencies go beyond market relations and occur in „networks“ (DeBresson et al. 1991, Camagni 1991, Cooke and Morgan 1993) which are more stable and trust based relations allowing common learning (Asheim 1996).
2) Knowledge in a broad sense is becoming more important. It is relevant not just at the beginning (in the form of R&D) but throughout the whole innovation process and there are various forms of knowledge involved (Lundvall and Borrás 1997). On the one hand there is „codified knowledge“ which can easily be transmitted through various channels of (tele)communication and does not require spatial proximity for exchange. On the other hand there is „tacit knowledge“ which is „embodied“ in the labour force, in human skills, or in organisational routines. Tacit knowledge is more tied to particular firms, social groups and places and it can only be accessed through direct face to face communication or through joint activities (e.g. cooperative R&D projects).
3) Uncertainties (with respect to technology and markets) are a main feature of the innovation process as well as appropriability problems (Kay 1988). It is only through institutions that these problems can partly be overcome. Institutions in the sense of (Hodgson 1988) include „rules of the game“ (e.g. patent laws), organisations (e.g. technology transfer agencies) as well as behavioural values and routines (e.g. attitudes towards change and risk). Institutions fulfill several functions in the innovation process (Edquist and Johnson 1997): First, they reduce uncertainties e.g. through standards or the provision of information. Second they regulate conflict between various actors and give rules for cooperation. Third, they provide incentives for innovation by granting economic and other rewards (e.g. through the protection of patents for a certain time).

4) The institutional setting of a region and a country, thus, is highly relevant for the stimulation and implementation of innovations. Such a setting is strongly shaped by the respective „governance model“ which includes the actions of public, semi-public and private actors and organisations. In the field of innovation, governance is becoming increasingly „multi-level“ and therefore the result of a complex interplay between local, regional, national and supranational (European) actors and organisations (Cooke at al 1998).

5) Another type of institution, allowing firms to cope with uncertainty, are routines. For the innovation process this has been pointed out by Nelson and Winter (1977) and Dosi (1988). Routines with respect to search, screening and selection of information give stability and direction to the innovation process by bringing firms on specific technology paths or trajectories. Once routines are shared among firms in a specific region they may constitute a „regional trajectory“, i. e. a specific pattern of finding technological solutions and of innovating (Saxenian 1994). Such trajectories may for a while support the innovation process through the accumulation of specific knowledge and the building up of competences. However, there is an inherent danger of „lock in“ due to a homogenization of „world views“ (Grabher 1993). These views may become an obstacle to adjustment once technologies and economic conditions change.

The innovation systems approach rests on these propositions and is a tool to analyse interdependencies in the innovation process. According to Lundvall (1992), an innovation system is constituted by actors and elements which interact in the production, diffusion and the use of economically useful knowledge. It is a social system in the sense that interactive learning as a social activity is in the center, and it is also a dynamic system where ... „the elements either reinforce each other in promoting processes of learning and innovation or, conversely, combine into constellations blocking such processes“ (p.2). The approach has been originally applied to the national level where industrial economists have demonstrated that industrial systems, institutions and technology paths within countries are strongly related. It has been shown that particular research environments, systems of education, finance and regulation to a high degree shape the innovation process of specific countries (Porter 1990, Nelson 1993).

More recently the systems approach has been extended to a multilevel setting (Edquist 1997, Lundvall and Borrás 1997) where regional, national and the supranational (European) levels play a role. Concerning the regional level there are parallels with concepts such as the innovative milieu (Aydalot and Keeble 1988, Camagni 1991, Ratti et al 1997) as well as technology districts (Saxenian 1994, Castells and Hall 1994 Storper 1995, Langendijk 1997). The following arguments support the suggestion that innovation systems have also a regional dimension :

1) Important preconditions for innovation such as the qualification of the labour force, the availability of educational institutions and of research organisations are tied to specific regions (and not very mobile) giving some regions an innovation advantage over others (Tödtling 1992, Simmons 1997).

2) Industrial clusters often are localised, giving rise to networks between firms at the regional level (Saxenian 1994; Enright 1995). Often these networks go beyond the mere exchange of goods and services and include „untraded interdependencies“ where relevant information for innovation is shared (Storper 1995).

3) Interactions between knowledge providers and firms such as university-industry links, knowledge spill overs and spin-offs are often localised since they work through the mobility of persons on local labour markets and through face to face contacts between actors. Under certain conditions this may and lead to high-tech development in specific regions (Saxenian 1994, Castells and Hall 1994, Tödtling 1994).

4) Regions have been taking a more active and stronger role in innovation policy in the past years (Sternberg 1995, Hassink 1996, Brazyk et al. 1998). Many regions (such as Wales, Styria or the Basque country) have developed technology policy concepts or innovation plans and have become active in supporting technology transfer and innovation activities. Often these concepts included the strengthening of particular industrial clusters in the region. These efforts went parallel with an emerging European innovation policy (e. g. the Framework Program) leading partly to joint (regional – EU) support programs. Obviously under these conditions some regions are faster learners than others, moving faster in the directin of „regional innovation systems“.

5) Due to the stated interactions between firms, knowledge providers and policy agents a common technical and organisational culture (a specific trajectory) may develop in a regional production systems which under certain conditions supports collective learning and innovation (Maillat, 1991, Asheim 1996). However, in case that such systems become too closed and networks too rigid „lock in“ may occur leading to a loss of adjustment capability and to collective decline (Camagni 1991, Grabher 1993, Saxenian 1994).

Elements of a regional innovation system, then, are first of all firms of the main industrial clusters of the region, including their support industries. They constitute various kinds of networks, both within the region and to the outside world (supplier/client-, cooperation-, information-networks) through which relevant information flows and interactions occur. Research and development organisations, laboratories and universities act as knowledge suppliers. They only become effective, however, if they interact with firms in the region. The quality of the labour force is another important factor for innovation. Here, not just R&D personnel is relevant but also qualifications in production, marketing and management. As a consequence, training organisations are another

element of a regional innovation system. Financial institutions should provide necessary finance for innovation projects, helping firms to overcome capital shortages. Then, industrial associations and institutions like business innovation centers, science parks or technology transfer centers aim to support particular segments of firms (e.g. SMEs or new firms), trying to lower their specific innovation barriers.

It is to be expected that European regions differ quite strongly in their ability to develop a regional innovation system. The following factors may be responsible for this:

- Regional firms differ in their ability to innovate due to their sectoral specialisation as well as their functional and organisational characteristics (Malecki 1991, Tödtling 1992).
- Regional firms differ in their propesity to interact depending on the existence of clusters, networks and, more general, the attitude of actors towards cooperation (Saxenian 1994).
- Regions differ in their capacity to build up relevant institutions (research, education, technology transfer) and in the „governance model“, depending on their decision making power, financial resources and their policy orientation (Brazyk et al. 1998, Cooke et al. 1998).

We can therefore expect that some regions have no or a weak innovation system while others have systemic interaction to a higher degree. There are also differences with respect to the main actors and driving forces. These may be networks of firms (firm-based system), universities and research organisations (science based system) as well as policy actors (policy based system). Concerning the governance model Cooke (1998) distinguishes between bottom up („grassroots“), cooperative („network“) and top down („dirigiste“) approaches.

In the following I will briefly characterise the innovation activities firms in selected regions of Europe (section 3). Then, in section 4 it will be investigated to which extent firms interact in the innovation process, which kind of partners they have and at which spatial level these are located. Interaction patterns will be analysed for different types of firms as well as for selected regions.

3. Innovation activities of firms

Which kind of innovation activities do firms undertake in the investigated regions of Europe? I will mainly use the common data base from the REGIS firm survey (based on answers from 833 firms) for answering this question. We have looked at indicators for innovation inputs (R&D budgets and R&D employment) as well as for innovation outputs (new products and processes introduced in the past 3 years). In addition, we asked for the introduction of new organisational practices in order to cover the organisational side of the innovation process. R&D indicators usually have the problem

that they do not reach the full spectrum of the innovation process and particularly the innovation activities of small firms. The introduction of product and process innovations on the other hand depends strongly on the respective industry and is also a rather subjective indicator.

Table 1 demonstrates that, overall, **product innovations** are more frequent than process innovations. 2/3 of the firms have indicated the introduction of new products in the past 3 years. To a large extent these are smaller modifications or mere imitations. Only 39% of companies have stated that these new products were novelties also to the respective market and not just to the firm. More radical innovations (i.e. those entering new trajectories) were rare events, however, as subsequent firm interviews have shown. **New technologies (process innovations)** were introduced by 46% of firms. Again, most of these are adoptions of available technologies, only 17% of firms have indicated that process innovations were also new to the respective market (including own developments).

Table 1: Product- and process-innovation

% of firms having introduced the following types of innovation

		Firm size		
	Total	**small** <50	**medium** 50-200	**large** >200
n =	*833*	*379*	*258*	*157*
new products	**66.5**	55.7	74.8	88.5
products new to the market	**38.8**	31.1	41.5	58.6
new processes	**46.2**	35.6	53.5	64.3
processes new to the market	**16.8**	13.5	17.4	26.8

In our sample innovativeness increases with firm size. Medium and large companies are more often product- and process-innovators than small companies. But we cannot conclude from this that small firms are not innovative in general. From the analysis of **innovation inputs** (R&D budgets in % of sales, R&D personnel in % of employment) we can observe a segmented structure. More than ½ of the small firms do not report any R&D activities (either zero or missing values). However, about a quarter of all small firms has high innovation inputs in relative terms. Probably this has to do with certain „indivisibilities“ of R&D activities, as well as with the customer specific production of small firms leading to frequent „development“ activities but usually not to „research“. Concerning large firms, a clear majority reports R&D activities, but these are in most cases only on low or medium levels in relative terms.

Innovation, according to the evolutionary model, covers more than technology changes, however (Dosi 1988, Edquist 1997, Lundvall and Borrás 1997). Often, organisational and management changes may be more relevant for the competitiveness of firms than product or process innovations. New organisational practices most frequently have to do with quality improvements. Certification (e.g. ISO 9000) as well as the more comprehensive "total quality management" are quite common. Other practices refer to organisational decentralisation (group work, flat hierarchies, profit centers) which are supposed to lead to higher flexibility as well as to a better innovative performance. Most of these changes were internal ones. Obviously less frequent than stated in the literature we found networking strategies (cooperations with other firms) or the move towards new supplier relations (e.g. use of systems supplyers).

Different kinds of innovation, thus, are strongly linked. First, product and process innovations are correlated quite strongly, i.e. firms having introduced product innovations are also found to be more active with respect to process innovations (and vice versa). Second, both types of innovators also have higher adoption rates of new organisational practices. Generally, this supports the argument of the evolutionary innovation model that different kinds of technological innovations are interrelated and that they also have to be complemented by organisational change in order to become effective.

Differences between REGIS regions

From the 11 regions investigated in the REGIS project (see introduction) we have chosen the following six for a comparison in the present paper. Baden Württemberg (Germany) as a high performance region, Styria (Austria), Tampere (Finland), Wales (U.K.) and the Basque country (Spain) as reconverting regions and Aveiro in Portugal as an industrial district in a peripheral location. These regions have quite different preconditions for systemic innovation as was described in detail in Cooke et al. (1998).

With respect to innovation differences between the regions we do not find a totally clear and consistent picture. There are different patterns in particular with respect to input- (R&D-budgets: see table 3) and output-indicators of innovation (table 2). **New products** in a broad sense (including imitations and smaller changes) have been introduced frequently in Baden-Württemberg (79%) and in Aveiro (77%). Looking only at novelties to the market, Baden-Württemberg, according to expectations, is clearly leading (64% of companies), but high scores can also be found in Aveiro, Styria and Wales.

Table 2: Product- and process-innovation by region

% of firms having introduced the following types of innovation

		Selected regions					
	Total	**Ba-Wü**	**Styria**	**Tamp.**	**Wales**	**Basque**	**Aveiro**
n =	*833*	*81*	*107*	*142*	*103*	*80*	*56*
new products	**67**	79	65	74	63	66	77
products new to the market	**39**	64	47	29	45	26	48
new processes	**46**	38	41	49	52	53	66
processes new to the market	**17**	12	20	21	19	13	23

New production technologies (process innovations) were introduced to a high degree in the district of Aveiro (66%). In addition, the reconverting Basque country, Wales and Tampere have strongly introduced new technologies. In these regions the innovation focus is more on the modernisation of production technologies, supporting the restructuring process. Most of these are adoptions of available technologies, only in a minority of cases it implies the creation of new technologies or own developments.

To which extent are these innovations backed by respective **innovation inputs**? Looking at the R&D-budgets we find that Baden-Württemberg has the highest level of R&D activities, followed by Styria and Tampere (table 4).

Table 3: R&D-budgets (1995)

% of firms belonging to certain classes of relative budget

		Selected regions					
	Total	**Ba-Wü**	**Styria**	**Tampere**	**Wales**	**Basque**	**Aveiro**
n =	*833*	*81*	*107*	*142*	*103*	*80*	*56*
top third (1)	**16.3**	28.4	26.2	16.9	20.4	11.3	3.6
middle third (2)	**16.2**	40.7	28.0	17.6	12.6	6.3	8.9
lowest third (3)	**16.3**	6.2	15.9	23.9	8.7	10.0	14.3
no budget	**12.7**	8.6	10.3	4.2	39.8	10.0	12.5
missing values	**38.4**	16.0	19.6	37.3	18.4	62.5	60.7

Categories:
(1): relative R&D-budget >5.41,
(2): relative R&D-budget <=5.41 and >1.85
(3): relative R&D-budget <=1.85 and >0

In Wales we find a polarised situation: A high share of companies (about 40%) does not indicate any R&D. But those who do, have a relatively high level. This contrasts with the Basque country

and Aveiro where we find low response rates with respect to R&D inputs indicating also low levels of R&D activities.

Overall, we can conclude that innovation activities are clearly strongest in Baden-Württemberg[2] followed by Styria, Wales and Tampere. There is a different emphasis, however. In Baden-Württemberg the focus is more on product innovation, in Tampere on process innovation and in Styria and Wales on a combination of both. In these regions innovation outputs are also backed by respective inputs (R&D-budgets and -staff) so that the pattern looks robust. In Aveiro the output indicators for innovation are quite impressive, but they are not really backed by R&D and qualification inputs. This can be explained by the high shares of design intensive consumer goods in the sample (such as textiles and shoes). These are industries where product changes are frequent, depending e.g. on fashion cycles, but these are usually small changes (incremental change, modifications) requiring design inputs or fast imitation rather than R&D. In addition, firms adopt new production technologies which are available on the market and do not require much own R&D. Similarly, in the Basque country innovation activities seems to be at a low level. Although many firms indicate innovations, these are mostly imitations (new only to the firm) rather than novelties to the market. Only a minority of firms reports any R&D activities.

4. The innovation process and interactions of firms

Which interactions do firms maintain in the innovation process and which partners do they have? We are interested in the types of partners as well as in their location (spatial scale of networks). Of interest is particularly the role of the region in this respect investigating potential elements and actors of regional innovation systems. In this context we also analyse which types of firms are more embedded into innovation systems and whether there are differences between the investigated regions.

[2] The firms in Baden-Württemberg may in fact have followed too much the strategy of technological innovation and of high quality products, however, since some of them have been facing problems of "over-engeneering" and a loss of price competitiveness more recently (Bechtle et al. 1997).

4.1 Partners in the innovation process

Our survey data probably underestimate the linkages of companies to innovation partners since the respective question in the survey required some attention by the firms in order to answer it properly. Presumably, some were not willing to spend this effort and did not answer in full detail.

We can see from table 4 that clearly the most important partners for all REGIS regions in the data set are first of all the **customers** and second the **suppliers**. This supports the findings of other studies (Hakansson 1987, von Hippel 1988, Lundvall 1992) that innovation often takes place interactively along the value chain. Customers frequently provide first ideas for product modifications as well as for new products and they may contribute to the design and development process. Also, suppliers may trigger innovation e.g. through the provision of better performing components or new materials and they often contribute to the required process technology. Frequently these relations are not of the market type (short term) but interactive and more durable (network-type). Generally, customers and suppliers as innovation partners are not confined to the region but for our sample more frequently located at the national and European levels. This is not surprising because it reflects the distribution of the firms input / output markets. Still, customers and suppliers of the region are also relevant innovation partners for 44% and 35% of the firms, respectively. In fact, they are at the level of the region still more important than any other type of partner.

Table 4: Innovation Partners of firms

(percent of firms having partners; n = 652, missing 14%)

	regional	national	European	global
customers	44	61	48	25
suppliers	35	52	37	14
consultants	16	20	10	4
research org.	13	17	6	3
universities	24	22	8	3
tech.transfer	11	9	3	2
vent.capital	9	7	2	1
subsidies	17	16	6	1
government	14	10	3	0
trade ass.	12	17	4	1
training inst.	17	14	3	1

Share of firms with partners 10-19%
Share of firms with partners ≥ 20%

Consultants also play a vital role in the innovation process. They provide know-how in various relevant fields, from legal aspects of patenting and licensing to consulting with respect to technology-access, innovation management and marketing/distribution (Moulaert and Tödtling 1995). Due to the specialised nature of the required knowledge, they are not only drawn from the region (16% of firms) but more frequently from the national (20%) and also the European (10%) levels.

Overall, the third most important innovation partner to the firms are the **universities**. They have a multiple function as source and interface for new ideas, partners in the R&D process, and as a source for highly qualified labour. Universities are relatively more important at the level of the region (24% of firms have relations to them) and the respective country (22%). This is probably due to their character as public organisations as well as to the often tacit nature of knowledge and the importance of proximity for these relations.

From the other potential partners, providers of subsidies, training and government institutions seem to have a certain relevance. For these, the level of the region is the most important, followed by the respective country. Rarely indicated as innovation partners are organisations for venture capital and for technology transfer. The low indication of support organisations partly may be due to the fact that some of these services (such as technology transfer and training) are regarded more as an „externality" rather than as a specific and identifiable contribution to the innovation process.

There are some remarkable differences by firm size, organisational status and innovativeness with respect to the innovation partners and the respective networks. For **small companies** (i.e. those with less than 50 employees) we observe generally less interactions in the innovation process (table 5).

Table 5: Innovation partners of small firms (< 50 employees)

Deviation from total (table 1) in %points; n = 302, missing 15%

	regional	national	European	global
customers	4	-7	-13	-7
suppliers	-1	-6	-14	-6
consultants	1	-7	-5	-2
research org.	-3	-7	-2	-1
universities	-7	-9	-2	-1
tech.transfer	-5	-4	-1	-1
vent.capital	2	-2	0	0
subsidies	0	-4	-2	0
government	-3	-4	-2	0
trade ass.	-1	-7	-1	0
training inst.	-4	-6	-1	0

Positive deviation from total ≥ 3

This is somewhat contrary to expectations, because in principle their limited resources should make complementary assets of partners more relevant to them. A possible reason for their fewer links might be the lower frequency and smaller scale of innovation activities (e.g. only small modifications or imitations: see section 3 above) which can be done more or less internally. Another reason might be that they have more barriers to enter into cooperations in the innovation process. Small firms often are not well informed about potential partners, they do not know the supply of innovation support well enough and they do not spend many resources or manpower on search activities either (Malecki 1991, Tödtling 1992). From the pattern of deviations (compared to the total sample of table 4) we can see that small firms have in particular fewer relations to customers and suppliers at larger spatial scales, while the only type of partner to which they relate more frequently than the average are the customers in the region. They have clearly fewer links to universities, research organisations, technology transfer and training. With respect to universities and research organisations this is to be expected and has to do with a lower demand for cooperation with science as well as with differences in „language“ and „culture“ between these types of organisations (Lundvall and Borrás 1997). With respect to technology transfer, this finding is rather surprising, however, since small firms are often the very targets of transfer activities. From our results it appers, thus, that these support activities do not reach an important group of clients well enough.

Clearly more partners in the innovation process have **medium sized companies** (50 to 200 employees) as well as large firms. The medium sized firms are in comparison to the total sample better integrated into the respective national and regional innovation systems. Nationally, they maintain more links both to other firms (customers, suppliers, consultants) and to support institutions. Regionally they interact more with support organisations such as government, training institutions and technology transfer.

Large companies (> 200 employees) clearly have most frequently partners in the innovation process (table 6). This is probably due to more regular and larger innovation projects as well as to better preconditions for cooperation. The latter has to do with better developed „boundary spanning functions“ (Tödtling 1992) as well as more assets to offer for potential partners. Not surprisingly, the customers and suppliers as innovation partners are more frequently on a European and global scale, reflecting the larger spatial scale of input and output markets as well. Consultants and funding agencies are also used more frequently from outside the region (national and European levels). With respect to universities, research organisations, technology transfer and training we observe, however, that large firms are linked more intensively to the region than the smaller firms. Large

companies, thus, seem to be key actors in innovation networks on all levels, reaching from the region to the global one.

Table 6: Innovation Partners of large firms (> 200 empl.)

Deviation from total (table 1) in %points; n = 135, missing 14%

	regional	national	European	global
customers	-5	4	23	14
suppliers	1	4	17	13
consultants	-2	6	9	3
research org.	11	13	4	1
universities	17	19	4	3
tech.transfer	9	5	2	0
vent.capital	-2	2	2	2
subsidies	1	12	6	1
government	2	7	3	0
trade ass.	2	1	0	0
training inst.	5	8	4	1

Positive deviation from total ≥ 3

The pattern of interactions in the innovation process also depends on the status and ownership of plants, however. A clearly lower integration into the region have **dependent branch plants and subsidiaries**. These types of plants have, due to their integration into a wider enterprise network, innovation partners clearly more at a national and European level. Only with respect to universities, government institutions and training they also maintain links to the region.

Table 7: Innovation partners of foreign firms

Deviation from total (table1) in %points; n = 67, missing 16%

	regional	national	European	global
customers	-14	-9	27	5
suppliers	-4	-1	32	14
consultants	-1	4	9	5
research org.	-1	-1	2	0
universities	6	5	2	0
tech.transfer	1	0	-2	0
vent.capital	-6	-4	-1	-1
subsidies	-5	-4	0	0
government	1	6	2	0
trade ass.	-2	1	2	0
training inst.	-1	7	-1	0

Positive deviation from total ≥ 3

Foreign firms are even less embedded into the region and they have fewer links also at the national level (table 7). Customers, suppliers, consultants as innovation partners are mainly European or global. The only stronger innovation link to the region concerns universities. On the national level they maintain links also to government as well as to training institutions. Branch plants as well as international companies, thus, have only selective links to the region, and they do not seem to stimulate interfirm links to a major extent. They do use the universities and training organisations of the respective regions and countries, however, and in fact they do that to a higher degree than e.g. the small endogeous companies analysed above.

As to be expected, innovative firms have more links to other firms and organisations in the innovation process than the average. This applies both to product and process innovators. **Product innovators** maintain more relations with European and global customers as well as suppliers (table 8). Product innovators relate more to consultants on all spatial levels, including the regional one. Links to universities and technology transfer are relatively more frequent at the level of the region and the country. They are, thus, generally more embedded into networks, both distant and close. In fact these findings demonstrate that regional and large scale networks are complementary rather than substitutes. Firms which have learned to work with partners at the level of the region also seem find it easier to engage into national, European or even global links. There may also be an interdependence between innovation and networking: on the one hand product innovators require complementary assets to a higher degree (know-how, technology, finance, market access) so they are looking more intensively for partners. On the other hand they might be stimulated by some of these relationships to further innovations.

Table 8: Innovation partners of product innovators

Deviation from total (see table 1) in %points; n = 269, missing 8%)

	regional	national	European	global
customers	-1	3	6	10
suppliers	2	0	6	6
consultants	3	5	5	3
research org.	0	3	1	0
universities	7	7	3	2
tech.transfer	5	4	0	0
vent.capital	0	2	0	0
subsidies	2	6	1	1
government	-2	2	0	0
trade ass.	-1	-1	1	1
training inst.	-2	3	0	0

Positive deviation from total ≥ 3

For **process innovators**, the basic pattern is not too different from the product innovators. Interestingly, process innovators are not less but relatively more emedded into the region. They maintain more links to universities and research organisations, to training institutions and technology transfer as well as to subsidy providers. The introduction of new processes obiously creates demand for specific knowledge, qualifications as well as finance which partly are provided by regional and national institutions. The pattern also supports the argument of the interdependent innovation model (Dosi 1988, Lundvall 1992) that innovation is a non-linear process where we cannot clearly separate different stages or product- from process-innovation. From our findings it appears that process innovations often go beyond mere adoptions of given technologies which can be ready bought on the market, but they require also certain development activities as well links to relevant institutions.

4.2 Innovation partners – differences between REGIS regions

How do the selected regions of the REGIS project compare with respect to interactions and partners in the innovation process? Table 10 shows that there is a considerable variation between the regions in the data set. It appears that the firms in Styria, the Basque country and in Baden Württemberg are generally innovating more in interaction with external partners than those in the other regions. Also with respect to the spatial levels and the dominant partners there are interesting differences.

In **Baden Württemberg** interfirm linkages, in particular to customers and suppliers, at the regional and national levels are clearly more important than in other REGIS regions. 89% and 93% of companies have regional and national customers as innovation partnes, in the case of suppliers it is 80% and 75% respectively. The services of consultants are used by 33% of companies in the region, and by 25% at the national level. This pattern partly has to do with the size of the respective economies but probably also with a certain tradition of cooperation. Links are by far more important than in other regions. The innovation system thus can be characterised as „firm-based“. Other partners, but of lower importance, are universities (25% in the region), research organisations (18%) and technology transfer (18%). Concerning the support organisations, the firms in Baden Württemberg certainly can or could benefit from one of the most sophisticated networks of relevant institutions (*Steinbeis, Fraunhofer, Fachhochschulen*, and other institutions: Kaufmann et al. 1997). Considering the dense support structure, the actual use of public or other support organisations through firms in the sample is in fact surprisingly low.

Table 10: Innovation partners by region

% of firms having partners in the innovation process

	Total	Ba-Wü	Styria	Tamp.	Wales	Basque	Aveiro
n =	***652***	*73*	*93*	*138*	*98*	*68*	*52*
missing %	***14***	*10*	*13*	*3*	*5*	*32*	*7*
Regional level							
customers	**44**	89	48	38	28	56	35
suppliers	**35**	80	38	22	22	56	35
consultants	**16**	33	20	5	11	46	8
research org.	**13**	18	21	16	1	37	6
universities	**24**	25	33	23	25	30	15
tech.transfer	**11**	18	8	4	1	63	2
vent.capital	**9**	8	14	8	5	11	2
subsidies	**17**	12	27	20	16	0	4
government	**14**	7	14	3	29	11	4
trade ass.	**12**	15	25	6	4	17	19
training inst.	**17**	6	24	6	20	44	31
National level							
customers	**61**	93	60	65	56	59	58
suppliers	**52**	75	54	35	51	54	63
consultants	**20**	25	22	12	27	17	31
research org.	**17**	20	23	20	14	15	23
universities	**22**	19	31	15	25	9	27
tech.transfer	**9**	12	13	2	10	15	15
vent.capital	**7**	6	20	4	4	6	4
subsidies	**16**	14	41	15	5	0	23
government	**10**	6	14	2	11	7	25
trade ass.	**17**	7	25	2	20	11	31
training inst.	**14**	6	19	6	11	20	40
European level							
Customers	**48**	73	69	38	22	68	58
Suppliers	**37**	36	43	26	26	48	60
Consultants	**10**	13	15	3	3	13	14
research org.	**6**	0	16	4	3	9	6
Universities	**8**	4	26	1	3	15	4
tech.transfer	**9**	1	8	0	2	9	2
vent.capital	**2**	0	7	0	1	0	0
Subsidies	**6**	1	22	3	0	2	2
Government	**3**	1	5	0	1	2	0
trade ass.	**4**	1	9	1	4	7	0
training inst.	**3**	0	5	1	0	2	6

Positive deviation from total ≥ 3

Styrian firms are cooperating quite strongly in comparison to other REGIS regions. For them the region is an important cooperation and support space, but they are also strongly oriented to the national as well as the European level. Relevant types of partners are the customers, suppliers, universities, consultants and the providers of subsidies. Compared to other REGIS regions, universities and research organisations both in Styria and the rest of Austria play a strong role, the regional innovation system, thus, can be characterised somewhat schematically as „university based". This pattern may be due to a certain bias in the sample towards larger and innovative firms (Tödtling and Kaufmann 1997). Both types of firms generally have more innovation projects and related interactions to report on than smaller and less innovative firms (see section 3).

For the **Basque firms** the region is clearly the most important cooperation and support space for innovation. Apart from the region, Basque firms are relatively more oriented to Europe than to the rest of Spain. This may be due to historical reasons such as the long enduring strive for more autonomy. With respect to innovation partners from the region we find that besides customers, suppliers and consultants in particular technology transfer organisations (63% of firms), training (44%) and research organisations (37%) are partners which are much more used than in other regions. This pattern partly can be explained by the strong role of technology centers and related policy programs (Basque team 1997) as well as to a certain history of cooperation in the region (Mondragon complex). We can characterise the Basque innovation system, like the one in Wales, therefore as „policy-based".

Due to the relatively strong and proactive role of respective organisations in **Wales**, innovation partners are frequently public or semipublic support organisations (government institutions, training organisations, universities). Links to other firms (customer, suppliers, consultants) are relatively rare in the region. This partly can be explained by the relatively high share of externally controlled plants in Wales and a certain lack of innovation relevant functions and competences. The results furthermore indicate that the cluster oriented policy approach of Wales has not yet really translated into dense interfirm relations in the region.

Compared to Baden Württemberg, Styria or the Basque country, the firms in the **Tampere** region report generally fewer innovation partners. Besides Finish customers, research organisations from the region and the rest of Finland as well as providers of subsidies have some relevance. This pattern reflects the relative strong role of respective institutions (e.g. *TEKES*) in the Finish innovation system (Kautonen and Schienstock 1997).

In the other investigated region, i.e. Brabant, Wallonia, Aveiro and Friuli, innovation partners were reported less frequently. In Brabant and in Wallonia there is a rather individualistic behaviour of firms leading to only few links with other firms and organisations. This contrasts with a rather

dense support structure in these regions indicating a considerable gap between the support structure and the firms. In the **Aveiro** case the situation is different. Here, the region in a policy sense and as support space does not really exist, most interactions (except training) are therefor at the national level. As a consequence, the innovation system in this case is clearly more national than regional (de Castro et al. 1997).

5. Conclusions

It has been argued that innovation is increasingly relevant for companies in a globalising economy and that the innovation process itself has become more interdependent and systemic. Innovations are regarded as outcome of systemic interaction between firms, knowledge suppliers and other organisations at various spatial levels. How actively are firms in European regions innovating under these conditions and how strongly are they relying on such networks? To which extent are they embedded in regional or national innovation systems? The following are the main conclusions from the REGIS project with respect to these questions.

1) Innovation is an important strategy to achieve competitive advantages. Product innovation is the main focus (2 out of 3 companies), most changes being small and incremental, however. Products which were novelties also to the respective market were indicated by less than 40% of firms, while more radical innovations (those involving major technological steps) were rare events. The vast majority of companies, thus, follows existing technological trajectories, a pattern which may create problems of "lock-in“ in the long run.

2) There are considerable differences between the investigated regions regarding innovation, but there is not always a clear and consistent picture. As expected, innovation activities are obviously more frequent in high performing Baden-Württemberg than in other REGIS regions. Here we find a high share of technologically advanced quality producers relying strongly on the knowledge of their work force as well as R&D. There are also intensive innovation activities in some of the reconversion regions such as Styria, Tampere and Wales. Specific trajectories can be observed: In Styria incremental product innovations were dominating in mechanical engineering industries, reflecting the traditional knowldege base of the region. Tampere firms were more focussed on the introduction of new information technology, backed by a specific strength of the (national) Finnish innovation system in this respect. In Wales, innovation is often the result of an upgrading of supplier relations. In particular large foreign firms as customers exert a pressure on Welsh suppliers to improve their products and to innovate.

3) Overall, innovation is still a rather internal process to the firms, depending on the competences of the work force (knowledge base, skills) and on „boundary spanning functions“ such as R&D and marketing. Despite this fact, there is evidence that interactions and networks are becoming more relevant.
   - Most important are the relations along the value chain (customers and suppliers), supporting the findings of von Hippel (1988) and Lundvall (1992). As the interviews have shown, these relations typically go beyond market relations and are of a network type, i.e. they are usually more durable and of an interactive nature.
   - Other relevant interactions are with consultants, universities and research organisations. From these, in particular the universities ranked surprisingly high, indicating a significant strengthening of university-industry relationships in the past years.
   - Only limited evidence we found for horizontal cooperations among firms. Preference for internal solutions, lack of trust and fear of losing economic benefits are among the reasons. Also technology transfer and other support organisations were used only little. It seems as if „intermediaries“ even if they are useful interfaces are not explicitly recognised by the firms as institutions providing valualble contributions.

4) These networks can be observed at various spatial levels supporting the findings of Camagni (1991), Edquist (1997), Lundvall and Borràs (1997) that they are complementary rather than substitutes for each other. Most important are the regional and national levels, with the European one of growing relevance. Only for a small segment of firms truly global links can be observed. At the level of the region firms interact more with universities, support organisations and training institutions. At the national and European levels most of the interfirm links take place but also relations to funding institutions and specialised research organisations.

5) Innovation networks differ between firm types:
   - Large and intermediate firms have more complex networks. This is probably due to their higher innovation activity as well as their better precondition for networking. Obviously they are better able to identify relevant partners and they have also „something to offer“ for potential partners. The small firms in principle have more need for partners but at the same time more barriers for networking.
   - Companies belonging to larger and foreign corporations are, due to their corporate links, generally more integrated into European and global networks. To the region they most often only have selective links such as to universities, funding and training institutions.
   - Not surprisingly, we found that the innovative firms (the „innovation avant-garde“) are better integrated into networks than the non-innovative firms. There were few differences

between product and process innovators supporting the view of the interactive innovation model.

6) The investigated regions of the REGIS project differ quite strongly with respect to the kinds and importance of innovation networks and in the regional embeddedness of firms. In Baden Württemberg interfirm relations are clearly most important, we could speak here of a „firm-based“ innovation system mainly based on vertical relations (to customers, suppliers and consultants). Support organisations (universities and research institutions, technology transfer) also play a role, but not as much as could be expected from the „thick“ institutional tissue of the region. The firms in Styria, Tampere, the Basque country and Wales, have more intensive relations to support organisations in comparison. Again there are differences: In Styria and Tampere these are mostly with universities or research organisations („university- or science-based“ innovation systems), while in the Basque country and Wales they are more often with technology centers, innovation support or regional agencies („policy-based“ innovation systems). A rather low level of embedding into a regional innovation system show the firms in the other REGIS regions (Aveiro, Wallonia, Brabant and Friuli). Aveiro, is simply lacking many elements of an innovation system on the regional level and depends rather on national institutions. The situation in Brabant and Wallonia is different in the sense that many elements of a support infrastructure are present, but clearly underused due to problems of information and access, „matching“ problems as well as an individualistic culture of firms.

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