

Innovation networks in metropolitan regions: the case of the Vienna urban region

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Abstract: Innovation networks have been analysed at several spatial levels, from the local to the global. There has been and still is much interest in innovation systems below the national level. A wide range of regions has been studied but there is still one type which has been so far neglected, the metropolitan or urban region. It is a region which reaches beyond the administrative boundary of a city, comprising the core city and the surrounding suburban municipalities which are closely interlinked with the center. In this paper the special case of the Vienna urban region is analysed with regard to the innovation networks in the city and the suburban area and, in particular, between the two parts of the metropolitan area. Based on data from an innovation survey covering the Vienna urban region it is shown that in this specific case the interrelations between the city and its surroundings are not sufficiently intensive for a metropolitan innovation system. Especially firms in the suburban area are more oriented towards innovation partners outside the urban region.

Keywords: Innovation system, metropolitan region, Vienna urban region

1 Innovation networks in metropolitan regions

Theories about the role of space in innovation processes have already a long tradition. Early work on space and innovation was done in studies on the so-called innovative milieux (Maillat, 1991) and in studies on specific high-tech regions like Silicon valley (Saxenian, 1994). In recent years the innovation system concept became the most often used model underlying research on innovation. In the beginning there was only a weak focus on space. Innovation systems were considered to be national, and research aimed primarily at differences between nation states (Lundvall, 1992; Nelson, 1993). Later the interest in regional specificities has been increasing, spurring a multitude of studies on specific regions based on the regional innovation system concept (Braczyk et al., 1998). Often, however, the regional innovation systems approach is too general for being able to grasp the differences between special types of regions. This is particularly true of the special type of region formed by the agglomeration around a big city. The size and diversity of the economy of an urban region, the size of its labour market, the rich institutional setting and the close proximity of a huge number of actual or potential innovation partners suggest that there might be something like a specific metropolitan innovation system.

Unfortunately, almost all studies dealing with urban innovation focus on the city only and not on the greater metropolitan region. But, for instance, for investigating whether agglomeration economies are due to localisation or urbanisation externalities (e.g. Capello, 2001) it is certainly not sufficient to look only at one part of the agglomeration area, the city, and to neglect its suburban part. In this paper, such a broader perspective will be applied on the specific case of the Vienna urban region.

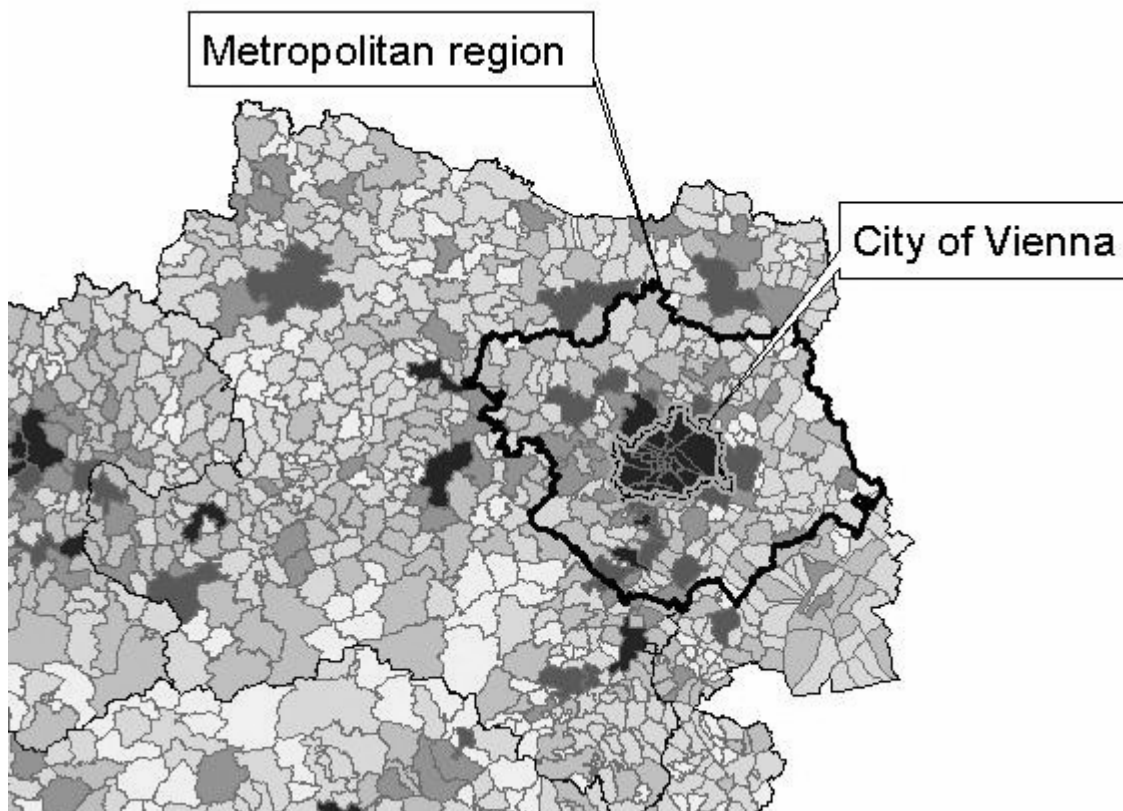
An innovation system can be called 'metropolitan' if its spatial extension corresponds more or less closely with the urban or metropolitan region around a major city. Such a spatial entity usually reaches beyond the administrative boundary of the city, comprising also the surrounding municipalities as far as they are closely interlinked with the center. There are several definitions how to draw the boundary of a metropolitan region. The daily commuting distance is often used for this purpose, because this is the longest distance which allows day-by-day business interaction. This is also the definition applied in this article. The terms 'metropolitan region' and 'urban region' are used as synonyms throughout this paper.

According to this spatial definition, a metropolitan innovation system is composed of urban as well as suburban elements. To find out whether such an innovation systems exists in the case of Vienna, a survey of firms located in the Vienna region was conducted in late 2004. The results are presented in the following.

2 The metropolitan region of Vienna

Vienna is the capital of Austria, located in its eastern part. The city of Vienna has a population of 1.57 million. The number for the whole urban region depends on the delineation applied. Applying a definition based on daily business and commuting interaction, the metropolitan area corresponds quite well with the NUTS 3-regions 'Wien', 'Wien Umland Nord' and 'Wien-Umland Süd' (see map 1). 2.16 million people are living in this area, about 600,000 people in the suburban region around the city of Vienna.

Map 1: The Vienna urban region (population)



Due to its history - Vienna was the capital of the Austro-Hungarian empire - this is a very large urban region considering the size of Austria. Vienna has always been the administrative center of Austria and it has also a long tradition as one of the major locations for science and research. But it is not one of the industrial core regions of Austria. They are to be found in parts of Upper and Lower Austria as well as Styria, areas which were well endowed with natural resources and energy when the process of industrialization started in Austria.

As in many other metropolitan regions in Europe the Vienna region has gone through phases of dis- and suburbanization after the second world war. These are phases of urban development described by van den Berg and Klaassen (1987). The phases are defined by the change in population of an urban region differentiated into core (city) and ring (surroundings). Suburbanization occurs when the ring is growing fast while the core only slowly or even may be shrinking. Overall, the agglomeration is growing. Disurbanization occurs when the core is shrinking fast while the ring either is also shrinking or still slightly growing. Overall, the agglomeration is shrinking. According to this definition, the Vienna urban region was disurbaniszing during the seventies and since then has been suburbanizing. In the past three decades population growth in the suburban region around Vienna clearly surpassed growth of the city itself. During the seventies the city shrunk by almost 6% which could not be compensated by a growth of 4% in its surroundings. Since then the whole agglomeration has been growing, but the surroundings much more than the city. The city's growth was about 1% in the eighties and 2% in the nineties while the surroundings' was 8% and 9%, respectively.

Part of this process of urban-suburban development affects industrial structure. the following table compares data on the overall development of employment, differentiated by industry, between the city of Vienna and its surroundings.

Table 1: Employment in the Vienna region by sector, 1991 and 2001

(1,000 employees)	Vienna	Surroundings	Metropolitan region
1 9 9 1			
Manufacturing	124	51	174
Services	559	111	670
Total	744	183	927
2 0 0 1			
Manufacturing	83	44	127
Services	681	158	838
Total	821	221	1043

Source: Statistik Austria.

In Vienna, much the same as in most big cities in the industrialized world, manufacturing is concentrated at the edge of the agglomeration while services are located predominantly in the core. This is due to general location factors, e.g. available space, density of residential population, land prices, traffic infrastructure, environmental standards. The structural shift in the Vienna region revealed by the data in table 1 is not unusual. Jobs in manufacturing are still being lost while services are expanding. Overall, this applies to the urban core as well as to the suburban surroundings, but the extent of these changes differs significantly. In the urban region of Vienna the share of manufacturing in total employment fell from 19% in 1991 to 12% in 2001, but the reduction was much stronger in the core - down from 17% to 10% - than in the surroundings - down from 28% to 20%. The city has lost about one third of its manufacturing jobs during the nineties, in the surroundings the minus was only 14%. Regarding services we find the opposite development. While in the city the service sector has grown by 22%, this was clearly topped by the suburban area with 42%. Services account now for 83% in the city and 71% in the surroundings.

The city of Vienna has undergone a significant structural shift in the past decades. Industries that are growing are producer services, research and development as well as data processing and storage. These are high-wage and high-productivity industries but also certain low-wage service industries, especially those which have been and still are affected by outsourcing in the manufacturing sector, are growing. On the contrary, the manufacturing as a whole and several service industries are shrinking (e.g. trade, construction). Fluctuation is rather high with about 10% of the firms being set up per year and approximately the same being shut down. It is even higher in the fast growing service industries (Huber et al., 2002).

In relative terms, there is a move of manufacturing firms from the city to the surroundings. It should not be overlooked, however, that the manufacturing sector is shrinking in the whole agglomeration and services are expanding. But we find that the remaining manufacturing base of the urban region concentrates in the surroundings whereas many producer services linked to these industries are located in the city. This leads to the assumption that there might be some kind of specialization in the innovation system of a metropolitan region. This will be analysed in the following sections.

3 Spatial structure of innovation networks in the Vienna metropolitan region

In order to get detailed information on the innovation networks of firms located in the Vienna region, a survey by telephone interviews was conducted in 2004. 302 firms answered to the comprehensive questionnaire. All responding firms are innovative, either having modified existing or introduced new products in the past three years or being engaged in an ongoing innovation project. The sample was stratified along sector and location: 46% of the respondents are manufacturing firms, 54% provide producer services. 77% of the firms are located in the city of Vienna, 23% in the surrounding municipalities. This corresponds roughly with the employment shares of manufacturing and producer services as well as urban and suburban firms. It was necessary to conduct this survey, because the most recent general innovation survey in Austria - CIS 3 (2000) - does not provide information on innovation networks in sufficient detail for our purpose and does not have representative data at the regional level.

Apart from the sectoral structure other general firm features like size and age differ only slightly between urban and suburban firms in the sample. Regarding organizational status fully autonomous firms are the most frequent category in both parts of the metropolitan region (around 3/4). In the city there are slightly more headquarters (15% vs. 12%), whereas in the surroundings there are more subsidiaries (22% vs. 13%). But this hardly affects innovation, because most subsidiaries are autonomous regarding innovation anyway (around 2/3 of subsidiaries). The size distribution in terms of employment is very similar, slightly more than 40% are microfirms (with less than 10 employees), around 1/3 are small firms (10 - 49

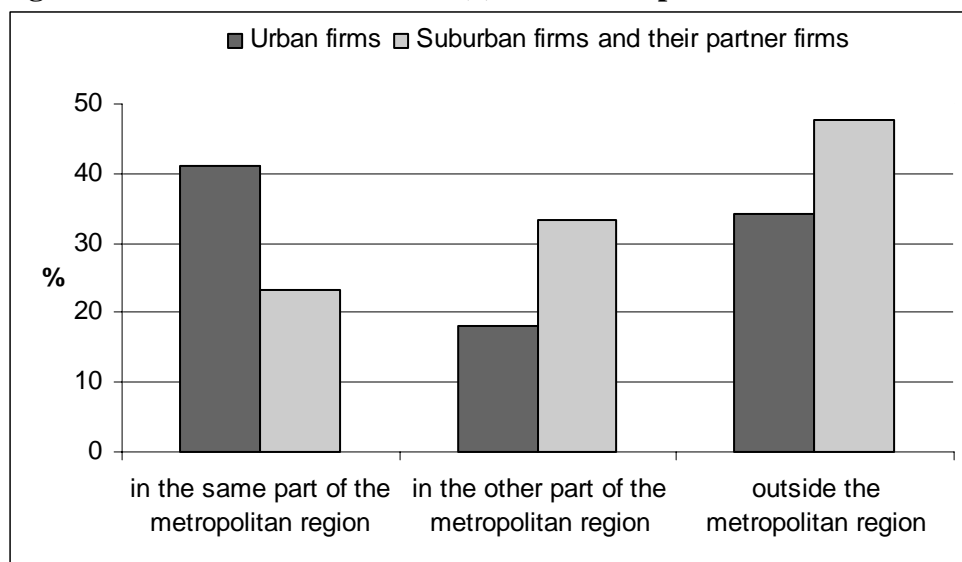
employees), and between 10% and 15% are medium-sized firms (50 - 249 employees) and large firms (250 and more employees). Most firms indicated no change in employment (around 60%) or slightly increasing employment (around 1/3). In Vienna slightly more firms (4%) indicated decreasing employment than in the surroundings (1%). Regarding age firms in Vienna are slightly younger than in the surroundings. While firms which are not older than 5 years account for about 10% in both parts of the urban region, more firms are up to 10 years old in Vienna (20% vs. 6%) while more up to 50 in the surroundings (2/3 vs. about 1/2). Very old firms, however, are more frequent in Vienna (18% vs. 14%).

For being able to compare the spatial structure of innovation networks of firms located in the Vienna metropolitan region the firms were asked to indicate the types of innovation partners, their location and the kind of relations. Regarding type of partner the responding firm had to choose from a given list comprising business, financial, research and technology organizations. The list consisted of customers, suppliers, service firms, competing firms, banks, providers of venture capital, public support institutions, universities, contract research organizations, technical colleges (also called universities of applied sciences), commercial providers of technology, technology and incubation centres as well as technology transfer organizations. Regarding location only three spatial levels were distinguished: the city of Vienna, the surrounding suburban region and everywhere outside the agglomeration. Regarding the type of relation three basic categories were used: informal information relations without payment, market relations based on contracts ordering a specific contribution to the innovation project but without further interaction and cooperation in a joint innovation project with a common objective and pooled resources.

The following four figures (figures 1 to 4) show the relative frequency of urban (left dark column) and suburban (right bright column) firms' innovation partners differentiated by their location. The two columns at the left show the frequency of a certain partner category in the same area as the responding firm (i.e. in the city in the case of an urban firm, in the surroundings in the case of a suburban firm). The two columns in the middle show the frequency of the same category in the other part of the metropolitan region (i.e. in the city in the case of a suburban firm, in the surroundings in the case of an urban firm). Finally, the two columns at the right show the frequency of this category outside the agglomeration (i.e. in other parts of Austria or abroad).

Figure 1 presents the business partners in the innovation networks of urban and suburban firms. This is clearly the most important category of innovation partners. Almost two thirds (63%) of the responding firms have indicated innovation relations with business partners such as customers, suppliers, producer service firms and competitors (i.e firms in the same industry which are selling comparable goods).

Figure 1: Location of local firms' (1) innovation partners from the business sector

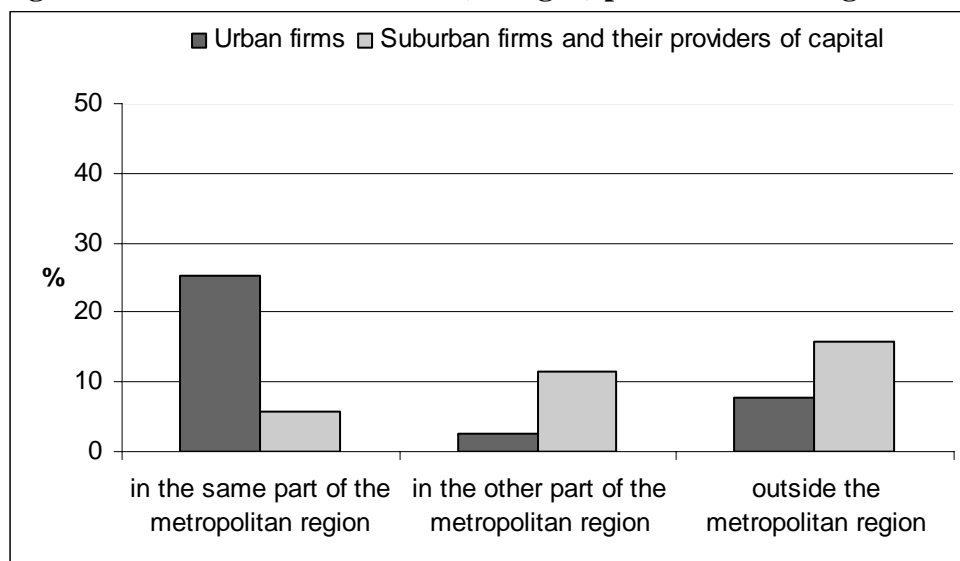


(1) Local firms are located in the Vienna metropolitan region (see chapter 2) and comprise urban firms, located in the city of Vienna, and suburban firms, located in the surrounding municipalities.

Source: Survey of innovation networks in the Vienna region.

Overall, the most important partners are suppliers (37% of all firms), customers only rank second with a remarkably big difference (24%). Less important are service firms and competing firms (both 19%). Differentiating by the partners' location we find that urban firms have business partners mainly in the city and outside the metropolitan region, only few partners are suburban. On the contrary, suburban firms have more partners in the city than in the surroundings, but most outside the agglomeration.

Figure 2: Location of local firms' (see fig. 1) partners financing innovation

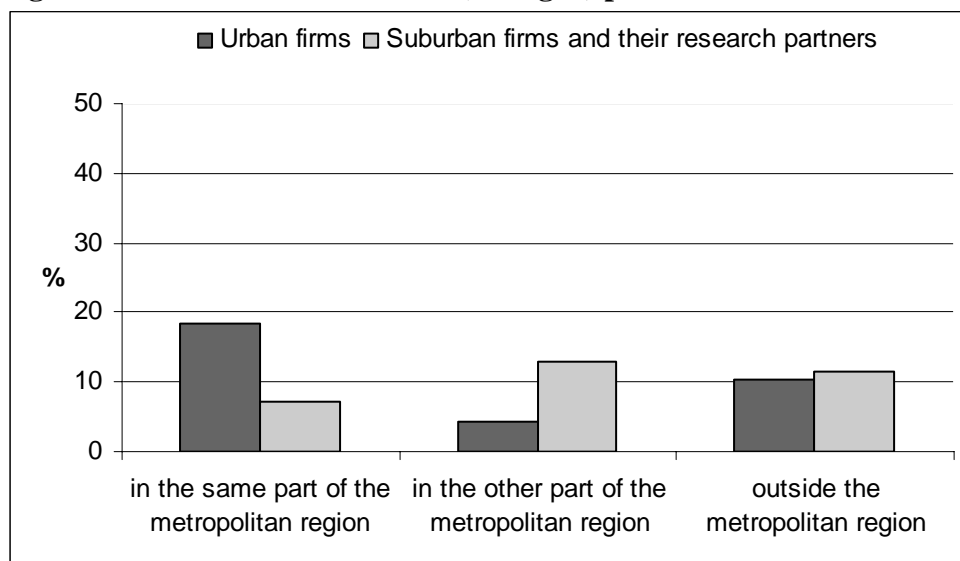


Source: Survey of innovation networks in the Vienna region.

Providers of financial resources are not often involved in innovation projects, only 27% of the firms indicated such a partnership. Furthermore, it is only one type of partner which accounts for most of these relations, public support institutions which are co-funding innovation projects (20%). Banks are hardly involved in the innovation process (only 7%). Institutional providers of risk capital are not at all used, only a negligible 1% of the firms have venture capital partners. The location of most financial partners is the city (see figure 2). This is not only true of urban firms but also of suburban firms. Even considering that many partners are from outside the agglomeration, especially in the case of suburban firms, the unambiguous financial centre is the city of Vienna.

The situation as far as science and research partners are concerned is quite similar (see figure 3). Again only few firms have partnerships with providers of scientific and research knowledge (only 24%), a category that comprises universities, contract research organizations and technical colleges (universities of applied sciences or "Fachhochschulen").

Figure 3: Location of local firms' (see fig. 1) partners from science and research

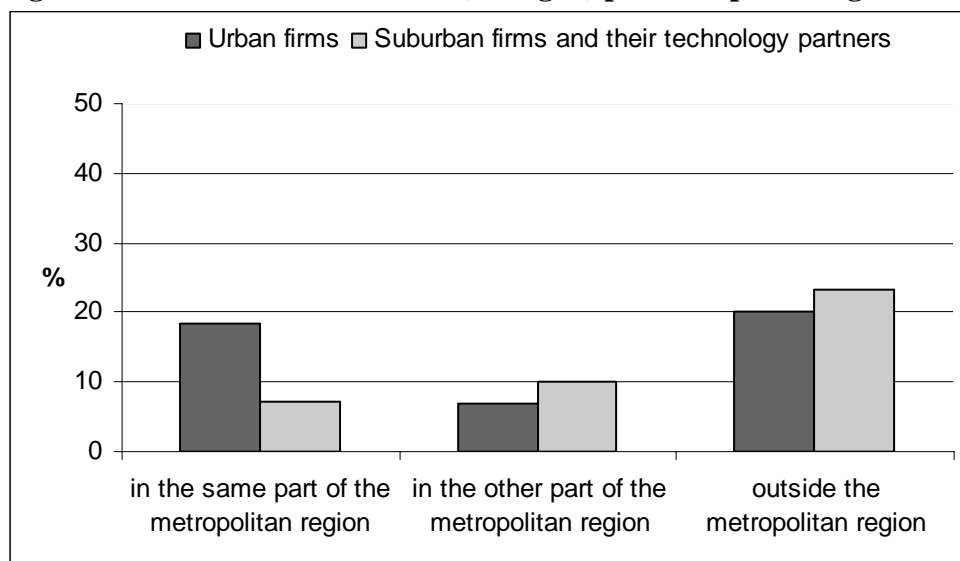


Source: Survey of innovation networks in the Vienna region.

Most science and research partners are for both urban and suburban firms located in the city. Of course, this is to a large extent due to the fact that most of these organizations are located in the city, but there are a few research facilities - providing applied knowledge - in the surroundings too. In comparison, partners from outside the agglomeration are very important which reflects the global nature of modern science and research. At present universities and contract research organizations are equally important, both used by 15% of the firms. Technical colleges are still lagging behind (6%), but their importance is likely to grow because they have been established only recently.

The last category of innovation partners are providers of technology (see figure 4). It is a more important category than research. One third of the firms indicated relations with this partner category. But this is almost exclusively due to one type of partner, the commercial supplier of technology (31%). Technology, incubation and technology transfer centres are negligible. Only 1% of the firms use incubation centres, slightly more (3%) technology transfer organizations. What matters most in this category is the spatial structure. It is the only category where the most important spatial level for both urban and suburban firms is outside the agglomeration.

Figure 4: Location of local firms' (see fig. 1) partners providing technology



Source: Survey of innovation networks in the Vienna region.

Figures 1 to 4 show that there is a strong relation between city and surroundings concerning innovation, but this relation is unilateral. Suburban firms have strong links with the city while the networks of the urban firms are predominantly within the city. Looking at the importance of partners outside the metropolitan region, it seems that suburban firms are more oriented beyond the agglomeration than urban firms. Overall, partners in the city or its surroundings are especially for urban firms more important than partners from outside the metropolitan region. Of the firms located in the city 43% have business innovation partners in the agglomeration, and only 34% have such partners from outside. Regarding providers of financial resources 25% have local and 8% external partners, regarding suppliers of technology 21% have local sources and 20% external ones and as far as research partners are concerned 19% have local partners and 10% external ones. Suburban firms are less embedded in metropolitan innovation networks. Only their research partners are primarily in the metropolitan region (19% against 12% which are external). In all other categories partners from outside the urban region are more frequent than local ones: business 48% against 41%, finance 16% against 13% and technology 23% against 13%. In some sense suburban firms act obviously more as an interface between the urban region and the external world.

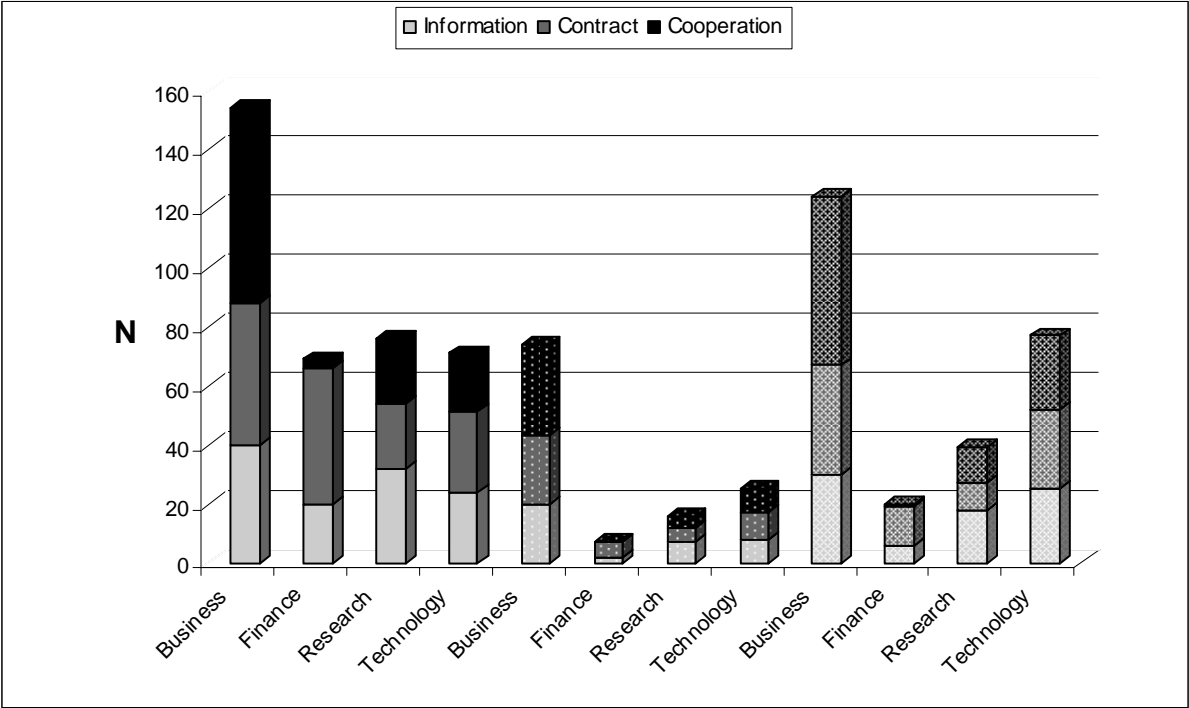
It is a matter of interpretation whether these results justify to speak of a metropolitan innovation system. We think that the urban firms are too concentrated on innovation partners within the city and suburban firms are too strongly oriented towards partners beyond the urban region for a coherent innovation system. There are several innovation networks within

the metropolitan region with certain special and important interrelations between urban and suburban firms. In the following chapter it will be analysed whether there are special functions of urban and suburban elements in the Vienna metropolitan region.

4 Functional specialisation in innovation networks of urban and suburban firms in the Vienna metropolitan region

Comparing the innovation networks of firms located in the city with those in the surroundings it is possible to find out whether there is some kind of specialization between urban and suburban firms. The comparison concerns the categories of innovation partners, their location and the types of relations. The following two figures present the results, first, from the perspective of urban firms (figure 5) and, second, from the perspective of the suburban firms (figure 6).

Figure 5: Innovation networks of urban firms (number of indications)
 Location of partners from left to right: city of Vienna (columns 1-4, full), surroundings (columns 5-8, dotted), outside the urban region (columns 9-12, hatched)



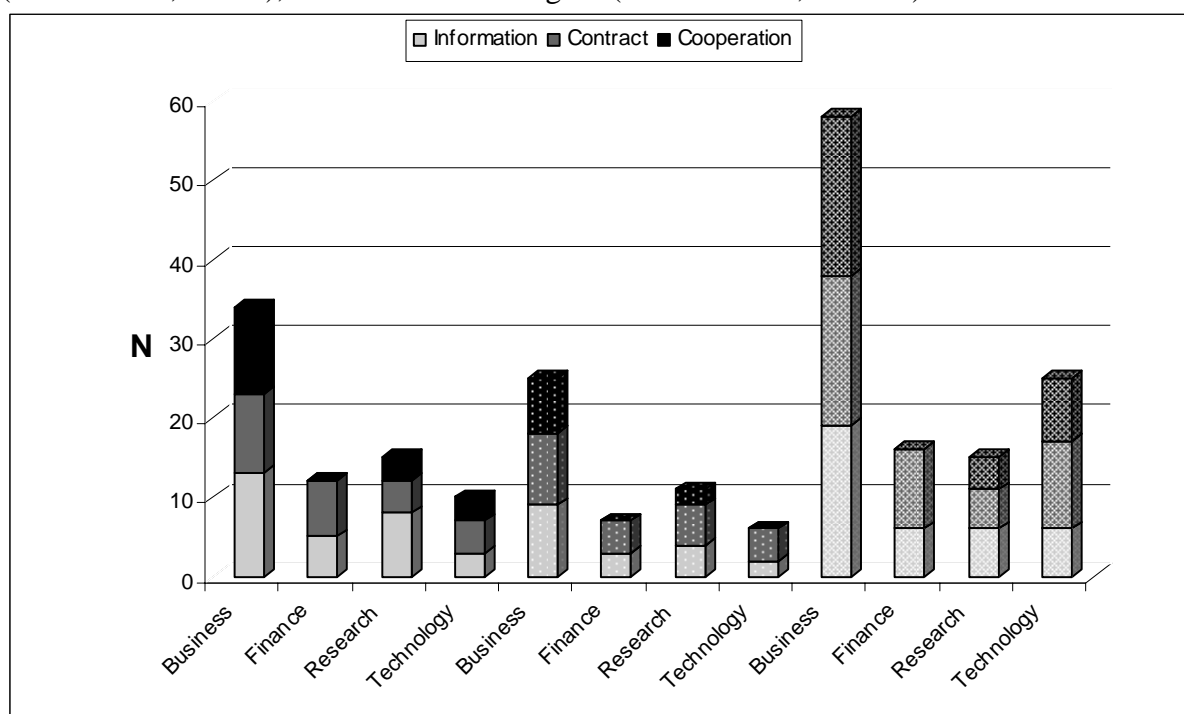
Source: Survey of innovation networks in the Vienna region.

Regarding the overall importance of the three spatial levels which have been distinguished in our survey the urban level ranks first, followed by the external level. The suburban level is least important. The only category of suburban innovation partners that matter for urban firms are business partners. This category is actually at all spatial levels the most important one. Regarding the type of relation, cooperation is the most important one in business and finance. Mere informal information relations less important, most relevant with research partners. Contract relations are most important in finance, the provision of venture capital, which is labelled as 'cooperation', is still of little importance. Contract relations are also rather important with business and technology partners (mostly firms too), but rare with research partners.

Looking at innovation networks from the perspective of suburban firms the picture is quite different. The results are presented in figure 6. Scales in figure 5 and 6 differ in order to be better readable. The number of indications of suburban firms is much lower than of urban firms.

Figure 6: Innovation networks of suburban firms (number of indications)

Location of partners from left to right: city of Vienna (columns 1-4, full), surroundings (columns 5-8, dotted), outside the urban region (columns 9-12, hatched)



Source: Survey of innovation networks in the Vienna region.

Suburban firms are less strongly involved in innovation networks within the Vienna metropolitan region (see section 3). Accordingly, the most important spatial level of innovation partners is outside the urban region. The city comes second and the suburban area is least important. The interrelation of suburban firms with both parts of the metropolitan region is rather weak. Business partners are again predominant, research partners seem to be comparatively more relevant than in case of urban firms. For suburban firms' innovation activities cooperation is comparatively less important than for urban firms while information relations are more important.

One can assume that there are other factors than location which make the difference between innovation networks of urban and suburban firms. We have controlled for the influence of features like sector, size and age on the structure of innovation networks by running several regression models. Overall, those features are rarely significant for explaining types of partners, their location and the kind of relation. In some cases the sector is significant. This applies, on the one hand, to innovation partnerships with suppliers, banks and technology transfer as well as with firms outside the urban region which are more likely in the case of manufacturing firms than producer service firms and, on the other hand, to services in general as well as firms and research in Vienna which are more likely in the case of producer services. Regarding size and age there are hardly any significant patterns besides the fact that micro-firms (with less than 10 employees) are more likely to have innovation relations with their customers and less likely to interact with research organizations than larger firms.

The following table summarizes the relative frequencies of all categories of innovation relations discussed above. The results suggest that there is some but rather weak functional specialization of the two parts of the metropolitan region of Vienna regarding innovation.

Table 2: Innovation networks of urban and suburban firms

% of urban firms with				% of suburban firms with			
Location	Partner	Relation		Location	Partner	Relation	
Urban	Business	Cooperation	28.3	Outside	Business	Cooperation	29.0
Outside	Business	Cooperation	24.5	Outside	Business	Information	27.5
Urban	Business	Contract	20.6	Outside	Business	Contract	27.5
Urban	Finance	Contract	19.7	Urban	Business	Information	18.8
Urban	Business	Information	17.2	Outside	Technology	Contract	15.9
Outside	Business	Contract	15.9	Urban	Business	Cooperation	15.9
Urban	Research	Information	13.7	Urban	Business	Contract	14.5
Suburban	Business	Cooperation	13.3	Outside	Finance	Contract	14.5
Outside	Business	Information	12.9	Suburban	Business	Information	13.0
Urban	Technology	Contract	11.6	Suburban	Business	Contract	13.0
Outside	Technology	Contract	11.6	Urban	Research	Information	11.6
Outside	Technology	Information	10.7	Outside	Technology	Cooperation	11.6
Outside	Technology	Cooperation	10.7	Urban	Finance	Contract	10.1
Urban	Technology	Information	10.3	Suburban	Business	Cooperation	10.1
Suburban	Business	Contract	9.9	Outside	Finance	Information	8.7
Urban	Research	Contract	9.4	Outside	Research	Information	8.7
Urban	Research	Cooperation	9.4	Outside	Technology	Information	8.7
Urban	Finance	Information	8.6	Urban	Finance	Information	7.2
Suburban	Business	Information	8.6	Suburban	Research	Contract	7.2
Urban	Technology	Cooperation	8.6	Outside	Research	Contract	7.2
Outside	Research	Information	7.7	Suburban	Research	Information	5.8
Outside	Finance	Contract	5.6	Urban	Research	Contract	5.8
Outside	Research	Cooperation	5.2	Urban	Technology	Contract	5.8
Suburban	Technology	Contract	3.9	Suburban	Technology	Contract	5.8
Outside	Research	Contract	3.9	Suburban	Finance	Contract	5.8
Suburban	Technology	Information	3.4	Outside	Research	Cooperation	5.8
Suburban	Technology	Cooperation	3.4	Urban	Technology	Information	4.3
Suburban	Research	Information	3.0	Suburban	Finance	Information	4.3
Outside	Finance	Information	2.6	Urban	Research	Cooperation	4.3
Suburban	Research	Contract	2.1	Urban	Technology	Cooperation	4.3
Suburban	Finance	Contract	2.1	Suburban	Technology	Information	2.9
Suburban	Research	Cooperation	1.7	Suburban	Research	Cooperation	2.9
Urban	Finance	Cooperation	1.3	Outside	Finance	Cooperation	0.0
Suburban	Finance	Information	0.9	Urban	Finance	Cooperation	0.0
Outside	Finance	Cooperation	0.4	Suburban	Finance	Cooperation	0.0
Suburban	Finance	Cooperation	0.0	Suburban	Technology	Cooperation	0.0

Source: Survey of innovation networks in the Vienna region.

Business relations are the most important innovation relations of both urban and suburban firms. Regarding the type of relation cooperation ranks first for both. Especially urban firms have more often such closer innovation partnerships than contract or mere information relations. The latter type is more important for suburban firms. Firms in the city have primarily partners in the city and outside, less in the surroundings. If they have suburban partners, however, they interact most often closely in cooperations. Suburban firms have more partners outside the urban region than in the city. For them, too, suburban partners are less important and are more of the information and contract type than cooperative.

The second most important class of innovation relations, in particular for urban firms, are with providers of technology. Partners outside the urban region seem to be slightly more important than urban partners in the case of firms located in the city and clearly more important in the case of firms in the surroundings. Contract relations are comparatively most frequent.

For firms located in the city relations with research partners are primarily within the city. The most frequent type of relation is information, contract and cooperation relations are less frequent. Relations with partners from outside are rare and those with partners in the surroundings negligible. The situation is similar in the case of suburban firms but the ranking of spatial levels is less pronounced.

Innovation relations with providers of finance are dominated by the city. For urban firms contract relations (i.e. the provision of grants and loans but not venture capital) are by far most frequent with urban organizations. For suburban firms partners from outside rank first, those from the city second. All other types of relations and providers of funds located in the surroundings are negligible.

5 Conclusions

Summarizing the findings from the innovation survey in the metropolitan region of Vienna it can be concluded that urban-suburban interrelations as far as innovation is concerned are too weak to argue for a metropolitan innovation system. There are strong intra-urban innovation networks, but only rather weak relations of suburban firms both with partners in the surroundings and in the city. Suburban firms have surprisingly loose innovation relations with the city, other types of relations like supplying intermediate goods and employing people are obviously much more intensive between these two parts of the Vienna urban regions.

Nevertheless, some kind of functional specialization can be observed. For suburban firms the city matters as the location of finance and research partners, in addition to the generally predominant business relations. But for urban firms, suburban partners hardly matter at all. It

seems that suburban firms, where manufacturing is still more important than in the city, have much broader innovation networks regarding their spatial scope. Partners from the city are only a small part of these networks. Urban firms, which belong overwhelmingly to the service sector, have a more pronounced local perspective, and for their extra-local relations there are too few partners in the comparatively small suburban area.

This is a challenge for Vienna's innovation policy. Due to the economic structure the focus must be on services, but for them to thrive, an industrial base is required which is more and more outside the city. Furthermore, manufacturing in the surrounding suburban area, which could, to some extent, compensate the loss of manufacturing in the city seems to have a more global perspective as far as their innovation networks are concerned.

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