Paul J.J. Welfens *Editor*

# Clusters in Automotive and Information & Communication Technology

## Innovation, Multinationalization and Networking Dynamics

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# Preface

Information and communication technology (ICT) and the automotive sector are two of the most important industries in the EU and the USA. Therefore, there is broad interest in the sectoral dynamics of these two sectors. ICT is an enabling technology that is used by every sector and the automotive is one of the strong sectors in the Old Economy that heavily relies on ICT for product and process innovations. The ICT sector—while heterogeneous with respect to the subsectors—is leading in terms of innovation performance both in the USA and in the EU. A key trait of the ICT sector is that firms and innovators rely on digital networking and the opportunities to exploit regional (and international) clustering dynamics: While part of the new knowledge is codified and can easily be transferred to firms or innovation partners around the world, there also is a considerable element of tacit knowledge that is only diffused on the basis of face-to-face contacts and the mobility of skilled labor/inventors across firms. Cluster building has been an endogenous growth element in the Silicon Valley and there is no doubt that the regional innovation system—including venture capital financing and specialized universities—and the innovation dynamics of leading ICT firms as well as start-up companies have created a critical minimum of networked knowledge. Several regions in the EU have also tried to create dynamic ICT clusters and this study looks into seven regions of six EU countries to highlight the regional ICT dynamics observed. Moreover, we also look into cluster dynamics in the automotive sector which has undergone enormous changes in the context of the EU eastern enlargement: Many countries in Eastern Europe have attracted production of automotive parts or of motor vehicles which has put pressure on automotive regions in Western Europe. Relocation within the new Europe is taking place in the automotive industry, but this does not mean that there is a full transfer of technology through foreign direct investment. The analysis presented here for selected key countries of EU27 suggests that creating innovation networks in Eastern Europe is a sluggish process and that the international division of knowledge within multinational companies is quite asymmetric across countries. The general idea that the level of technology is the same across OECD countries—a typical assumption within modeling on the basis of the Heckscher–Ohlin approach —is quite doubtful even if some countries in some sectors probably stand for similar technology levels; the analysis of technological networks shows how strong these networks in crucial sectors of leading western European countries are and how difficult the creation of technology networks even in advanced regions in eastern Europe is. By implication, factor rewards will not converge easily across countries and even if factor rewards were the same in both countries (in a two-country model) the existence of asymmetric foreign direct investment implies that GNP per capita is not converging across countries—an idea that has been explicitly emphasized in Innovations in Macroeconomics (a book that is now in the third edition).

The analysis not only contains new analytical findings, but also has several clear implications for rational policymakers. For instance, there is urgent need to monitor the innovation dynamics in EU cluster regions. The European Commission has established a unique cluster observatory and some of the results available from the EU have been reproduced in this study; however, it is not fully clear so far that cluster projects of EU countries have been a consistent element of the innovation policy of the Community and of the Lisbon 2010 Agenda, respectively. Thanks to the presented case studies, one can also understand that there are some key ingredients for success for ICT clusters and automotive clusters, respectively. It is not possible to have a dynamic regional ICT cluster without involving universities and specialized research centers. As regards the automotive industry, there is clear evidence that the regional supplier networks are rather mobile within the EU27. While supplier networks are relatively mobile across countries, knowledge networks that have grown over many years or even decades in western EU countries are not easily replicated in EU accession countries. Even in eastern European EU accession countries with considerable automotive production by automotive companies from EU15 countries, there is no evidence that comprehensive regional knowledge networks or mobility networks can be created relatively quickly in Eastern Europe. Headquarter countries of automotive multinational companies face the advantage that innovation is a relatively centralized sphere of overall value-added and there is no inherent interest of the headquarter to make knowledge generation a much internationalized and flexible element of overall value-added. Certainly, headquarters of MNCs have a strong interest to give subsidiaries abroad access to the latest technologies within the MNC, but such access is only available for fees paid by the subsidiaries abroad and certainly MNCs are reluctant to establish strong innovation activities in subsidiaries abroad (China as a location is a different case, since China apparently has enough politico-economic leverage over western firms to not only transfer technologies to China but also establish some regional R&D activities in this big and fast growing economy—foreign firms would often not benefit in a significant way from China's public procurement if the firm is not undertaking at least some R&D in certain locations in China).

The results presented in this study are mainly the outcome of the cooperation between researchers of the European Institute for International Economic Relations (EIIW) at the University of Wuppertal and the Hungarian Institute for World Economics in Budapest. We are grateful for the support from the Hans Böckler

Foundation (Düsseldorf) and in particular to Mr. Marc Schietinger who has supported our activities with many suggestions from the Scientific Advisory Board active under his leadership. The findings presented cover only part of the analytical ground for understanding regional adjustment dynamics in the ICT sector and the automotive sector in the EU. More research is to be conducted in the future.

The EIIW is grateful for the funding of this project by the Hans Böckler Foundation and a broader network—including trade unions ver.di and IG Metall as well as local savings associations (Stadtsparkassen) in the Bergish City Triangle Wuppertal, Remscheid, and Solingen. As regards the calculation of technology networks on the basis of EU patent statistics, we have relied particularly on the excellent work of Zafir Mahmutovic and Oliver Emons at the European Institute for International Economic Relations (http://www.eiiw.eu). Jens Perret has been responsible for calculating the indicators relevant for international competitiveness—that is the Revealed Comparative Advantage (RCA) and the Export Unit Values (EUV). The organization of workshops was handled swiftly by Mr. Christian Schröder, EIIW at the University of Wuppertal, and colleagues from the Hungarian Academy of Social Sciences in Budapest.

As regards the editing of this book we very much appreciate the support by Lilla Voros, University of Birmingham. Finally, we appreciate the facilities used at the Schumpeter School of Business and Economics at the University of Wuppertal.

Wuppertal Paul J.J. Welfens

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# Chapter 1
# Regional Innovation and Cluster Policies in the New and Old Economy

**Paul J. J. Welfens**

## 1.1 Introduction

Information and communication technology (ICT) is a driver of structural change and economic growth in OECD countries. As the relative price of ICT capital goods is expected to continue to fall, the share of ICT capital in the overall capital stock will increase, and as the use of ICT capital is considered to be a major driver of productivity growth, there are excellent prospects for higher growth in OECD countries (here we, of course, disregard the problems of the transatlantic banking crisis). Since the 1990s, policymakers in the EU have increasingly emphasized the role of ICT for economic growth, and often, regional cluster policies were adopted by national or regional policymakers in EU member countries. The EU Lisbon Agenda adopted in 2000 has encouraged the expansion of digital networks as a means of the knowledge society. ICT networks are natural elements for networking among firms and hence for the creation of sectoral regional clusters.

The idea that regional clusters can contribute to growth is related to dynamics within a region in which the presence of many—partly complementary—firms from the same sector generate specialization gains and enhanced innovation performance so that regional and national innovativeness are reinforced. This is the basic idea of Porter (1998) who has emphasized the role of clusters for regional economic development, productivity growth, and international competitiveness.

The ICT sector (EITO 2002, p. 454) can be broadly defined by three subsectors:

- Information technology, including IT services
- Telecommunications equipment (including equipment for communication infrastructure networks)
- Telecommunications services.

In the field of telecommunications services, the EU has adopted comprehensive liberalization in network operation and voice telephony—with some transition periods for eastern European accession countries. In many EU countries, the government has pushed for the expansion of broadband telecommunications so

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that the opportunities to generate and exploit knowledge on the basis of faster networks are reinforced. According to figures from the ITU (2010), a 10% rise in the broadband penetration rate will generate a 1.3% increase in output; this, however, is a transitory effect and further impulses on output growth, dependent on structural change and competition as well as the specific approaches in various countries and regions with respect to using digital services and new knowledge, respectively.

### *1.1.1 Towards a Schumpeterian Network Theory*

How can we characterize the Schumpeterian force of a network in a given region—assuming that the network is facing international competition with other networks in other countries and regions? The basic hypotheses used here are as follows:

- The Schumpeterian force is higher the larger the network is (at least until a critical point of saturation is reached); basically, it may be assumed that $F$ is a function of the size of the network as indicated by the number of direct and indirect links. Overcentralization certainly would not raise $F$; therefore, an intelligent division of labor among first- and second-tier firms, etc. should be useful. Indirect links can be measured through the betweenness centrality $C_{\mathrm{B}}$, while the number of direct links is measured through the centrality indicator $C_{\mathrm{D}}$.
- Moreover, in a knowledge network, part of knowledge is tacit knowledge, which cannot be easily transferred across firms. It is necessary to have some minimum mobility ($M'$) of innovators/inventors across firms.

At the bottom line, it may be argued that a country's revealed comparative advantage—that is, the relative sectoral export–import balance relative to the aggregate export–import balance—as well as the export unit value of a sector should be a positive function of $F(C_{\mathrm{D}}, C_{\mathrm{B}}, M', N' \ldots)$, where $N'$ is the number of regional networks in a given sector in the country considered. If several firms have jointly submitted a patent application, it may be assumed that the technology field is relatively complex—more complex than if only one inventor would be on the patent application—and for more complex products, higher relative world market prices or higher export unit values can be earned. In some sectors, it may be adequate to calculate the benchmarking export unit value, which is defined as the ratio between the export unit value of the home country to the average global export unit value (or the export unit value of the world's leading economy; this is a rough approximation only). The higher the Schumpeterian sectoral force $F_i$ in sector $i$, the larger—possibly with some delay—the revealed comparative advantage of the respective sector should be. If the number of regional networks is proportionate to the size of the economy, so that $N' = n'Y$, $N'$ could be replaced by $Y$ (assuming that $n'$ is a positive parameter); the idea—which is in line with standard arguments of Porter—is that competing clusters in an economy breed diamonds, that is, reinforce the quality and sophistication of the final product considered. A more refined final product requires more sophisticated and more complex intermediate products so that more complex clusters might emerge at the level of intermediate products. However, in an open economy with multinational companies conducting research both at home and abroad—this amounts to "Schumpeterian globalization"—it may be argued that $F = F(C_D, C_B, M', Y, Y^*)$. This function thus assumes that regional and national impulses—the latter concerning the size of GDP ($Y$) in the home country and in the foreign country ($N^* = n'^*Y^*$ indicates the role of the number of networks abroad where $n'^*$ is a foreign positive parameter and $Y^*$ is foreign GDP)—contribute to the Schumpeterian force of a regional network. It may be assumed that the argument of the function $F$ is increasing in all "quasi-input factors" and has declining second derivatives. Thus, we have an interesting element for a refined approach in industrial economics.

The relevant indicators $C_D$, $C_B$, and $M'$ can be calculated from social network analysis, which is a well-known mathematical tool in part of social sciences. It can be applied as much to innovation analysis as to international trade networking and to the analysis of the vulnerability of the banking network and financial instability risk.

Hence, innovations and RCA positions are partly related to network dynamics, and the specific analytical innovation suggested here is that the competitiveness of a given sector can be explained from the interaction of regional network traits plus national impacts (as proxied by $Y$) and foreign impacts (as proxied by the variable $Y^*$).

Let us consider a certain region with a network of firms, where firms are active in the same sector and are aiming for high innovation performance that can be measured through patent applications. Joint patent applications—patent applications that carry the names of inventors from at least two different firms (which could be part of a multinational company or not)—are part of Schumpeterian network activities, as is researcher mobility between firms that bring about diffusion of knowledge, particularly of tacit knowledge. Networks can be described through various parameters.

- The average degree centrality $C_D$ can be calculated so that an understanding of the role of key actors can be acquired. The formula for the degree centrality is given by:

$$C_D(n_i) = \frac{d(n_i)}{g - 1}. \tag{1.1}$$

If one puts the focus on patent applications, $d(n_i)$ is the number of all neighboring points of the applicant $i$. $g$ is the size of the network and $d(n_i)$ is the degree, the number of connections, of actor $i$.

- Moreover, the size of the wider network activities can be assessed by the betweenness centrality $C_B$ which takes into account the intensity of indirect links between the hub (central actor) and actors not directly linked to the hub actor. The formula for the "betweenness centrality" is given by:

$$C_B(n_i) = \frac{1}{g_{j_k}} \sum_{j<k} g_{jk}(n_i). \tag{1.2}$$

Betweenness centrality is defined as the average numbers of relations between two partners ($g_{jk}$). It is not fully clear how the optimum cluster size and network intensity can be determined. However, the basic idea of cluster analysis is that the growth rate of patents should be positively affected by relevant network parameters. This should hold for both the sector of information and communication technology, which itself has a natural starting point for Schumpeterian networking, namely the fact that ICT is based on digital networks and networking of companies and inventors, respectively. From this perspective, ICT patents in a given period can be explained by various network parameters.

As regards the developments of ICT clusters, there are several key issues that partly refer to innovation dynamics:

- Has the degree centrality ($C_D$) of the cluster increased over time? A rise in $C_D$ indicates that central actors in the network of the region have reinforced their respective position; if $C_D$ has fallen, the number of network actors has increased.
- Has the mobility of innovators ($M'$) increased over time?
- Has the betweenness centrality $C_B$ increased over time so that a wider indirect network has emerged over time?

These and other issues are evaluated on the basis of the data bank of the European Patent Office, namely for 1992–1999 and 2000–2007. Subsequently, key findings from the data bank developed at the European Institute for International Economic Relations will be presented.

The broader analysis presented in this study has two key focuses, namely on regional innovation dynamics and structural change in seven selected regions of six EU countries. As the ICT sector is an enabling technology affecting all sectors using ICT—while the ICT sector itself is highly innovative—there is a special interest in the innovation dynamics of ICT clusters; such clusters are largely defined by regional clustering (although international and interregional links also play a role). However, even in a sophisticated digital sector, such as ICT, there is a certain need to organize regional networking of innovators as is amply borne out by the Philips science park in Eindhoven where about 1,000 scientists and engineers cooperate with about 1,000 colleagues from international competitors; the crucial role of tacit knowledge in innovation implies that at least some face-to-face communication and joint local experimentation can be quite useful and often decisive for leading-edge technologies. In a more general sense, supplier networks as well as networking among similar firms engaged in specific layers of the value-added process can play a key role for successful clusters. Such clusters enhance regional growth and employment that are likely to benefit from dynamic competence building, which enhances the competitive edge of the firms active in the respective cluster. In many EU countries, cluster policies have become popular elements of economic policy; in Germany, several states—above all North-Rhine Westphalia (the most populous state, which has established a special cluster secretariat) and Bavaria (one of the economically leading states)—have adopted an active cluster policy at the beginning of the twenty-first century. The UK, Austria, the Netherlands, Sweden, and Hungary are among the countries that are partly covered here. The ICT sector as well as the automotive sector is of key importance for many EU countries, and therefore, the sectors considered are economically crucial.

At the beginning of the twenty-first century, ICT had been most crucial for the economy in OECD countries; at the same time, this sector was often underestimated since the relative share of ICT value-added in total GDP—based on current prices—was only about 5% in Germany and in some other EU countries in 2010. However, in real terms (evaluated in prices in 1995), the share of ICT was roughly twice as high—the ICT sector is characterized by prices that continuously fall over time. One economic implication from this latter trend is that the share of ICT capital in the total capital stock of most economies will continue to grow in the long run. Moreover, many ICT goods are classified as high-technology goods, and they are characterized by economies of scale that stimulate the expansion of ICT; and finally, there are many digital services that stand for network effects, and this effect amounts to generating endogenous growth of demand for the respective service. The combination of economies of scale and network effects strongly stimulates the expansion of the ICT sector. It is clear that countries and regions are, respectively, differently specialized. At the same time, it is also obvious that the increasing use of ICT makes most industries more "footloose"; that is, ICT facilitates regional, national, and international outsourcing and offshoring.

ICT goods are often high-tech products, and this can be covered through patent statistics. By contrast, digital services are rather differentiated in terms of technology intensity, and while high skill intensity is a natural element of ICT services, only part of these activities can be characterized by strong patenting activities (in the EU, copyrights, of course, play a critical role for software; in the USA, there are explicit software patents).

In recent economic history, one may point to the dynamics of the Silicon Valley ICT cluster as an example of successful regional ICT clustering in the USA (Hellmann and Puri 1999); it may be emphasized that part of the early ICT clusters in the Silicon Valley emerged in a rather spontaneous process related to leading universities in the region that all had a particular strength in computer science—in addition, broad access to venture capital for high-technology start-ups as well as the strong wave of skilled immigrants/foreign students from India, China, and other Asian countries was part of the success story in California. Similarly, there were also ICT clusters emerging around dynamic university activities and the creation of small business around a network of regional universities; both Massachusetts and Texas can be mentioned in this context. In the EU, there are regional ICT success stories that have benefitted from government support: Sophia-Antipolis in Southern France, Scotland's ICT cluster, and a strong ICT cluster in Ireland stand for particularly strong cases of regional clustering in Western Europe. In Germany, the high-technology initiative of the German government has helped reinforce an ICT cluster around the region of Darmstadt–Heidelberg–Kaiserslautern—the German government supports ICT cluster activities in this city triangle which combines the competences of top universities and high-technology companies, including the global player, SAP, whose headquarter is close to Heidelberg (Meijers et al. 2008).

As regards innovation dynamics, the ICT sector has been No. 1 in both the USA and in the EU in the first decade of the twenty-first century. It is also notable that the subsector telecommunications offers a crucial infrastructure platform on which modern digital services are provided—increasingly on a broadband basis, both in the fixed-line network and in mobile telephony. Modern telecommunications networks are most crucial for networking activities of inventors, innovators, and venture capitalists. As regards general access to broadband services, one may point to Korea and a few other countries in Asia; in Europe, it is only Finland that has adopted the principle of broadband digital services. In effect, it should not be too difficult to implement broadband mobile services on the basis of LTE, the next mobile telecommunications standard that is facing rollout in the EU in the second decade of the twenty-first century. Finland is the first country in the EU that has adopted broadband universal services so that every citizen has full access to broadband services. Societies that use fast broadband communications networks not only face favorable prospects for networked innovation activities but fast diffusion of new digital services as well. It is noteworthy that Scandinavian countries are often considered as leading markets. Therefore, innovative firms use these countries as a testing ground for the most advanced new products and services (Beise 2005).

Many western EU countries that are high-wage economies face strong pressure to quickly adopt new digital technologies, not least because these allow for strongly raising labor productivity. Improving skills of employees and workers as well as the digital knowledge of entrepreneurs is a key challenge for EU knowledge societies willing to fully exploit the advantages of digital networks. It should not be ruled out that the expansion of the ICT sector and of ICT technologies goes along with a rising demand for skilled labor and hence increasing wage dispersion as measured by the wage ratio of skilled workers to unskilled workers.

A well-known example of regional ICT clustering is the Helsinki region in Finland. Finland's economic policy had started the promotion of a regional ICT cluster in the 1990s, not least because the ICT sector itself drives economic globalization. Having a dynamic ICT sector in Finland, therefore, should not only stimulate economic growth through the sector's technology dynamics but the growth of ICT output as well. In addition, a strong ICT sector should allow both the regional and national business community to understand modern globalization dynamics better and earlier, including the dynamics of digital international outsourcing and offshoring. The Internet economy to a large part is a truly global economy for digital services.

In Finland, Nokia plays a crucial role in the regional ICT network; however, it is also important to note that Finland was able to attract ICT firms from Sweden and the USA. Part of the Finnish ICT sector is ICT producing, not just using ICT services; the ICT-producing sector typically has a high rate of technological progress. The traditionally strong Finish company, Nokia, and the Finish ICT sector have been reinforced by an internationally shaped ICT cluster. Foreign ICT firms stood for about 15% of all ICT firms and 20% of all employees in the Finish ICT cluster (the Finish government assumes that globalization implies a bigger role of cities in the future, and hence, agglomerations are considered as a future platform relevant for successful economic globalization).

It is interesting to put the focus not only on countries producing ICT goods but also on those that are mainly users of ICT. Among those countries is Spain, where both the industry and the services sector are major users of modern ICT. Despite an increasing use of ICT in the Spanish economy in the 1990s, there was no measurable productivity acceleration related to ICT. However, in the period of 2000–2004, the productivity performance improved. This suggests that there could be considerable lags in productivity dynamics, and it is also clear that a short-term increase of the use of ICT will not automatically raise productivity. Among the many countries in Europe that have emphasized ICT clustering as a means to enhance economic growth are many countries, including countries with a high per capita income such as Germany, Switzerland, and Finland, but also low per capita income countries such as the Czech Republic and Hungary. As regards Germany, the national high-tech strategy has played a certain role in promoting regional ICT clusters.

The EU has stimulated research and development in the ICT sector over many years, particularly within the 6th framework program (and previously in the 5th framework program): The European Commission has emphasized the field Information Society Research and Technological Development (IST-RTD).

Among the interesting international studies on IST networks, there is a comprehensive study by Breschi et al. (2009), who look into specific indicators reflecting successful network dynamics: The authors emphasize the number of patents, the number of quotations of patents, and patents with a relatively high frequency of quotations by other inventors who had applied for a patent. Among the indicators considered were also the degree centrality and the betweenness centrality (the intensity of network partners beyond the direct links). Compared to other innovative sectors, IST-RTD actors showed a relatively high degree of centrality, to the extent that big firms/global companies were active in a hub position in the network. Those big firms were very active and important in the network. It is therefore clear that analyzing network dynamics in the ICT sector is crucial.

## 1.2 ICT and Structural Change

The expansion of ICT has created new markets and contributed to massive structural change in many OECD countries (Welfens 2008; Meijers et al. 2008). As regards the strong impact of ICT on growth and structural change, it is remarkable that the number of patents per capita has increased strongly over time in many OECD countries—with the USA being a leading country in the OECD. The US lead in the ICT sector is remarkable as US companies from both the ICT-producing subsector and the software sector have shown very strong performance over time; at the same time, the expansion of US ICT has stimulated the growth of the US services economy. Since many digital services can only be provided on a broad scale for industrial clients, the ongoing deindustrialization of the USA raises some concerns. Certain developments in the UK and in some continental EU countries are following the pattern of the USA; however, western EU countries have a particular advantage since EU eastern enlargement not only amounts to the creation of new markets for digital products but also allows the ICT sector of EU15 countries a rather favorable international offshoring and international outsourcing within the EU single market. Eastern European accession countries with low wages and sustained growth are increasingly important as locations of ICT industry. US companies have also taken advantage of EU eastern accession countries, namely through EU subsidiaries.

The expansion of ICT in Europe and worldwide has stimulated structural change as relative factor prices have changed (with the price of ICT capital falling), while many digital innovations have created new markets or contributed to falling costs of production. The number of patent applications per capita at the US Patent Office strongly increased in the decade after 1995 where Luxembourg, Finland, and Sweden—with about 40 ICT patent applications per 1 million inhabitants in 2008—were leading EU countries, followed by Germany, the Netherlands, Ireland, the UK (about 20 patents per 1 million inhabitants) and France, Denmark, Austria, and Belgium; at the end of the league of EU15 countries is Italy, Portugal, Spain, and Greece (with about 4 patents per capita), and this finding is already part of an explanation for slow productivity growth and lack of international competitiveness in these two countries for many years (Jungmittag 2010) (Fig. 1.1).

In Germany, the number of workers in the ICT sector has increased continuously between 1998 and 2008. ICT is defined as the media sector (with about 2 million gainfully employed in 1998 and 2006) and the IT sector (with 2 million employed in 1998 and about 2.8 million in 2008). The share of ICT in total employment has gained over time, the increase in the number of people employed is particularly remarkable in the software sector, where employment has roughly doubled from 0.5 million in 1998 to more than 1 million in 2008 (data from Bundesagentur Für Arbeit). Germany's government has decided in 2010 to promote a high-tech cluster ICT in the area around Darmstadt–Heidelberg–Kaiserslautern. Thus, focus needs to be put on an area with a modern innovation system and visible strength in ICT (including such companies as SAP and Software AG). The support for this region in the southern/central part of Germany is a disappointment for other German regions that are eager to promote existing regional ICT clusters; in North-Rhine Westphalia, the region of Dortmund has been strong in ICT for several decades. Other EU countries have also emphasized building ICT clusters; the Vienna Region is of particular interest as the government has undertaken considerable initiative to promote the ICT sector in the Vienna Region, which has important clients as well as a highly educated workforce and a strong regional innovation system. Subsequently, we will take a critical look at the network dynamics in the regions of Vienna and Dortmund—followed by further case studies in several EU countries. The analytical perspective puts the focus on cooperation networks that stand for networked patent applications (showing regional clustering) as well as mobility of inventors. The combination of cooperation networks and mobility networks is also shown for selected regions—the combined network is dubbed the relationship network.

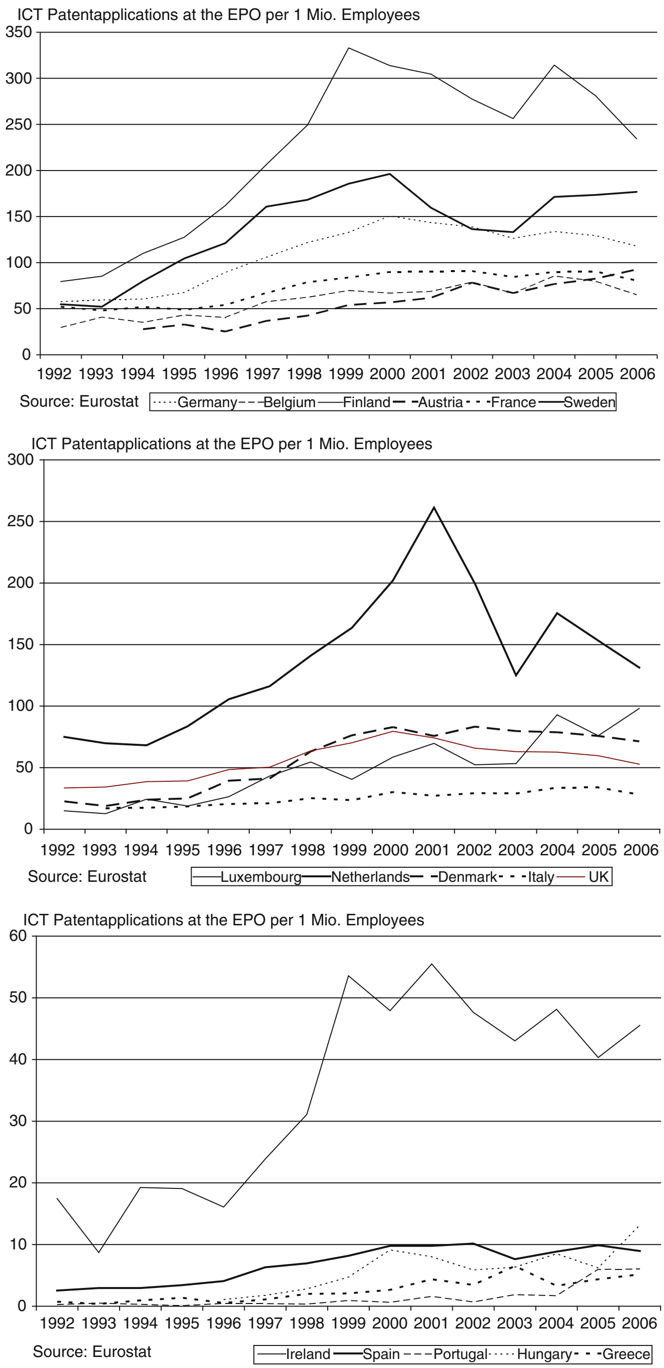



**Fig. 1.1** ICT patent intensity—European Patent Office

## 1.3 ICT Regions

### *1.3.1 Vienna Region*

Research on the Vienna Region shows that the ICT network has not achieved an internationally leading position. As regards policy options, the analysis has some crucial implications (KMU Forschung Austria/FHG ISI 2007, p. 6); one important aspect of the ICT sector is that information and communication technology is a rather broad heading; therefore, a useful clustering strategy is required to develop a specific focus on an adequate subsector—and there is the problem that the region should be able to develop a critical minimum number of innovative firms active in the regional network. Cluster mapping analysis shows that successful clustering strategies are rather rare. Many ICT firms are rather small, and there are only a limited number of high-technology start-ups, often coming from universities. Comprehensive locational policy could be an important element of economic policy, which emphasizes international locational marketing. Governments might try to stimulate the demand for local ICT services, and this requires taking the role of non-ICT sectors and non-ICT firms (including big firms) into account.

It is not clear that this critical view on the ICT sector of the Vienna Region is adequate. Basically, four criteria may be emphasized for developing a successful cluster:

- It is necessary to achieve a critical number of firms in a given region.
- It seems to be crucial that knowledge-intensive firms of the region should develop closer networks over time.
- There should be a certain mobility of inventors across firms so that tacit knowledge is characterized by minimum mobility.
- Over time, a rise in relative real value added and employment should be seen.

Looking at the Vienna Region, the analysis reveals several interesting results:

- Positive development is observed in the field of patent cooperation over time: The network of 2000–2007 is more complex than that of 1992–1999. The centrality index has declined as networks have become more complex.
- There is certain mobility of innovators—already in the initial period of 1992–1999—and mobility across firms has slightly increased over time. However, one should not be surprised that innovator mobility is rather small since there are strong incentives for firms to raise remuneration for active innovators of the company over time.
- Both value added and employment in the ICT have increased over time in the Vienna Region.
- At the bottom line, the Vienna Region—according to the analysis developed at the European Institute for International Economics—may be considered to stand for a successful clustering approach.

Snapshots on the Vienna ICT Region

- "In 2005 around 8300 ICT companies were located in Vienna Region. This accounts for about 57% of all Austrian ICT companies. The ICT companies employed about 73,200 people, which accounts for about 66% of all employees in the ICT sector" (p. 27).
- "The ICT sector generated revenue of approximately 21.2 billion € and gross value added of around 7.5 billion € in 2005" (p. 2).
- "The regional gross value added of ICT companies is almost 6.5 times higher than gross value added of the tourism industry" (p. 1).
- "In 2001 around 89% of Vienna's ICT companies employed 9 people at most, 9% had 10–49 employees and only 3% had more than 50 employees. 99% of Vienna's ICT companies were small and medium-sized enterprises" (p. 29).
- "The vast majority of ICT companies (97%) in Vienna are located in the service industry" (p. 31).

*Source*: http://www.wien.gv.at/wirtschaft/eu-strategie/wirtschaft/pdf/ikt.pdf (Figs. 1.2–1.5)

## 1.3.2 The Region of Dortmund and the Bergisch City Triangle

Germany's largest state has promoted ICT in the region of Dortmund that consists of the cities of Dortmund, Hamm, and Unna. This area had a strong focus on iron and steel over decades, but since the 1980s, local and regional policymakers have

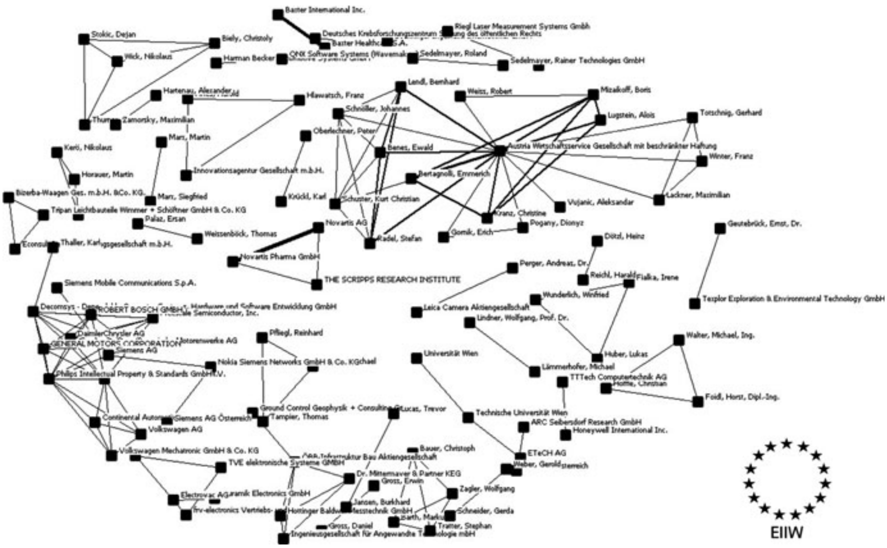



**Fig. 1.2** Cooperation network ICT—Vienna Region 2000–2007. *Source*: EIIW calculations

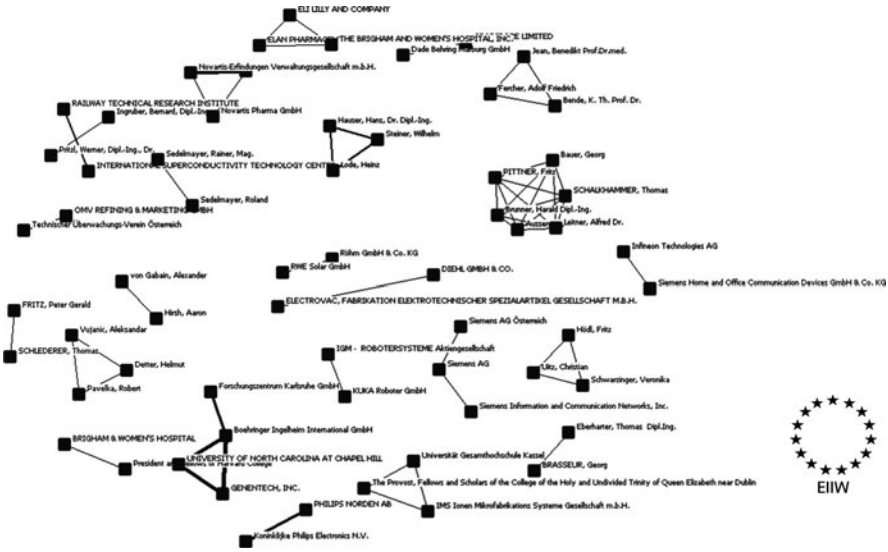



**Fig. 1.3** Cooperation network ICT—Vienna Region 1992–1999. *Source*: EIIW calculations

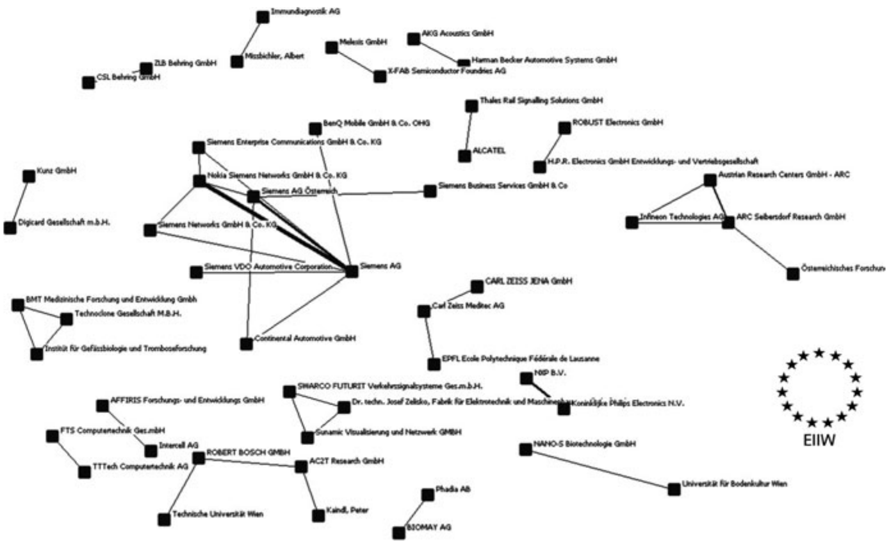



**Fig. 1.4** Mobility network ICT—Vienna Region 2000–2007. *Source*: EIIW calculations

tried to rejuvenate the region through several initiatives and the ICT sector has been promoted strongly. The Technical University of Dortmund—with a strong focus on computer science—has played a key role for the expansion of the regional ICT sector. Monse (2008) has characterized North-Rhine Westphalia as the state with

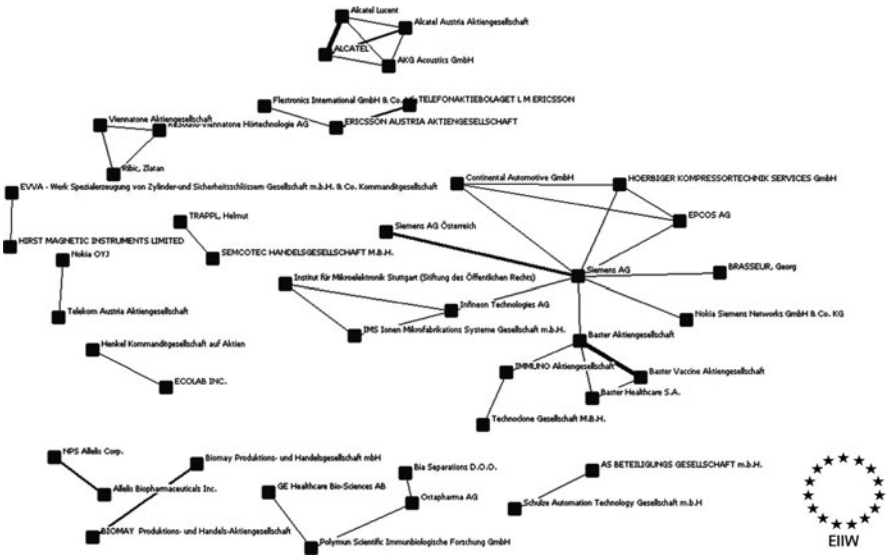



**Fig. 1.5** Mobility network ICT—Vienna Region 1992–1999. *Source*: EIIW calculations

the highest density of ICT firms in Germany and also as one of the leading regions in the subsector of telecommunications (with more than 1,000 firms and about 49,000 people employed). Moreover, North-Rhine Westphalia is also a strong region in the field of software development—with more than 14,000 firms and more than 90,000 people employed; key fields emphasized for the ICT sector of the state of North-Rhine Westphalia are:

- RFID chips that are crucial for intelligent logistics systems (there are passive RFID vs. active RFID—an active RFID uses a special active signal)
- Mobile communications
- Geodata information systems

The cooperation network in the leading ICT region of (Industrie- und Handelskammer zu Dortmund 2009) has remained rather weak; it has not really grown over time. The mobility network also is relatively weak—the network in 2000–2007 is not stronger than in the period 1992–1999. These developments are sobering since the state of North-Rhine Westphalia has started a cluster initiative aimed at stimulating ICT clusters. However, as regards ICT employment in the Dortmund region (Dortmund, Hamm, and Unna), one may emphasize here that the number of ICT jobs has continuously grown over time. Moreover, the number of firms also has increased in the ICT sector. While the Technical University of Dortmund certainly is a strong actor in the regional innovation network, one should emphasize that the rapid decline of traditional steel industry in the region of Dortmund has weakened the regional client base for certain ICT services. Part of regional ICT services has a focus on insurance industry and other financial services which have expanded in the region over time. There also is a lack of big international ICT firms.

#### 1.3.2.1 Bergisch City Triangle

The Bergisch City Triangle is composed of Wuppertal, Remscheid, and Solingen (famous for the production of knives and scissors) that are located northeast of and close to Cologne. This triangle stands for about 630,000 inhabitants. The share of the manufacturing industry in this area exceeded that of the state of North-Rhine Westphalia by about 10% points, whose output in manufacturing was slightly above the average for Germany in 2008. Given the strong fall in the number of industrial firms—the number of firms with more than 20 employees has fallen by 34% and the number of employees by 54% in the 15 years since 1991—it is obvious that there is a strong structural change in the Bergisch City Triangle. It also is noteworthy that the Bergisch City Triangle has been integrated into an EU-2-structural program of the state of North-Rhine Westphalia. The state government has invested more than €1 million for the development of new products and for enhancing locational promotion; however, the focus is mainly on the production of capital goods and blades/knives/scissors. It is not really clear that there are positive external effects from this promotion that would justify this focus.

Interestingly, the share of the ICT sector in the Bergisch City Triangle is rather small in the field of employment. The share of employment in this triangle was close to 1.5% in 2009 (Wuppertal leading with 1.6%, trailed by Remscheid and Solingen that both reached 1.3%). This is less than one half of the state average of 3.2%, but it is all the more noteworthy how strong the performance in the field of ICT patent application in the Bergisch City Triangle is; to some extent, it seems ICT firms that are not mainly specialized are strong in ICT patent applications, but there are firms from the manufacturing industry (e.g., heating and car manufacturing (Ford)) as well as the chemical industry (Bayer whose historical roots are in Wuppertal where the company still has its main R&D center) that have applied for patents in the ICT sector. Apparently, some of the main users of ICT are themselves strong in developing new ICT applications and innovative digital products.

At the beginning of the twenty-first century, several of the SMEs in the regions stand for hidden champions with a very strong international market position. Since ICT is an enabling technology that is used intensively by all technology and knowledge-intensive industries, there are interesting opportunities for the regional New Economy to find a growing client base in the regional manufacturing industry. Moreover, several entrepreneurs in ICT have created dynamic firms that offer innovative services (e.g., Riedel Communications). The Bergisch City Triangle's relationship network has grown over time in the field of ICT; both the cooperation network and the mobility network have expanded. The most notable feature from regional patent statistics is that the number of ICT patents in the Bergisch City Triangle has exceeded that of the traditional leader in North-Rhine Westphalia, the Dortmund region, in 2000–2007. The chamber of commerce in the Bergisch City Triangle has so far not picked up the topic of ICT expansion. One may recommend that both business associations and the state of North-Rhine Westphalia should encourage excellence in ICT networking more strongly. The new government of

North-Rhine Westphalia (coming into office in 2010) has emphasized the concept of lead markets—in line with the new strategy of the European Commission. For the state of North-Rhine Westphalia, there is a considerable challenge in the field of ICT (not least in comparison to Baden-Württemberg and Bavaria where regional governments have strongly pushed ICT for many years). However, it should also be emphasized that both the traditional Ruhr area—with the region of Dortmund as a key player—as well as the Bergisch City Triangle and the media centers of Cologne and Düsseldorf have strong potential for ICT expansion. Empirical analysis on the region of North-Rhine Westphalia has pointed out that North-Rhine Westphalia has suffered a relative decline in its technology position in the late 1990s when Hamburg and Baden-Württemberg marked the top of the technological frontier among Germany's region; it was found that the lack of high-technology services was a major reason for the decline in the technological position. While the state of North-Rhine Westphalia has decided to create new universities, there has—surprisingly—been no emphasis on high-technology services. Here the regional government faces a true challenge. The government has decided in 2011 to eliminate tuition fees at state-run universities in North-Rhine Westphalia (typically €1,000 per year) in order to broaden the access to higher education. However, it is surprising that the government has not allowed at least a group of universities to experiment with tuition fees in the sense that one might have eliminated tuition fees in the first year (to take account of the fact that studying at a university is an experience) but could have allowed differentiated fees for individual faculty—while imposing the requirement that one half of the tuition fees should be used for grants for students from lower strata of society. The natural aim to stimulate the quality of higher education and to broaden the access to higher education could thus have been combined in a better way than under the new regime. A further recommendation could be to strongly strengthen the field of computer science/informatics at all universities. North-Rhine Westphalia should also try to encourage new trade fairs with an innovative focus on such fields as computer science/software/telecommunications. It is noteworthy that public procurement has a visible weakness in the sense that the prices paid by cities in Germany are higher than those paid by private companies—digital procurement is obviously a weak element of the public sector, which is unacceptable for both principal reasons and in view of the high deficit-to-GDP ratios in most German states and cities.

### *1.3.3 Basic Information on Eindhoven, Karlskrona, and Budapest/Györ*

The ICT mobility network of Budapest/Győr has expanded over time: The mobility network of 2000–2007 was more complex than in 1992–1999. As regards the cooperation network of innovators, there has also been some progress in this region.

However, one of the early networks has disintegrated. The ICT relationship network has shown a slight qualitative improvement over time in Budapest/Győr, and this is remarkable since IBM, a key ICT player in the early transition years of the new Hungarian market economy, has relocated production from Hungary to China. Hungarian firms have been strong in the mass production of electronics, including mobile phones. The decision of Hungary's government to privatize the Hungarian national telecommunications operator partly seems to have contributed to rapid modernization of the fixed-line network. At the same time, it may also be pointed out that Hungarian firms, particularly from Budapest/Győr, were strongly involved in software developments, and some Hungarian software firms actually became foreign investors in EU15 countries. It may be pointed out that Hungarian cluster initiatives have partly been successful in the ICT sector; however, the government's serious budget problems obviously have undermined both the R&D budget and the promotion of innovations in the private sector, at the same time rather insufficient public investment in Hungarian universities can be observed—not least in the field of computer science. Certain ICT firms also faced the problem that only a few large industrial firms have shown high and sustained output growth in the two decades after transformation, and this implies that digital start-up companies face rather difficult conditions in terms of expansion opportunities.

Adopting a comparative perspective and taking a closer look at London, it can be seen that the cooperation network has widened over time while the mobility network has only slightly improved. It is clear that London offers enormous opportunities for innovative ICT firms, be it in the form of big clients or in the form of getting access to finance in the dynamic London bankers' scene. The British early decision—in 1984—to adopt competition in fixed-line telephony (at first on the basis of a duopoly, later on the basis of truly open telecommunications market) has obviously stimulated the creation of innovative digital services as has been emphasized in various OECD country reports on the UK. Digital services expansion has also benefited from US cable investors' market entry in the 1990s when the UK seemed to be an attractive marketplace, namely in a period in which the US government was still rather hesitant in allowing cable companies to enter markets for telecommunications services. London certainly is a stronger place in ICT than pure patent analysis can reveal. With nonexistent software patents and hundreds or even thousands of young computer experts eager to find a job, the regional ICT networks could change relatively quickly.

Taking a look at the Swedish city of Karlskrona (Telekom city 2010; Zenit 2002) that faced serious problems of economic decline in the 1990s when shipbuilding activities were cut back strongly—along with military expenditures after the end of the Cold War (the military had played a relatively large role in the port city of Karlskrona over many years). In Karlskrona, it was mainly the careful cooperation of the local university, regional government, and the local business community that helped to jump-start economic development in a city that was facing very serious structural problems (Guth et al. 2005). The tripartite innovation activities launched in Karlskrona were partly bundled in the creation of Telecom City, which stands for a new digital regional innovation system. Dynamics companies, including digital start-ups, and the university activities plus a flexible business-friendly city have interlinked favorably.

The new digital projects launched in Karlskrona have contributed to the creation of enhanced mobility networks in the regional ICT sector. At the same time, R&D cooperation has changed in the sense that one very active big network—along with a few very small networks—has emerged. These developments have contributed to the creation of a relatively large relationship network (the combination of the cooperation network and the mobility network).

The most impressive ICT network in continental Europe is the region of Eindhoven in which Philips plays a key role. Philips has not only embraced elements of an open innovation approach, it also has emphasized the creation of global standards in many fields; in the research park of Philips, the Dutch multinational company is cooperating with dozens of competitors, and this contributes to creating dynamic digital networks. Philips also has major R&D activities in Asia and the USA; it is a role model of technoglobalization. Over time, the mobility network as well as the regional cooperation network has improved, the relationship network was and is truly impressive. It has to be remembered that the Eindhoven region does not have more inhabitants than the Bergisch City Triangle. The long history of the success story of Philips and a strong regional innovation system—with a dynamic interaction between big and small firms, as well as firms and universities/research labs plus a business-friendly local government—have laid the foundations for the impressive networks in ICT created in this leading Dutch region. The cooperation network seems to have benefitted from the decision of Philips in the 1990s to give free access to a whole range of company patents so that complementary research and business activities could be developed.

The network indicators for ICT regions selected are shown in more detail in the Appendix. The number of patent citations received shows a very strong position of Eindhoven in the subsequent table: Innovators in other European regions and countries rely on the accumulated digital knowledge of the Eindhoven (talent pool) region to some extent. London and Vienna are behind the region of Eindhoven. As regards Germany, it is interesting that the relatively young ICT region of the Bergisch City Triangle has already received more patent citations than Dortmund. As regards citations made—an indicator for the import of knowledge—Eindhoven is no. 1, trailed by London, Vienna, and the Bergisch City Triangle. Somewhat surprisingly, Budapest/Győr is relatively weak in both citations made and in citations received. This may be interpreted in the following way:

- Even a rather dynamic region as Budapest/Győr—with many excellent universities and a broad range of companies in both industry and services—finds it rather difficult to create strong regional ICT dynamics. This partly seems to reflect a lack of government funds in promoting ICT research and development adequately. The massive government budget problems impair a reliable long-term R&D support by the government.
- It should not be excluded that the strong initiatives in the field of ICT cluster formation and regional networking in Vienna have diverted part of the potential

foreign direct investment inflows: As Budapest is so close to Vienna, some crowding out effects might have to be considered—the strong success of the Vienna Region implies that it is rather difficult for Budapest/Győr to quickly enhance digital innovation and networking. This holds particularly since 2011 when full labor mobility will reinforce the prospects of young Hungarian programmers moving westwards to Vienna (or other West-European ICT centers), where they are offered relatively high wages and also have vast opportunities to be hired at multinational companies which in turn offer career prospects worldwide.

The comparative perspective on selected European ICT regions has shown considerable differences across regions and countries. Despite the fact that the digital sector offers many opportunities for worldwide conveying of knowledge and innovations, it has become obvious that networking among ICT firms within a region is a crucial element of success. As the example of the Vienna Region shows, it may be assessed within less than a decade whether or not a digital regional policy initiative has been successful. Since skilled labor is so important for ICT innovation dynamics, regional innovation systems may be emphasized, which include adequately specialized universities facing rather favorable prospects for expansion. It is, however, not really clear here how important the creation of new digital firms is for broader long-term growth. As the example of the Bergisch City Triangle suggests, a dynamic combination of the Old Economy—with many firms being world market leaders in specialized niches of industry—and the New Economy could work well. It is, however, relatively surprising to witness how little the new digital success stories have been noted by the regional public and that even the university is rather slow in pushing for an expansion of computer science. The fact that in the ICT sector many firms are quite small could partly explain why the ICT sector is not so visible in the broader public. Part of Germany's strength in creating new ICT firms is linked to extra-university R&D institutions that allow researchers to pursue adequate specialization and innovation projects while creating a network of experts, which includes individuals or partner organizations with strong business contacts (e.g., the Fraunhofer Group that has become a fertile breeding ground for digital entrepreneurship). It remains to be seen whether or not regions previously dominated by Old Industry can be revitalized through ICT clustering. In some regions of Germany and Sweden (as well as Ireland), this seems to be the case. There is, however, also a problem in the field of regional governments: While some of the regional governments in Germany or Austria try to promote digital R&D projects, the small group of experts and staff in the responsible ministry are often a clear impediment to more rapid digital growth. It is rather surprising to notice that governments are not fully exploiting the digital dividend from more market transparency in the Internet age: Prices paid by regional and local governments in Germany are often relatively high because digital procurement platforms of governments are not up to the current challenges. Here better public procurement platforms could easily generate rather large cuts in public expenditures, namely by combining more price transparency on the Internet and advanced digital procurement tools. However, it should also be noted that the Internet can be used to reduce price transparency. The well-known Swedish Ikea group has created the Ikano bank, which offers credit cards that can be used at many retail groups. Ikea/Ikano bank has stopped mailing monthly account statements to users of credit cards, and it has argued that this is to the benefit of the consumers and the world: Consumers can look up the current account statement on the Internet, and using less paper implies saving trees. What sounds so good here means in reality that many people neglect the control of their accounts. So they would often not notice that, e.g., the interest rate on overdrawing the account goes along with an interest rate of more than 14% (in early 2011—when the ECB interest rate was still just 1%). Thus, it is clear that ICT expansion brings large benefits for the industry, private households, and governments; on the other hand, there are also new formidable challenges. There is, however, no doubt that the digital world is expanding fast and broadband fixed networks, as well as the expansion of mobile broadband services will stimulate not only the expansion of businesses but also the creation of innovative networks and dynamic ICT cluster activities.

Snapshots on the ICT Region Karlskrona (Telecom City)

- "TelecomCity is a leading knowledge center in telecommunications and IT, thanks to the climate of cooperation that characterizes the network, which creates unique conditions for business development" (http://www.telecomcity.org/in-english/about-telecomcity/development-environment.aspx).
- "Close to 20% of the work force in the region are employed in TelecomCity and the IT sector" (http://www.telecomcity.org/in-english/about-telecomcity/development-environment.aspx).
- "In five years the Karlskrona region has brought out more than 3000 new IT jobs" (http://www.telecomcity.org/in-english/about-telecomcity.aspx).
- "Close to 20% of the workforce is employed in the IT and telecommunications industry. As many as in Stockholm. And most likely a European record" (http://www.telecomcity.org/in-english/about-telecomcity.aspx).
- "With close to 8 new students, per thousand inhabitants, in IT and telecommunications programs at university level—the education capacity is one of a kind. That equals twice as many students being admitted each year than any other Swedish labour market region" (http://www.telecomcity.org/in-english/about-telecomcity.aspx).
- "The number of employees has during the past five years increased by approximately 2500 employees" (http://www.telecomcity.org/in-english/about-telecomcity/the-innovation-system.aspx).
- "Over the past ten years the number of students with a focus on IT has increased from 100 to 2000" (http://www.telecomcity.org/in-english/about-telecomcity/the-innovation-system.aspx).

Snapshots on the ICT Region London

- “London is home to the largest concentration of IT software and services companies in Europe, which generates a turnover of $7.8 billion. The London IT services market is growing at more than 7% per year” (http://www.thinklondon.com/business_facts/Your_sector_and_function/ict.html).
- “e-Government is a high-growth sector with contracts worth more than $1 billion.The UK’s public sector is forecast to spend 40% more on IT than France or Germany; most of these projects will be coordinated by government departments in London” (http://www.thinklondon.com/business_facts/Your_sector_and_function/ict.html).
- “London leads the way in the growth areas of mobile, broadband and wireless technologies and is at the forefront of developing Europe’s third generation wireless networks” (http://www.thinklondon.com/business_facts/Your_sector_and_function/ict.html).
- “19 of the top 25 European software and IT service suppliers have their HQ in London. All 25 are represented including Accenture, CSC, EDS, Compaq, Capgemini HP, Fujitsu, IBM, KPMG, Ernst & Young, Microsoft, Oracle, Infosys, Atos Origin, Wipro and TCS” (http://www.thinklondon.com/business_facts/Your_sector_and_function/ict.html).
- “The UK is Europe’s most liberalised and dynamic telecoms market and has the most advanced infrastructure in Europe. The European telcos market is the world’s largest, worth $873 billion, and the UK is Europe’s second largest national market, worth more than 6% of the global market” (http://www.thinklondon.com/business_facts/Your_sector_and_function/ict.html).
- “London companies received $830 million of venture capital funding in 2005—18% of the European total” (http://www.thinklondon.com/business_facts/Your_sector_and_function/ict.html).
- “More than 540,000 experienced IT professionals and technology graduates live in London. The city has the highest concentration of IT recruitment consultants in Europe” (http://www.thinklondon.com/business_facts/Your_sector_and_function/ict.html).

Snapshots on the ICT Region Eindhoven

- “Over 50,000 companies including about 300 foreign companies have established their business in the Eindhoven region” (http://www.hightechcampus.nl/viewfile.php/202).
- There are over 90 companies present at High Tech Campus Eindhoven. The different companies at the Campus can be characterized as follows (http://www.hightechcampus.nl/viewfile.php/202):
  - More than 40 start-up companies
  - Institutes
  - Global companies
  - Small and medium enterprises (SMEs)
  - Service companies

- "At this moment High Tech Campus Eindhoven has over 8,000 people with about 50 nationalities working on the Campus" (http://www.hightechcampus.nl/viewfile.php/2029).

Snapshots on the ICT Region Budapest

- As an initiative of IVSZ (Association of Information Technology Enterprises) (http://www.ivsz.hu), a National Electronics Roundtable was launched in March 2011. The goal of the roundtable is to coordinate strategy preparation in the field of electronics and to provide a network forum for Hungarian actors and stakeholders. *Source*: http://www.ivsz.hu.
- Five accredited ICT clusters signed a cooperation agreement in December 2010 ((1) First Hungarian E-Governance Information Technology and Innovation Cluster, Veszprém—http;//www.klasztermenedzser.hu; (2) North Hungarian Information Technology Cluster, Miskolc—http://www.infoklaszter.hu; (3) Mobility and Multimedia Cluster Budapest—http://www.mmklaszter.com; (4) Silicon Valley Regional Information Technology Cluster, Debrecen—http://www.sziliciummezo.hu; (5) Software Industry Innovation Pole Cluster, Szeged—http://www.infopolus.hu). Together, the five organizations represent 220 members and 180 SMEs (*Source*: http://www.infoklaszter.hu/content.html?contentID=94&TARANTULA_SESSID=iGtsnSKXWDGHRYkzea1r413t).
- The new Hungarian government adopted a "Digital Renewal Action Plan" in 2010 that summarizes its ICT and information society strategy up till 2014. http://www.kormany.hu/download/7/e2/10000/Digitalis_Megujulas_Cselekvesi_Terv.pdf. According to the document, the Hungarian ICT sector has currently 100,000 employees in 14,000 enterprises, and the output of the sector amounts to HUF 4,500 billion (Figs. 1.6–1.43).

### *1.3.4 Network Indicators for ICT Regions*

In all regions considered, the number of ICT patents has increased over time (note that the patent numbers shown allocate one half of a patent to region A and region B if there are two inventors from the two regions in the patent application). It is obvious that Eindhoven has a dominant position. It also is remarkable that the Bergisch Triangle has overtaken the region of Dortmund in the number of patent applications in 2000–2007. It should also be noted that the growth rate for the Karlskrona is impressive since the growth rate of 2000–2007 compared to period 1, namely 1992–1999, was 164%; the cooperation between the business community, the university, and the government has been rather successful in the sense that a dynamic ICT cluster has been established. As regards Györ/Budapest, the growth rate of 255% is high, but this is largely reflecting a very low initial level of 4,995 patents in the first period. The growth rates for the Dortmund region and for London are relatively low (Tables 1.1–1.9; Fig. 1.44).

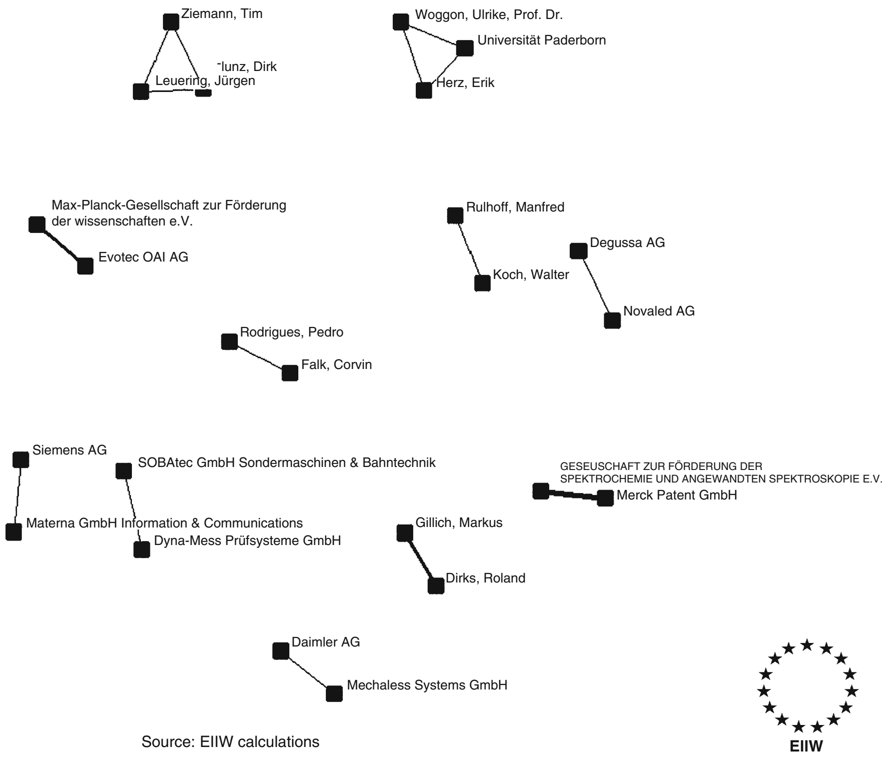



**Fig. 1.6** Cooperation network ICT—Dortmund 2000–2007. *Source*: EIIW calculations

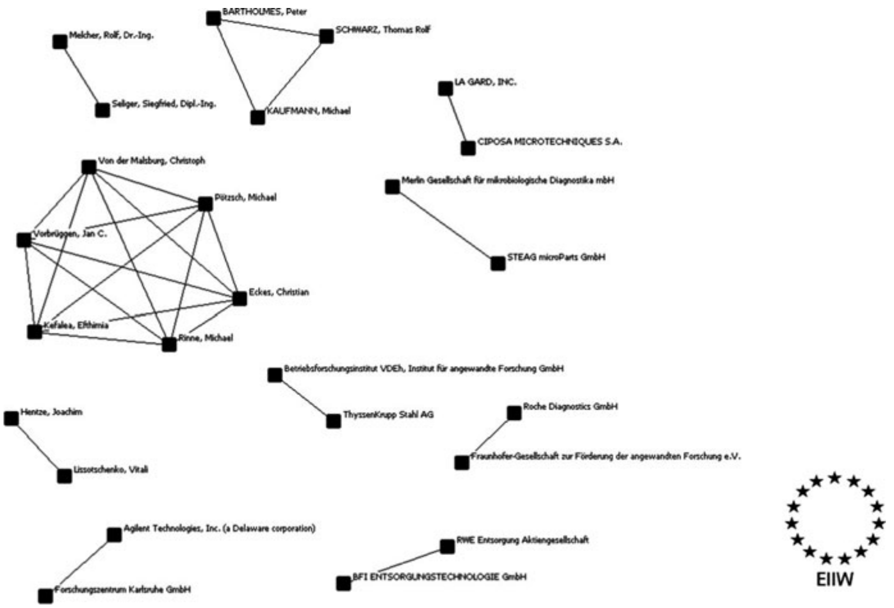



**Fig. 1.7** Cooperation network ICT—Dortmund 1992–1999. *Source*: EIIW calculations

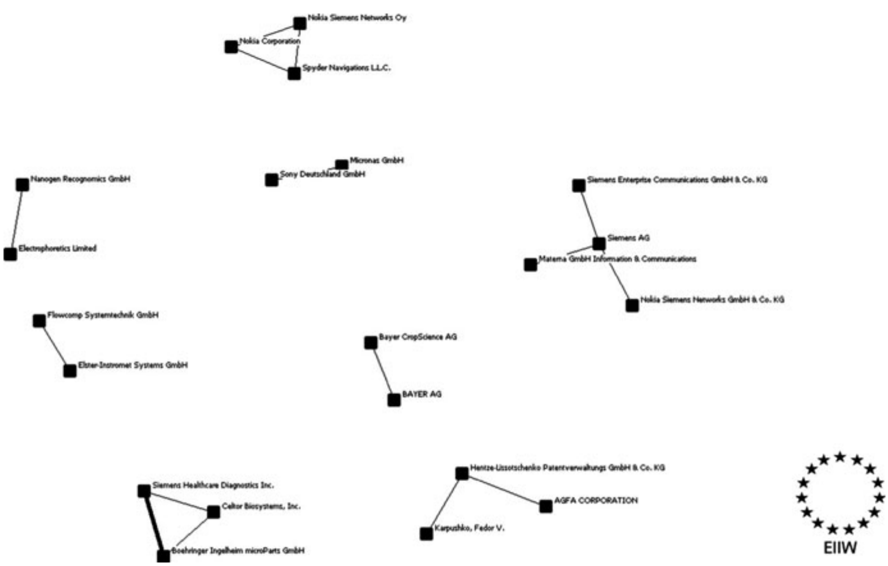



**Fig. 1.8** Mobility network ICT—Dortmund 2000–2007. *Source*: EIIW calculations

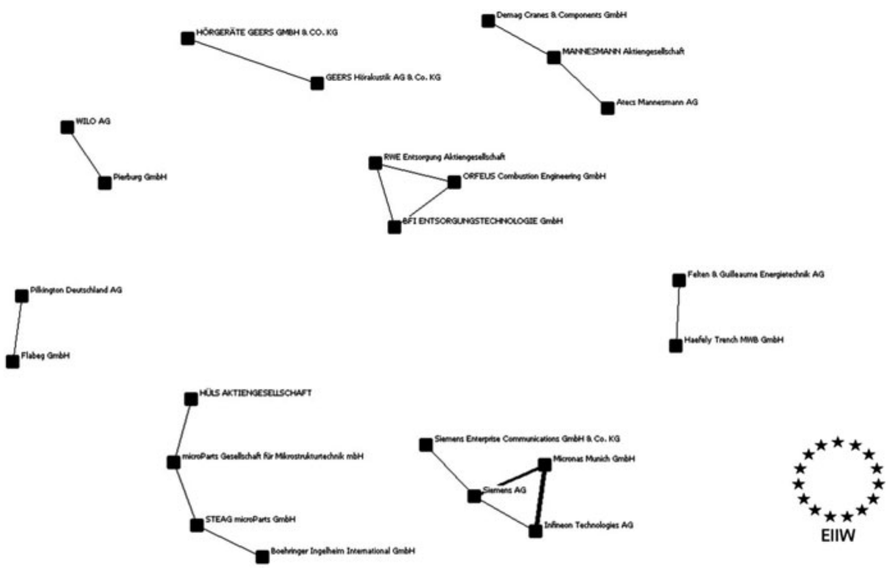



**Fig. 1.9** Mobility network ICT—Dortmund 1992–1999. *Source*: EIIW calculations

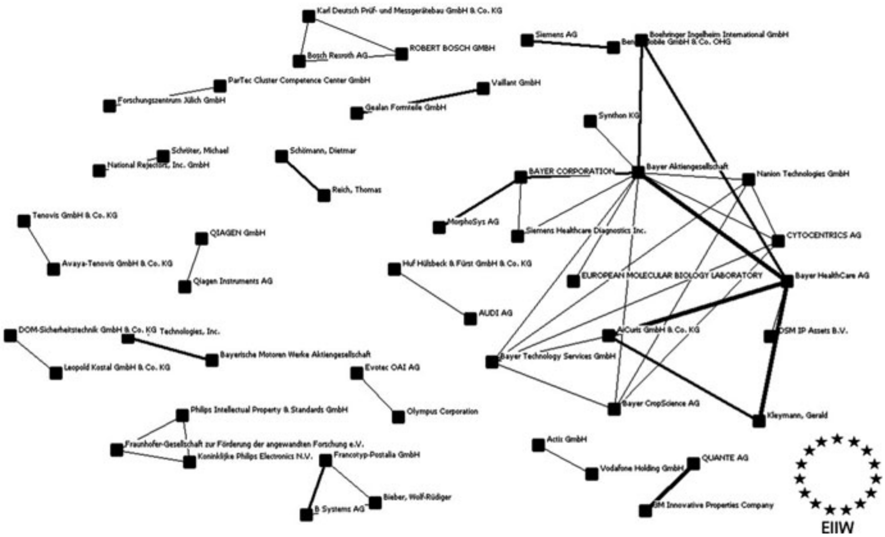



**Fig. 1.10** Relationship network ICT—Bergisch City Triangle 2000–2007. *Source*: EIIW calculations

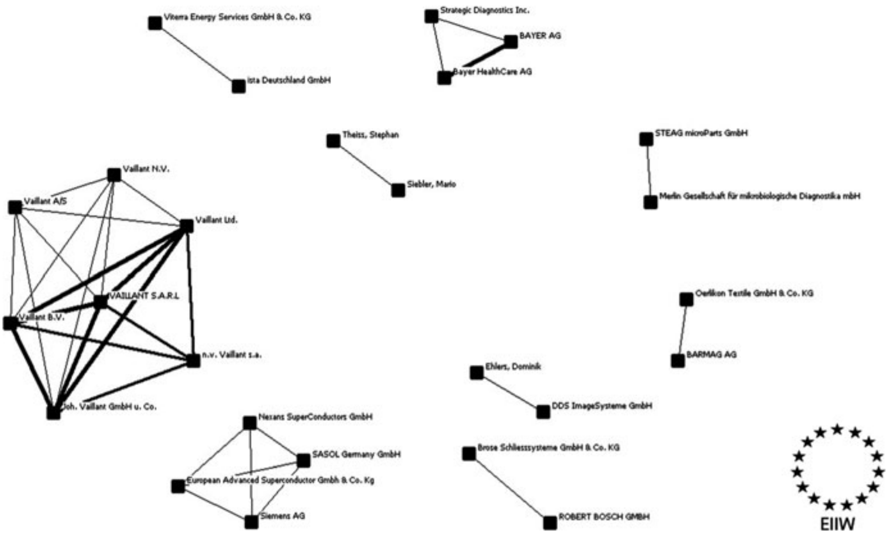



**Fig. 1.11** Relationship network ICT—Bergisch City Triangle 1992–1999. *Source*: EIIW calculations

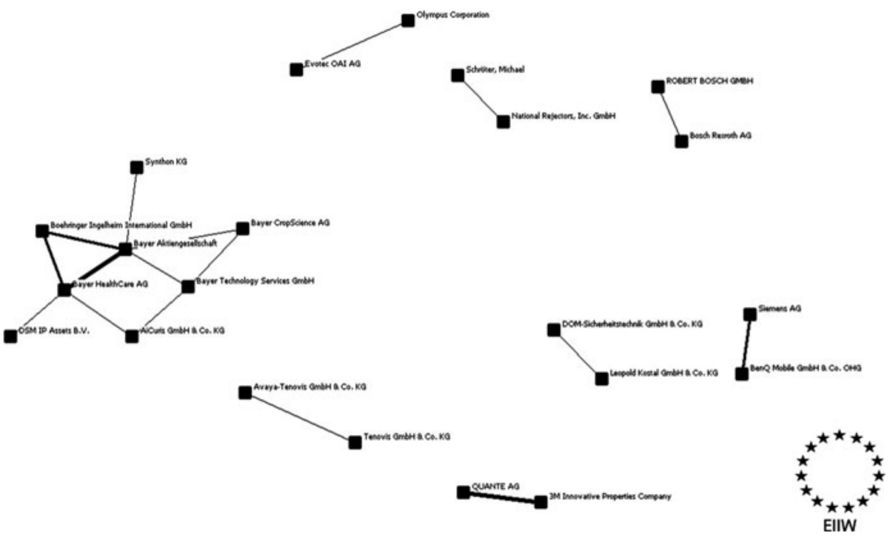



**Fig. 1.12** Mobility network ICT—Bergisch City Triangle 2000–2007. *Source*: EIIW calculations

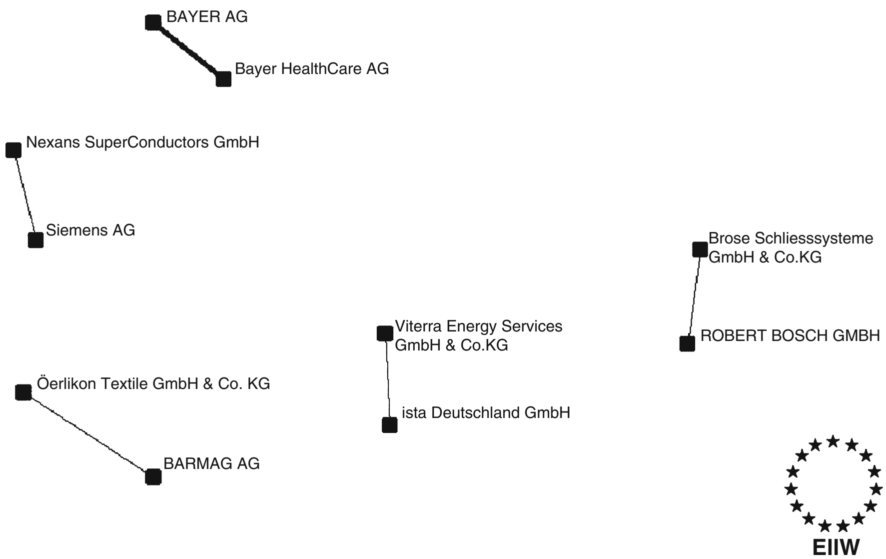



**Fig. 1.13** Mobility network ICT—Bergisch City Triangle 1992–1999. *Source*: EIIW calculations

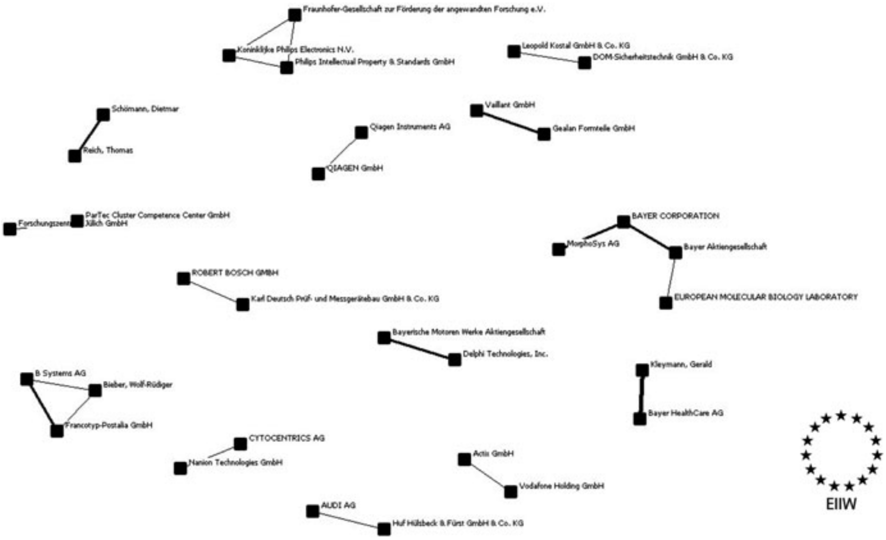



**Fig. 1.14** Cooperation network ICT—Bergisch City Triangle 2000–2007. *Source*: EIIW calculations

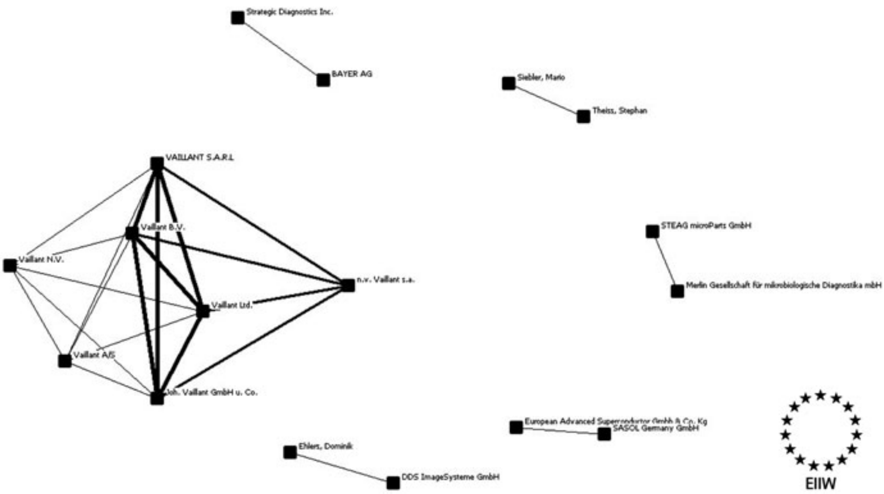



**Fig. 1.15** Cooperation network ICT—Bergisch City Triangle 1992–1999. *Source*: EIIW calculations

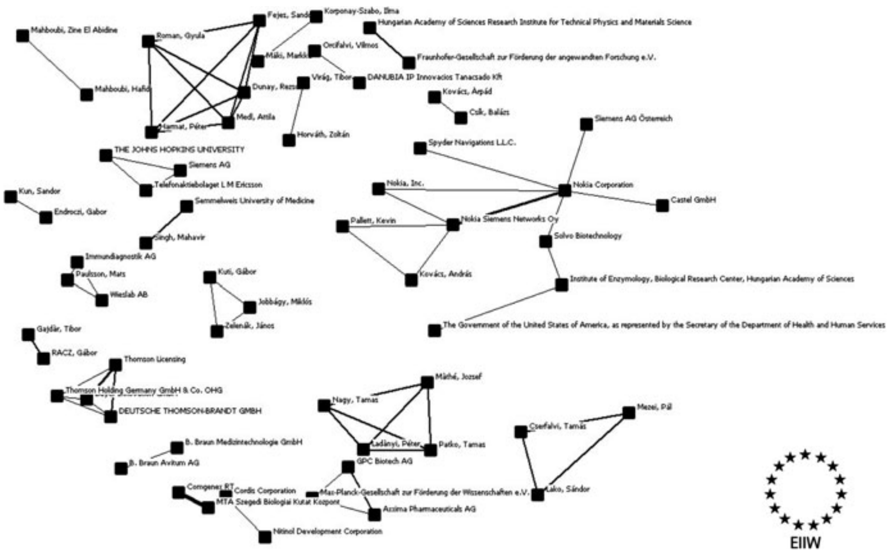



**Fig. 1.16** Relationship network ICT—Budapest/Györ 2000–2007. *Source*: EIIW calculations

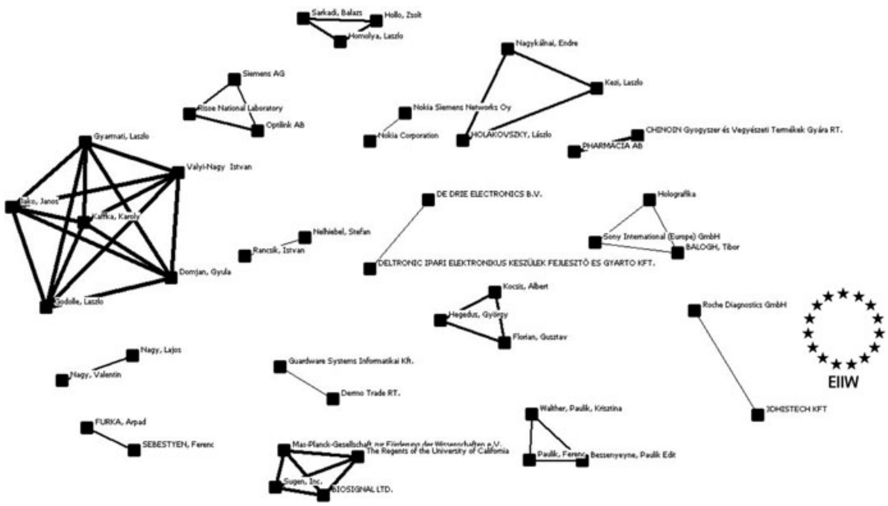



**Fig. 1.17** Relationship network ICT—Budapest/Györ 1992–1999. *Source*: EIIW calculations

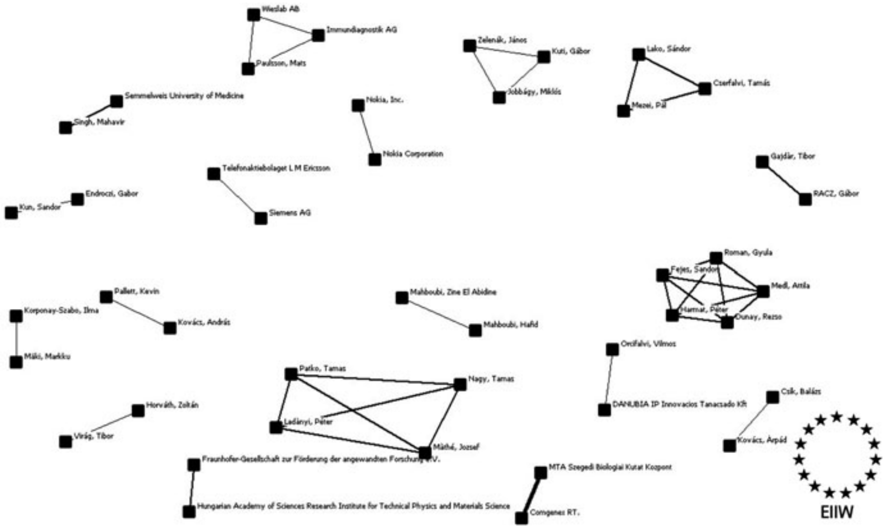



**Fig. 1.18** Cooperation network ICT—Budapest/Györ 2000–2007. *Source*: EIIW calculations

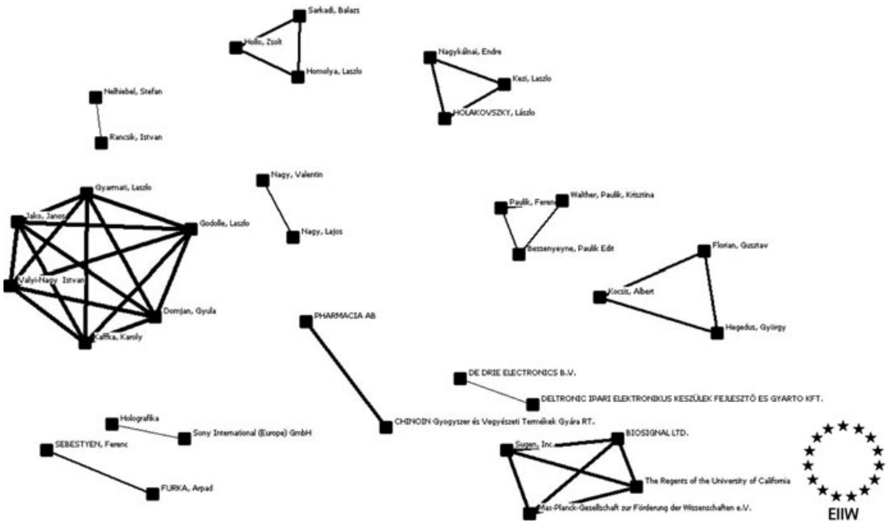



**Fig. 1.19** Cooperation network ICT—Budapest/Györ 1992–1999. *Source*: EIIW calculations

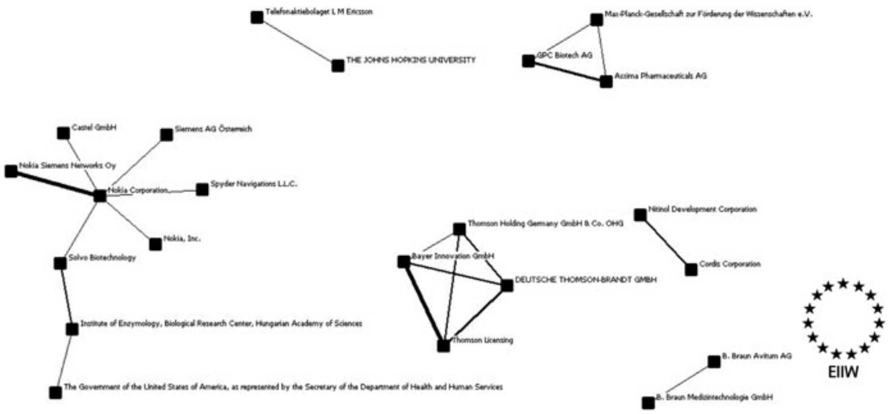



**Fig. 1.20** Mobility network ICT—Budapest/Györ 2000–2007. *Source*: EIIW calculations

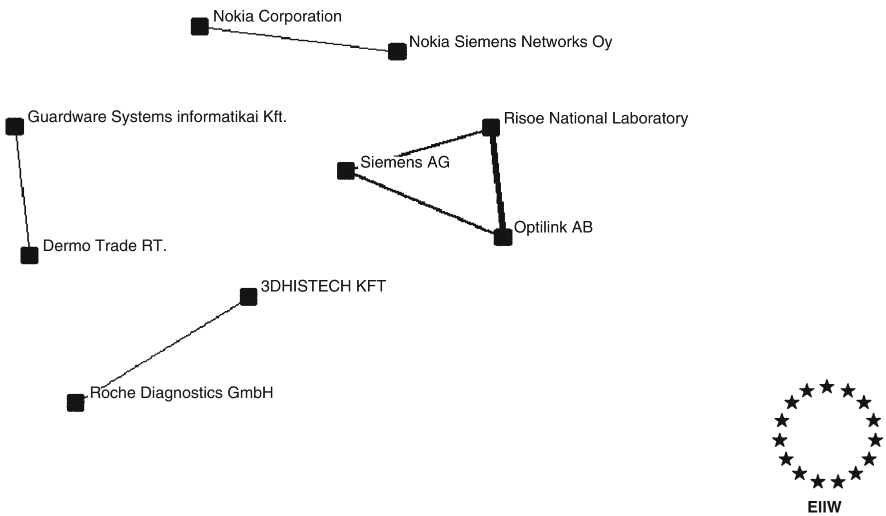



**Fig. 1.21** Mobility network ICT—Budapest/Györ 1992–1999. *Source*: EIIW calculations

## 1.4 Conclusions on Rational Cluster Policy for Regions

The comparative analytical perspective developed here suggests that the role of clusters in the ICT sector has become more important. Clusters can be created in certain regions provided that there are comparative advantages of key firms and institutions active in ICT research and development. The Karlskrona is a good example how regional economic policy in Sweden has achieved successful structural change—the city port that used to be known for military equipment and

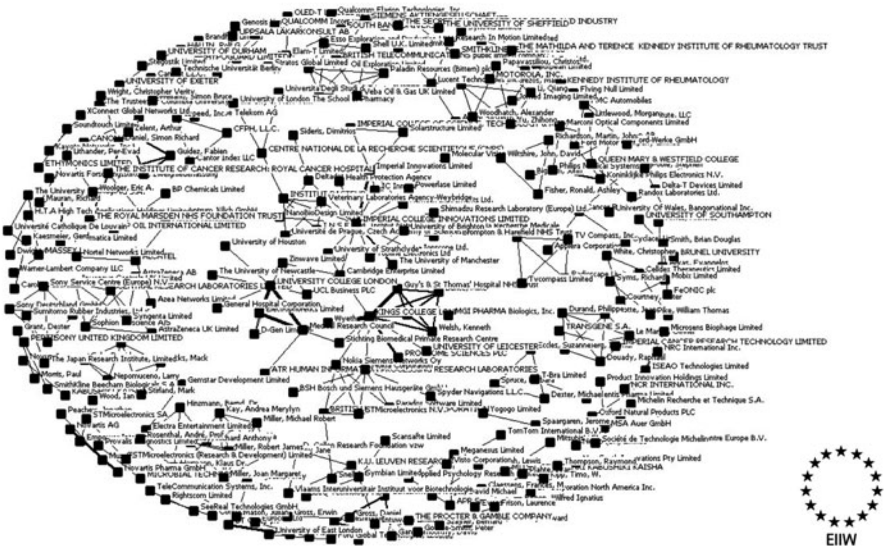


**Fig. 1.22** Relationship network ICT—London 2000–2007. *Source*: EIIW calculations

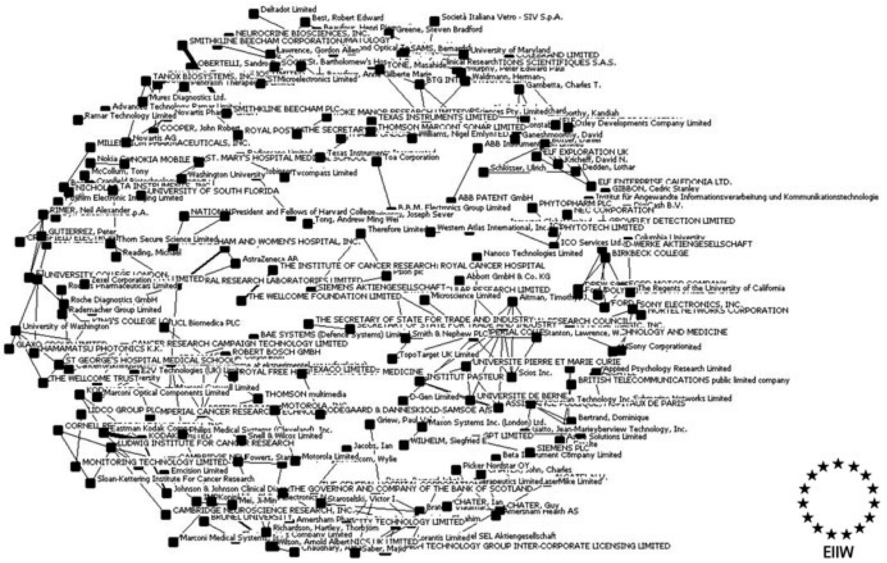


**Fig. 1.23** Relationship network ICT—London 1992–1999. *Source*: EIIW calculations

shipbuilding has become a high-technology cluster ("Telecom City"), whose innovation performance has strongly improved over time. Eindhoven is a world-class ICT cluster in the Netherlands, and it has been able to maintain this position over time: The growth rate of ICT patents has remained high. The Bergisch City

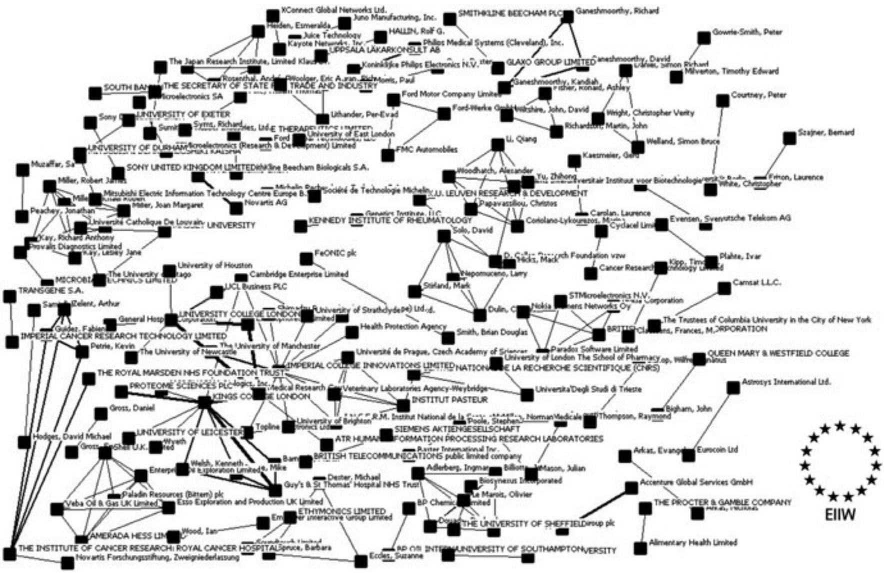



**Fig. 1.24** Cooperation network ICT—London 2000–2007. *Source*: EIIW calculations

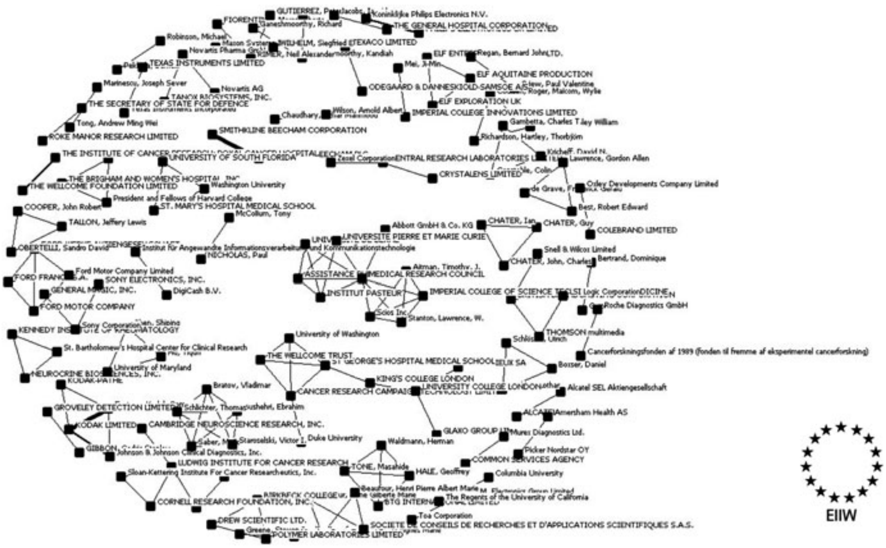



**Fig. 1.25** Cooperation network ICT—London 1992–1999. *Source*: EIIW calculations

Triangle stands for an Old Economy area that—through the production of machinery and equipment plus the activities of a modern automotive supplier sector—has developed a rather impressive ICT performance; surprisingly, regional economic policymakers have not picked up these dynamics—an adequate program of the state

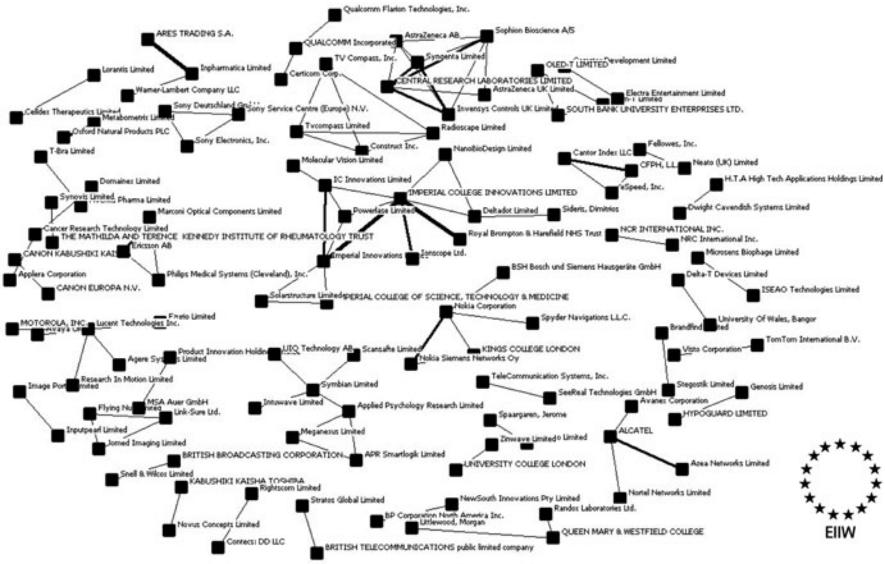



**Fig. 1.26** Mobility network ICT—London 2000–2007. *Source*: EIIW calculations

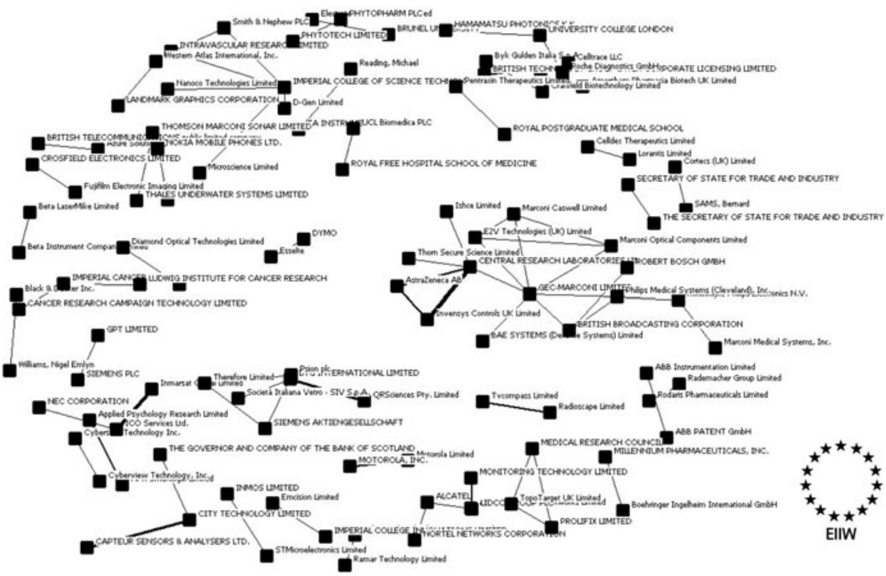



**Fig. 1.27** Mobility network ICT—London 1992–1999. *Source*: EIIW calculations

of North-Rhine Westphalia and the respective region is missing so far. From this perspective, it may be argued that positive external effects of network building still have to be fully mobilized. While it may be argued that part of ICT dynamics in the

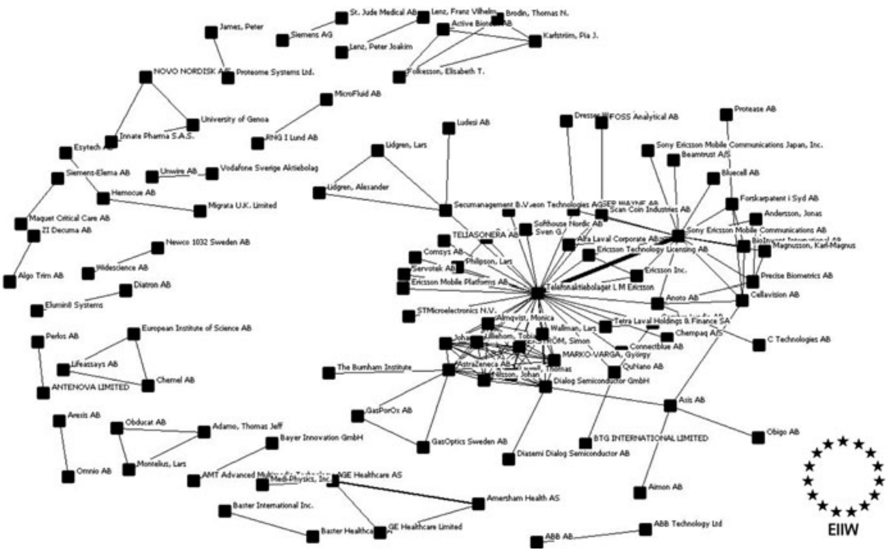



**Fig. 1.28** Relationship network ICT—Karlskrona 2000–2007. *Source*: EIIW calculations

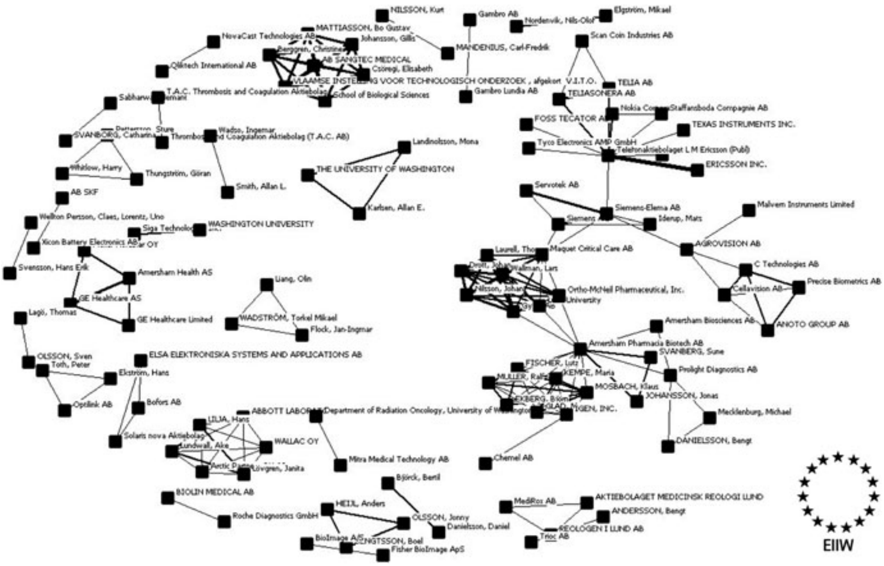



**Fig. 1.29** Relationship network ICT—Karlskrona 1992–1999. *Source*: EIIW calculations

traditionally leading area of Dortmund is possibly not covered through patent applications (software development is protected through copyrights, not through patents in the EU), it is noteworthy that network dynamics in the Dortmund region

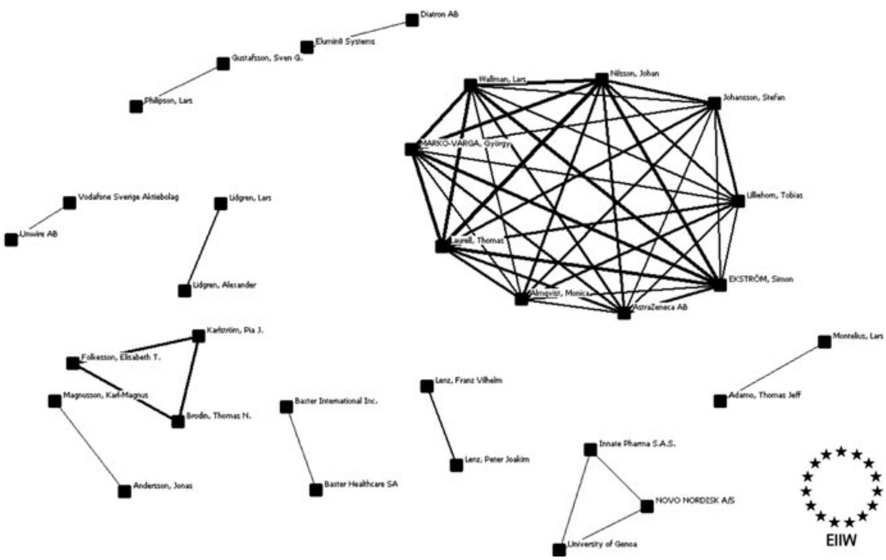



**Fig. 1.30** Cooperation network ICT—Karlskrona 2000–2007. *Source*: EIIW calculations

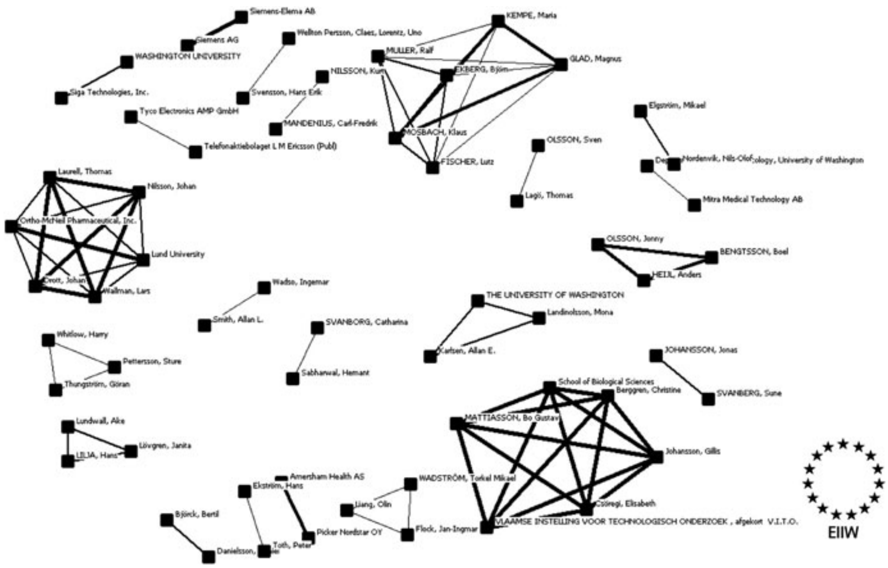



**Fig. 1.31** Cooperation network ICT—Karlskrona 1992–1999. *Source*: EIIW calculations

are not very dynamic. The fact that the cluster management of the state of North-Rhine Westphalia has been located for many years at the University of Dortmund stands for a doubtful strategy: It is necessary to adopt competitive tendering for the

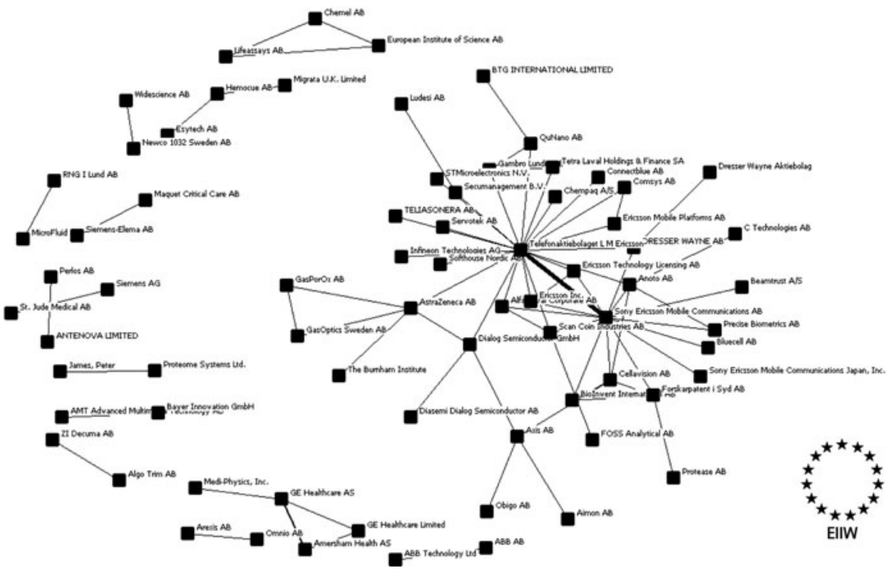



**Fig. 1.32** Mobility network ICT—Karlskrona 2000–2007. *Source*: EIIW calculations

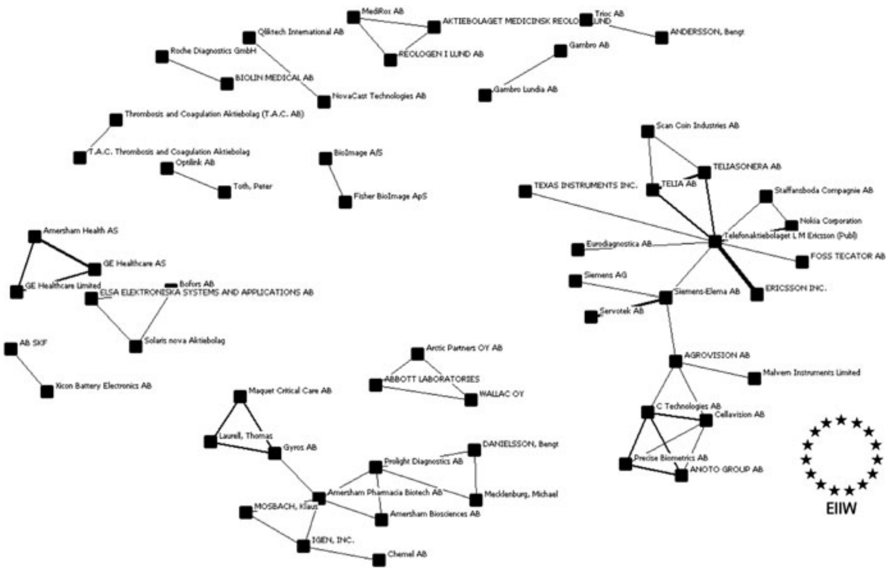



**Fig. 1.33** Mobility network ICT—Karlskrona 1992–1999. *Source*: EIIW calculations

ICT cluster management of the state of North-Rhine Westphalia, otherwise one cannot expect the state of North-Rhine Westphalia to be able to fully exploit the benefits of ICT dynamics. The new government that came to power in 2010 has

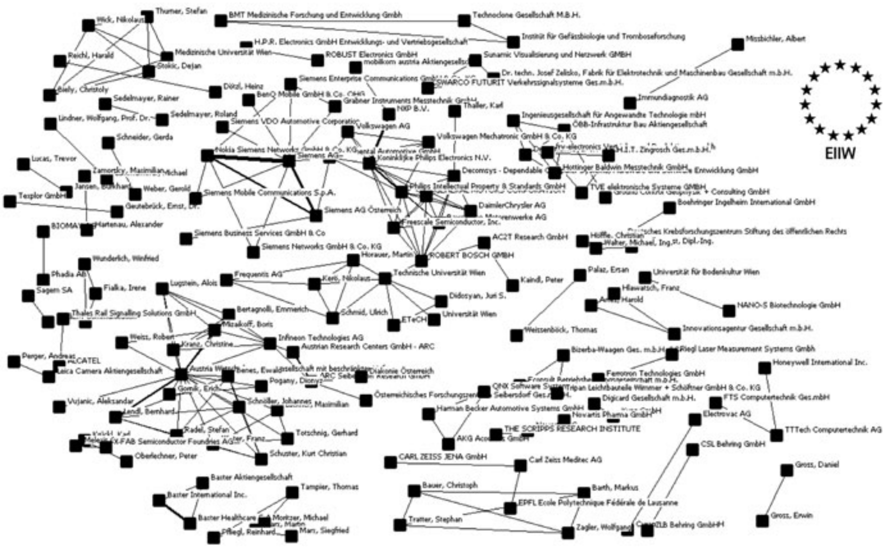



**Fig. 1.34** Relationship network ICT—Vienna Region 2000–2007. *Source*: EIIW calculations

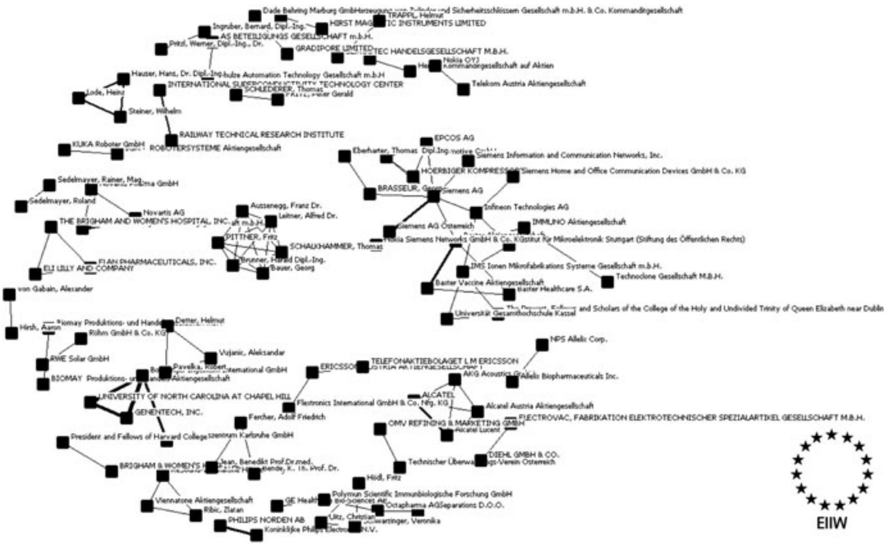



**Fig. 1.35** Relationship network ICT—Vienna Region 1992–1999. *Source*: EIIW calculations

emphasized the role of cluster strategies as a key pillar of innovation policy less than the previous government; rather the concept of lead markets—already pushed by the European Commission—has dominated the policy agenda. Indeed, the concept of lead markets could be combined with the concept of ICT cluster policies.

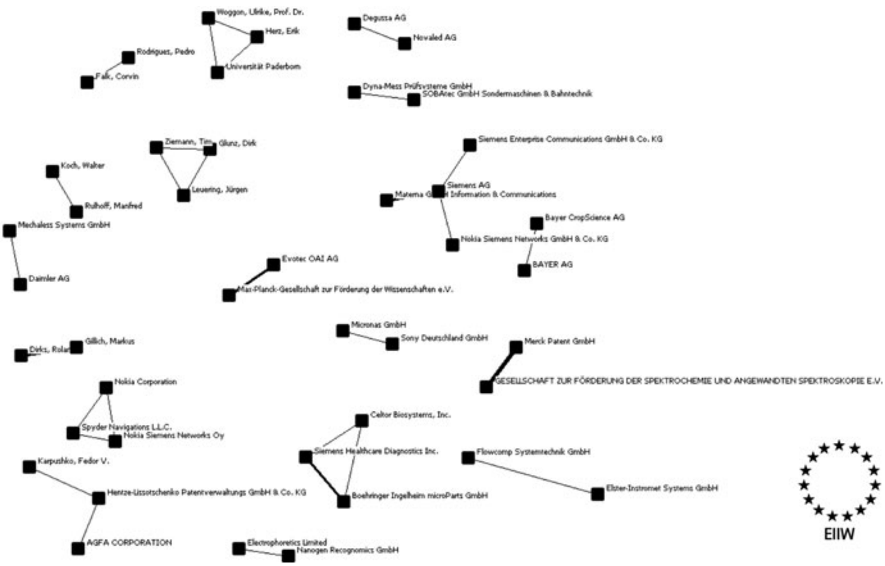



**Fig. 1.36** Relationship network ICT—Dortmund 2000–2007. *Source*: EIIW calculations

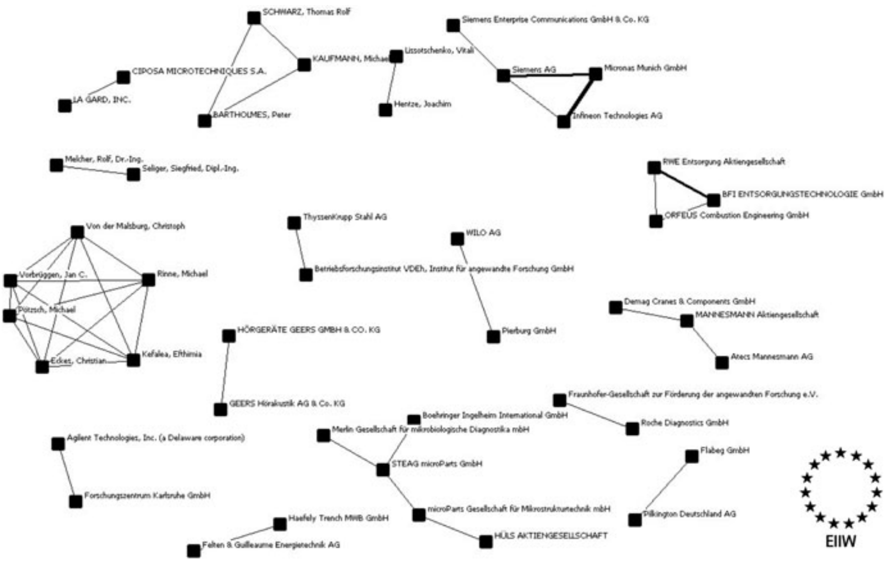



**Fig. 1.37** Relationship network ICT—Dortmund 1992–1999. *Source*: EIIW calculations

From our comparative perspective, the following conclusions can be drawn with respect to the requirements for a successful network:

- There is a need to establish a critical minimum of firms in the region, and this should include the presence of at least one multinational company. One may,

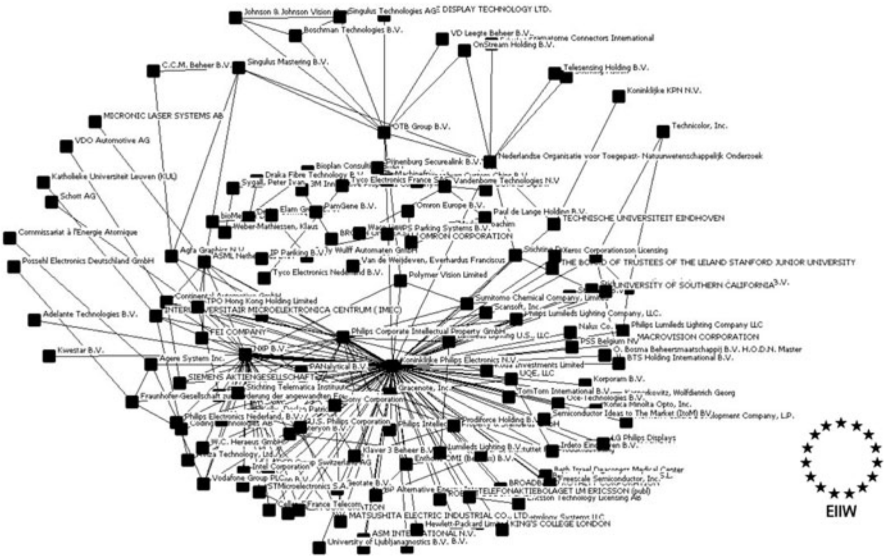



**Fig. 1.38** Relationship network ICT—Eindhoven 2000–2007. *Source*: EIIW calculations

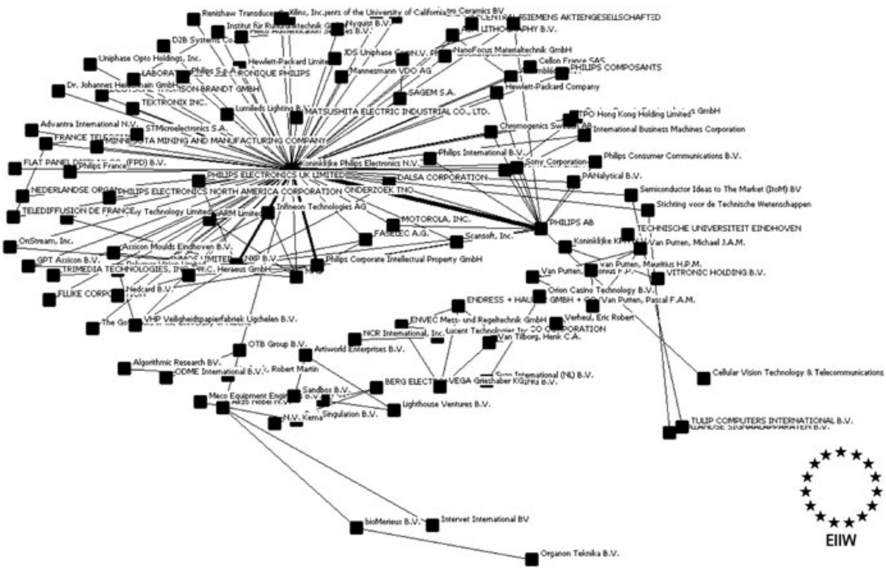



**Fig. 1.39** Relationship network ICT—Eindhoven 1992–1999. *Source*: EIIW calculations

however, point out that in the field of ICT, multinationalization is rather easy: A relatively small number of people from several countries in a digital start-up company can already be the basis for splitting up the value-added chain

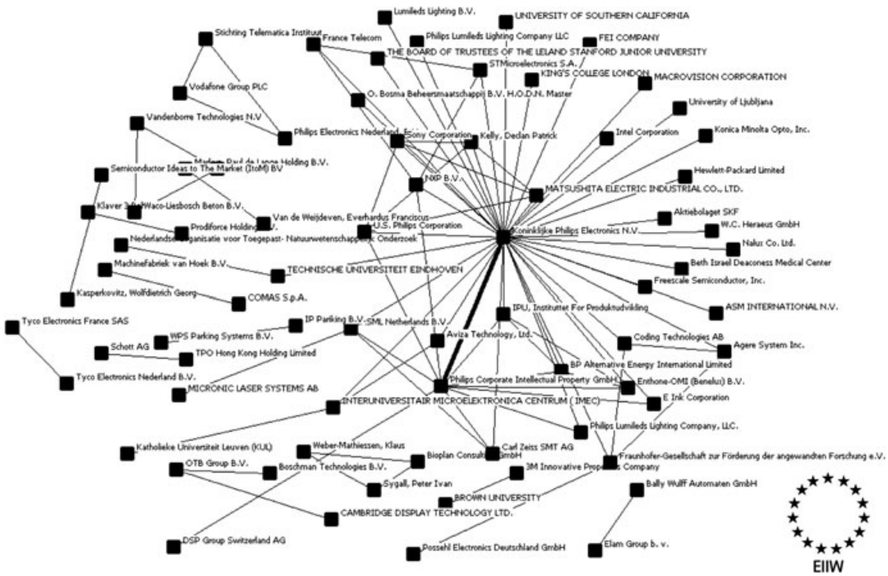



**Fig. 1.40** Cooperation network ICT—Eindhoven 2000–2007. *Source*: EIIW calculations

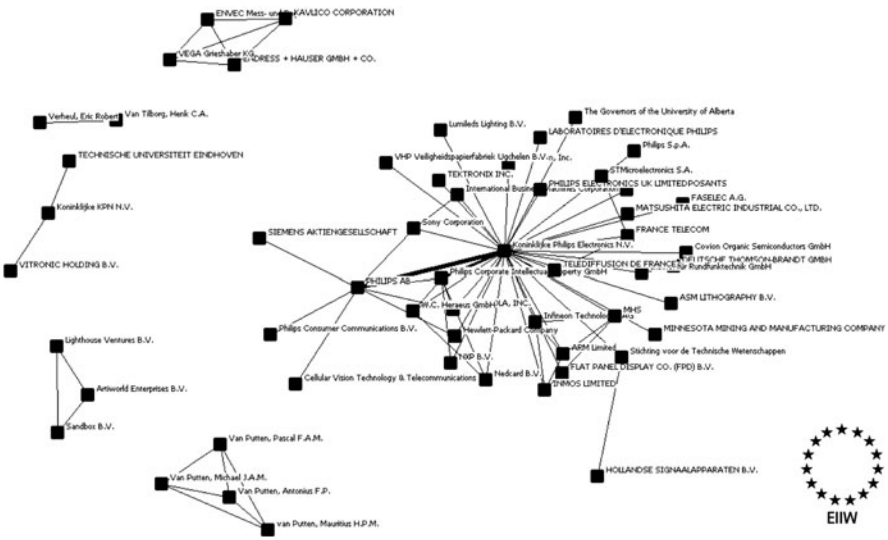



**Fig. 1.41** Cooperation network ICT—Eindhoven 1992–1999. *Source*: EIIW calculations

internationally—and here the digital Internet world can be fully exploited so that certain tasks are allocated to low-wage economies with a good specialization in digitally skilled workers (some eastern European countries as well as Russia and India are examples). Policymakers of these regions can provide crucial elements

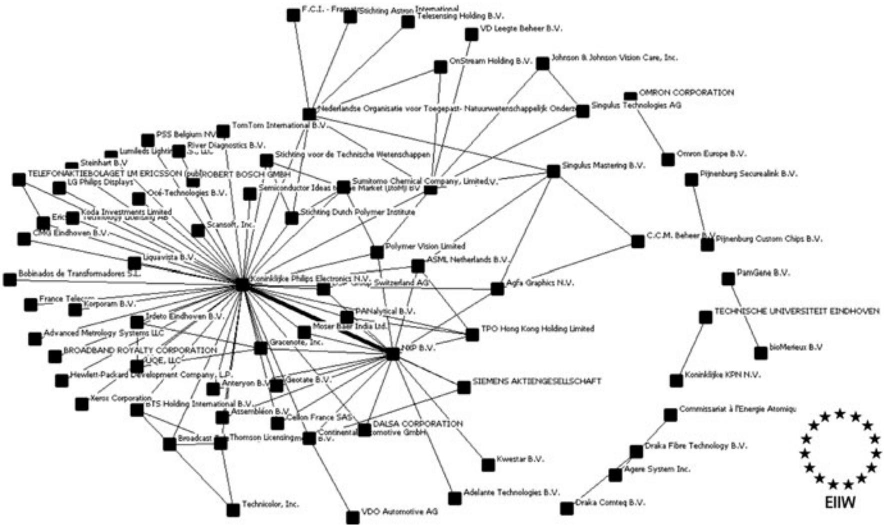



**Fig. 1.42** Mobility network ICT—Eindhoven 2000–2007. *Source*: EIIW calculations

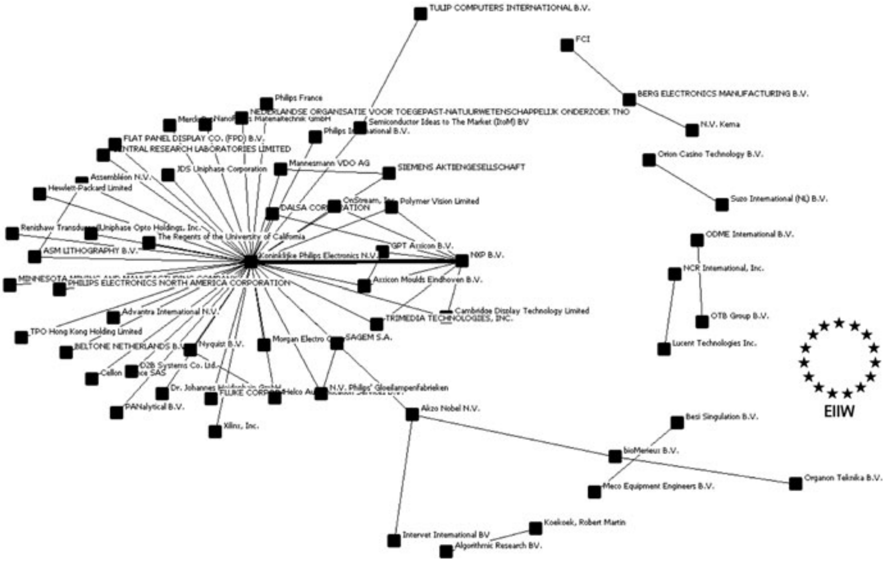



**Fig. 1.43** Mobility network ICT—Eindhoven 1992–1999. *Source*: EIIW calculations

of success provided that existing regional digital dynamics are combined with the promotion of digital start-ups and incentives for digital innovation.

- If the regional innovation system has a strong digital profile, ICT networking will be stimulated. A critical element here concerns the internationalization of

**Table 1.1** Network indicators for the Györ/Budapest (Coop = cooperation, Mobi = intercompany mobility of patent applicants, RN = relationship network = Coop + Mobi)

| | Coop: 1992–1999 | Coop: 2000–2007 | Mobi. 1992–1999 | Mobi. 2000–2007 | RN 1992–1999 | RN 2000–2007 |
|---|---|---|---|---|---|---|
| Total applicants (absolute figure) | 83 | 111 | 83 | 111 | 83 | 111 |
| Isolated applicant (absolute figure) | 66 | 79 | 73 | 89 | 57 | 61 |
| Centrality of network | 5.01% | 1.08% | 1.18% | 2.34% | 4.89% | 3.96% |
| Density of network | 0.0118 | 0.0046 | 0.0021 | 0.0039 | 0.0153 | 0.0105 |
| Joint applicants (absolute figures) | 17 | 32 | 10 | 22 | 26 | 50 |
| Average degree centrality (strength of internal structure) | 0.964 | 0.505 | 0.169 | 0.432 | 1.253 | 1.153 |
| Research institutes/ universities as part of the network | No | Yes | Yes | No | No | Yes |
| Most central actor | Vaillant B.V.<br>Vaillant Ltd.<br>VAILLANT S.A.R.L<br>Joh. Vaillant GmbH u. Co.<br>n.v.; Vaillant s.a. | Bayer Corporation<br>Kleymann, Gerald<br>Bayer HealthCare AG<br>Bayer Aktiengesellschaft<br>B Systems AG | Bayer AG<br>Bayer; HealthCare AG<br>Barmag AG<br>Oerlikon Textile GmbH & Co. KG<br>Nexans SuperConductors GmbH | Bayer Aktiengesellschaft; Bayer HealthCare AG; Boehringer Ingelheim International GmbH; Quante AG; Bayer Technology Services GmbH | Vaillant B.V.<br>Vaillant Ltd.<br>Joh. Vaillant GmbH u. Co.<br>n.v. Vaillant s.a | Bayer Aktiengesellschaft<br>Bayer HealthCare AG<br>AiCuris GmbH & Co. KG<br>Kleymann, Gerald |

*Source*: EIIW calculations/evaluations based on PATSTAT data

**Table 1.2** Network indicators for the Dortmund (Coop = cooperation, Mobi = intercompany mobility of patent applicants, RN = relationship network = Coop + Mobi)

| | Coop: 1992–1999 | Coop: 2000–2007 | Mobi. 1992–1999 | Mobi. 2000–2007 | RN 1992–1999 | RN 2000–2007 |
|---|---|---|---|---|---|---|
| Total applicants (absolute figure) | 90 | 98 | 90 | 98 | 90 | 98 |
| Isolated applicant (absolute figure) | | | | | | |
| Centrality of network | 5.08% | 0.92% | 1.75% | 1.41% | 1.53% | 1.15% |
| Density of network | 0.0065 | 0.0040 | 0.0047 | 0.0034 | 0.0112 | 0.0074 |
| Joint applicants (absolute figures) | 25 | 24 | 22 | 21 | 44 | 43 |
| Average degree centrality (strength of internal structure) | 0.578 | 0.388 | 0.422 | 0.327 | 1.000 | 0.714 |
| Research institutes/ universities as part of the network | Yes | Yes | No | No | Yes | No |
| Most central actor | Vorbrüggen, Jan C.<br>Rinne, Michael<br>Eckes, Christian<br>Kefalea, Efthimia<br>Von der Malsburg, Christoph | Gesellschaft zur Förderung der Spektrochemie und Angewandten Spektroskopie e.V.<br>Merck Patent GmbH<br>Evotec OAI AG<br>Ziemann, Tim | Micronas Munich GmbH<br>Infineon Technologies AG<br>Siemens AG<br>ORFEUS Combustion Engineering GmbH | Boehringer Ingelheim microParts GmbH<br>Siemens AG<br>Siemens Healthcare Diagnostics Inc.<br>Nokia Siemens Networks Oy | Vorbrüggen, Jan C.<br>Micronas Munich GmbH<br>Eckes, Christian<br>Rinne, Michael<br>Von der Malsburg, Christoph | Siemens AG<br>Gesellschaft zur Förderung der Spektrochemie und Angewandten Spektroskopie e.V.<br>Boehringer Ingelheim microParts GmbH<br>Siemens Healthcare Diagnostics Inc. |

*Source*: EIIW calculations/evaluations based on PATSTAT data

**Table 1.3** Network indicators for the Eindhoven (Coop = cooperation, Mobi = intercompany mobility of patent applicants, RN = relationship network = Coop + Mobi)

| | Coop: 1992–1999 | Coop: 2000–2007 | Mobi. 1992–1999 | Mobi. 2000–2007 | RN 1992–1999 | RN 2000–2007 |
|---|---|---|---|---|---|---|
| Total applicants (absolute figure) | 190 | 250 | 190 | 250 | 190 | 250 |
| Isolated applicant (absolute figure) | 135 | 175 | 130 | 176 | 80 | 111 |
| Centrality of network | 1.27% | 0.73% | 1.12% | 0.54% | 1.81% | 0.82% |
| Density of network | 0.0307 | 0.0156 | 0.0120 | 0.0251 | 0.0444 | 0.0443 |
| Joint applicants (absolute figures) | 55 | 75 | 60 | 74 | 110 | 139 |
| Average degree centrality (strength of internal structure) | 5.800 | 3.872 | 2.263 | 6.248 | 8.389 | 11.024 |
| Research institutes/ universities as part of the network | Yes | Yes | No(!) | Yes | Yes | Yes |
| Most central actor | Koninklijke Philips Electronics N.V.<br>PHILIPS AB<br>Philips Corporate Intellectual Property GmbH<br>Sony Corporation | Koninklijke Philips Electronics N.V.<br>Philips Corporate Intellectual Property GmbH NXP B.V.<br>Interuniversitair Microelektronica Centrum ( IMEC) | Koninklijke Philips Electronics N.V.<br>NXP B.V.<br>OnStream, Inc.<br>DALSA Corporation | Koninklijke Philips Electronics N.V.<br>NXP B.V.<br>TPO Hong Kong Holding Limited<br>Polymer Vision Limited | Koninklijke Philips Electronics N.V.<br>PHILIPS AB<br>Philips Corporate Intellectual Property GmbH<br>NXP B.V. | Koninklijke Philips Electronics N.V.<br>NXP B.V.<br>Philips Corporate Intellectual Property GmbH<br>TPO Hong Kong Holding Limited |

*Source*: EIIW calculations/evaluations based on PATSTAT data

**Table 1.4** Network indicators for the Karlskrona (Coop = cooperation, Mobi = intercompany mobility of patent applicants, RN = relationship network = Coop + Mobi)

| | Coop: 1992–1999 | Coop: 2000–2007 | Mobi. 1992–1999 | Mobi. 2000–07 | RN 1992–1999 | RN 2000–2007 |
|---|---|---|---|---|---|---|
| Total applicants (absolute figure) | 200 | 212 | 200 | 212 | 200 | 212 |
| Isolated applicant (absolute figure) | 139 | 181 | 142 | 139 | 86 | 107 |
| Centrality of network | 2.31% | 2.53% | 1.15% | 0.90% | 1.37% | 1.01% |
| Density of network | 0.0091 | 0.0062 | 0.0046 | 0.0063 | 0.0174 | 0.0144 |
| Joint applicants (absolute figures) | 61 | 31 | 58 | 73 | 114 | 105 |
| Average degree centrality (strength of internal structure) | 1.810 | 1.311 | 0.920 | 1.321 | 3.460 | 3.028 |
| Research institutes/ universities as part of the network | Yes | Yes | No | Yes | Yes | Yes |
| Most central actor | VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK , afgekort V.I.T.O.<br>Berggren, Christine<br>Mattiasson, Bo Gustav<br>Johansson, Gillis | Nilsson, Johan<br>Laurell, Thomas<br>Marko-Varga, György<br>EKSTRÖM, Simon | Telefonaktiebolaget L M Ericsson (Publ)<br>TELIA AB<br>TELIASONERA AB<br>Amersham Health AS | Telefonaktiebolaget L M Ericsson<br>Sony Ericsson Mobile Communications AB<br>GE Healthcare AS<br>Anoto AB | Gyros AB<br>VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK , afgekort V.I.T.O.<br>Drott, Johan<br>Johansson, Gillis | Telefonaktiebolaget L M Ericsson<br>Sony Ericsson Mobile Communications AB<br>AstraZeneca AB<br>Nilsson, Johan |

*Source*: EIIW calculations/evaluations based on PATSTAT data

**Table 1.5** Network indicators for the London Region (Coop = cooperation, Mobi = intercompany mobility of patent applicants, RN = relationship network = Coop + Mobi)

| | Coop: 1992–1999 | Coop: 2000–2007 | Mobi. 1992–1999 | Mobi. 2000–2007 | RN 1992–1999 | RN 2000–2007 |
|---|---|---|---|---|---|---|
| Total applicants (absolute figure) | 573 | 895 | 573 | 895 | 573 | 895 |
| Isolated applicant (absolute figure) | 422 | 701 | 464 | 776 | 324 | 589 |
| Centrality of network | 0.24% | 0.44% | 0.34% | 0.44% | 0.24% | 0.47% |
| Density of network | 0.0019 | 0.0008 | 0.0006 | 0.0003 | 0.0025 | 0.0012 |
| Joint applicants (absolute figures) | 151 | 194 | 109 | 119 | 249 | 306 |
| Average degree centrality (strength of internal structure) | 1.068 | 0.758 | 0.325 | 0.264 | 1.407 | 1.091 |
| Research institutes/ universities as part of the network | Yes | Yes | Yes | Yes | Yes | Yes |
| Most central actor | Kodak Limited<br>Eastman Kodak Company<br>SmithKline Beecham PLC<br>SmithKline Beecham Corporation | Kings College London<br>Medical Research Council<br>University College London<br>Guy's and St Thomas' NHS Foundation Trust | Central Research Laboratories Limited<br>Invensys Controls UK Limited<br>GEC-Marconi Limited<br>Imperial College of Science Technology and Medicine | Imperial College Innovations Limited<br>Imperial Innovations Limited<br>Central Research Laboratories Limited<br>Syngenta Limited | Kodak Limited<br>Eastman Kodak Company<br>SmithKline Beecham PLC<br>SmithKline Beecham Corporation | Kings College London<br>Imperial College Innovations Limited<br>Medical Research Council<br>University College London |

*Source*: EIIW calculations/evaluations based on PATSTAT data

**Table 1.6** Network indicators for the Györ/Budapest (Coop = cooperation, Mobi = intercompany mobility of patent applicants, RN = relationship network = Coop + Mobi)

| | Coop: 1992–1999 | Coop: 2000–2007 | Mobi. 1992–1999 | Mobi. 2000–2007 | RN 1992–1999 | RN 2000–2007 |
|---|---|---|---|---|---|---|
| Total applicants (absolute figure) | 70 | 121 | 70 | 121 | 70 | 121 |
| Isolated applicant (absolute figure) | 36 | 77 | 61 | 99 | 26 | 58 |
| Centrality of network | 6.29% | 0.79% | 2.12% | 1.59% | 6.19% | 0.74% |
| Density of network | 0.0683 | 0.0142 | 0.0046 | 0.0051 | 0.0737 | 0.0198 |
| Joint applicants (absolute figures) | 34 | 44 | 9 | 22 | 44 | 63 |
| Average degree centrality (strength of internal structure) | 4.714 | 1.702 | 0.314 | 0.612 | 5.086 | 2.380 |
| Research institutes/universities as part of the network | Yes | Yes | Yes | Yes | Yes | Yes |
| Most central actor | Valyi-Nagy Istvan<br>Jako, Janos<br>Gyarmati, Laszlo<br>Kaffka, Karoly | Medl, Attila<br>Dunay, Rezso<br>Fejes, Sandor<br>Patko, Tamas | Optilink AB<br>Risoe National Laboratory<br>Siemens AG<br>Dermo Trade RT. | Thomson Licensing<br>Nokia Corporation<br>Bayer Innovation GmbH<br>Deutsche Thomson-Brandt GmbH | Valyi-Nagy Istvan<br>Jako, Janos<br>Gyarmati, Laszlo<br>Kaffka, Karoly | Medl, Attila<br>Dunay, Rezso<br>Fejes, Sandor<br>Patko, Tamas |

*Source*: EIIW calculations/evaluations based on PATSTAT data

**Table 1.7** Network indicators for the Vienna Region (Coop = cooperation, Mobi = intercompany mobility of patent applicants, RN = relationship network = Coop + Mobi)

| | Coop: 1992–1999 | Coop: 2000–2007 | Mobi. 1992–1999 | Mobi. 2000–2007 | RN 1992–1999 | RN 2000–2007 |
|---|---|---|---|---|---|---|
| Total applicants (absolute figure) | 202 | 328 | 202 | 328 | 202 | 328 |
| Isolated applicant (absolute figure) | 140 | 218 | 159 | 279 | 102 | 171 |
| Centrality of network | 1.11% | 0.85% | 0.95% | 0.59% | 1.08% | 0.59% |
| Density of network | 0.0052 | 0.0132 | 0.0027 | 0.0021 | 0.0078 | 0.0093 |
| Joint applicants (absolute figures) | 62 | 110 | 43 | 49 | 100 | 157 |
| Average degree centrality (strength of internal structure) | 1.040 | 4.328 | 0.535 | 0.699 | 1.574 | 3.037 |
| Research institutes/ universities as part of the network | Yes | Yes | Yes | Yes | Yes | Yes |
| Most central actor | Boehringer Ingelheim International GmbH<br>Genentech, Inc.<br>University of North Carolina at Chapel Hill<br>Novartis AG | Austria Wirtschaftsservice Gesellschaft mit beschränkter Haftung<br>Bertagnolli, Emmerich<br>Lendl, Bernhard<br>Mizaikoff, Boris | Siemens AG<br>ALCATEL<br>Baxter Aktiengesellschaft<br>Alcatel Lucent | Siemens AG<br>Nokia Siemens Networks GmbH & Co. KG<br>Siemens AG Österreich<br>NXP B.V. | Boehringer Ingelheim International GmbH<br>Genentech, Inc.<br>University of North Carolina at Chapel Hill<br>Siemens AG | Siemens AG<br>Austria Wirtschaftsservice Gesellschaft mit beschränkter Haftung<br>Nokia Siemens Networks GmbH & Co. KG<br>Koninklijke Philips Electronics N.V. |

*Source*: EIIW calculations/evaluations based on PATSTAT data

**Table 1.8** Patent citations index—ICT regions

| ICT | Citations made | Ranking | Received citations | Ranking | Index[a] |
|---|---|---|---|---|---|
| Bergisch City Triangle | 1,704 | 5 | 878 | 4 | 1.94 |
| Eindhoven | 5,826 | 1 | 25,134 | 1 | 0.23 |
| Karlskrona | 2,690 | 4 | 790 | 5 | 3.41 |
| London | 5,677 | 2 | 8,249 | 2 | 0.69 |
| Budapest/Györ | 518 | 7 | 218 | 7 | 2.38 |
| Vienna | 3,092 | 3 | 2,189 | 3 | 1.41 |
| Dortmund | 1,568 | 6 | 377 | 6 | 4.16 |

*Source*: EPO (2008), EPO worldwide Statistical Patent Database
[a]Citations made per-keeping citations

**Table 1.9** ICT patent applications to NUTS-3 level

| ICT | Period | | |
|---|---|---|---|
| | P1: 1992–1999 | P2: 2000–2007 | Change between P1 and P2 |
| London | 9,852,509 | 13,379,278 | +35% |
| Dortmund | 791,203 | 1,119,324 | +41 % |
| Bergisch City Triangle | 690,262 | 1,406,199 | +104% |
| Eindhoven | 34,655,001 | 76,333,277 | +120% |
| Vienna | 3,542,126 | 8,193,136 | +130% |
| Karlskrona | 4,723,844 | 12,474,070 | +164% |
| Györ/Budapest | 499,535 | 1,776,318 | +255% |

*Source*: Own calculation, EPO PATSTAT, weighted absolute values

the digital regional innovation system. Regions in which new state-sponsored universities are created should be checked by policymakers and expert bodies whether or not the new developed profiles are in line with the top-notch requirements of modern ICT. To the extent that the use of ICT is a major focus of regional specialization, it will be important to organize creative flexible links between leading firms from the "Old Economy" and leading digital innovators. In ICT, it is important to have productivity-enhancing international links, and from this perspective, there might be a need for an intelligent overlap of the regional innovation system and the national innovation system; in the EU, useful stimulus could also come from the supranational innovation policy. However, the question is sometimes whether or not there is sufficient emphasis on digital excellence, which includes the ability to not only be strong in the innovation cycle but also to be flexible and efficient in global outsourcing.

Since the expansion of ICT—partly based on fast broadband networks and increasing mobile broadband services—facilitates the creation of international innovation networks, the growth of ICT will stimulate technoglobalization in the long run.

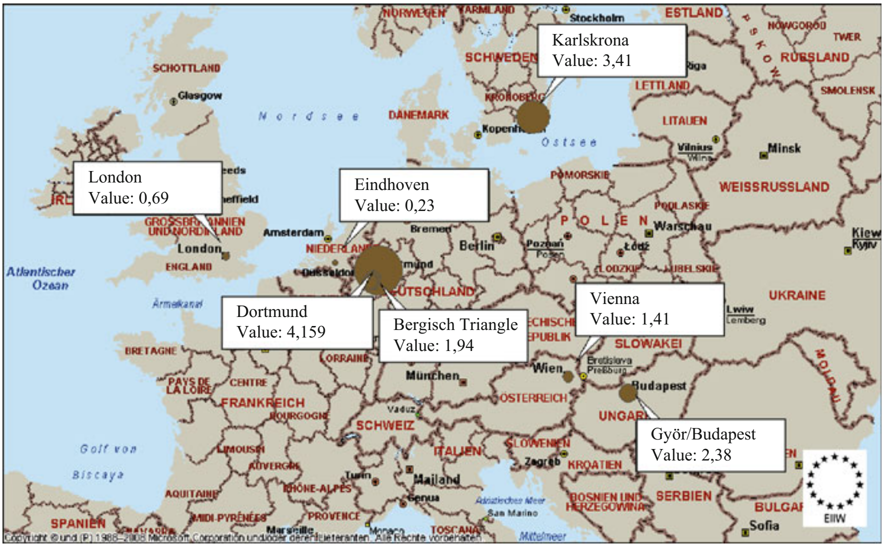



**Fig. 1.44** Patent intensity: citations made relative to citations received. *Source*: Designed with MapPoint (2009), own calculations

Part of innovation tasks will be outsourced to specialized subcontractors and partners abroad.

In some regions, there are also special challenges in the creation of networks:

- It is important to keep access to regional innovation networks open—that is, to establish transparency about the criteria relevant for joining the regional "innovation club."
- At the same time, it is important—particularly if government supports regional innovation clusters—to establish critical quality criteria for those seeking access to the innovation cluster and to government R&D funding. Whenever government funds can be tapped, there is an incentive for managers of outsider firms to raise their voices to argue that they would like to become a member of the cluster since the respective firm has certain relevant innovation projects; however, there are serious information asymmetries here, and there is some risk that a considerable share of firms willing to join an existing dynamic innovative cluster consists of non-innovative foot-draggers. Once they join the cluster, the speed of innovation in the cluster might actually be slowed down as the cluster has become not only bigger—and this brings some additional administrative costs—but the average quality of networking could deteriorate as a consequence of perverse incentive effects in selecting new firms for the cluster ("adverse cluster selection problem"). An independent expert panel might be useful for the assessment of the Schumpeterian quality of cluster expansion.

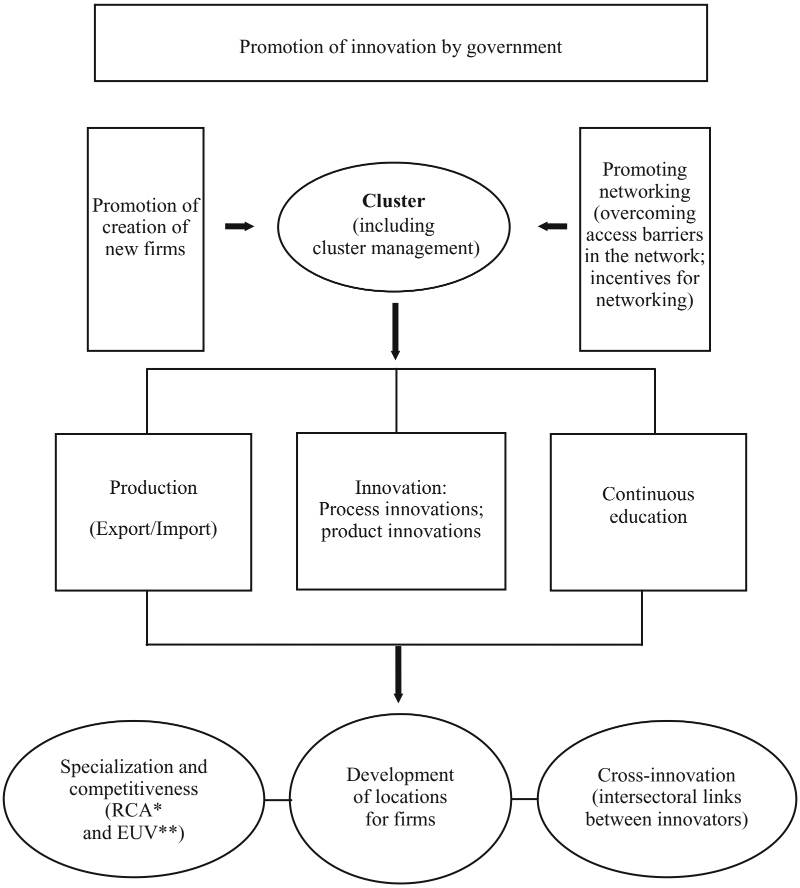



**Fig. 1.45** Cluster policy and innovation. **RCA*, Revealed Comparative Advantage; ***EUV*, Export Unit Value

- A useful institutional learning procedure could be based on prime league and secondary league mechanisms that imply that 10% of the worst performers of those in league 1 will lose this status every 5 years, while 10% of the best performers of those in league 2 will be allowed to join the prime cluster—the group of firms that get a higher R&D promotion from government than those firms in league 2. The basic idea of R&D promotion for individual firms within cluster groups is to optimally internalize group-specific positive spillover effects. Here further empirical research is needed (Fig. 1.45).

As regards the experience with EU-sponsored ICT innovation projects in the sixth framework program (Breschi et al. 2009), it may be pointed out that the involvement of at least one major international innovative firm in the cluster to be formed or supported plays a crucial role. It is, however, unclear whether the mixture or regional, national, and supranational innovation promotion in the EU is efficient or not.

As regards the market-based financing of innovation, it may be pointed that the transatlantic banking crisis has undermined the opportunities of venture capital financing and particularly of more long-term financing. Risk premiums have strongly increased in financial markets in the aftermath of the crisis years of 2008/2009, and the maturity of bonds placed in markets have fallen in many OECD countries. As the expansion of ICT has strongly stimulated financial innovation dynamics—some of which are rather opaque and might generate negative spillover effects—a careful eye should be kept on the various fields of digital innovations.

The comparison of regions with similar sectoral specializations in the EU shows considerable differences with respect to the size and characteristics of technology-intensive networks. Interestingly, some regions have made considerable progress on the basis of regional and national political initiatives, but in the case of ICT, it seems that there is some potential for endogenous ICT networking—if there is a critical number of high-technology firms active in the use of ICT, such firms could themselves become a major source of ICT innovations and such firms might also embark upon regional networking strategies. With an explicit focus on most EU countries and a selected number of regions in Germany, the UK, Sweden, Netherlands, Austria, and Hungary, we can come up with new insights into the dynamics of ICT and the automotive sector. As regards cross-innovation, there is only a rather small and restricted focus on recent developments in a few regions.

The EU had emphasized ICT innovation in the fifth and sixth framework programs—a special frame for internationally networked ICT innovation projects—and part of these impulses have generated sustained digital expansion in certain regions. However, the EU's projects typically support the creation of very heterogeneous groups of firms: a typical requirement to get a project proposal through the EU application procedure is that a minimum of three and often five or seven countries should be involved, ideally with partners in central European EU countries, plus one cohesion country (Spain, Portugal, Ireland, Greece), plus one of the eastern European accession countries. This is a strange way to promote excellence in innovation in the EU since such a heterogeneous group of project participants is unlikely to deliver optimum innovation dynamics. The European Commission should reconsider innovation policies and at least provide a large part of EU funds to promote high-technology innovation dynamics in leading EU countries.

# Appendix 1: Relationship Networks of Ingolstadt and Györ/Budapest

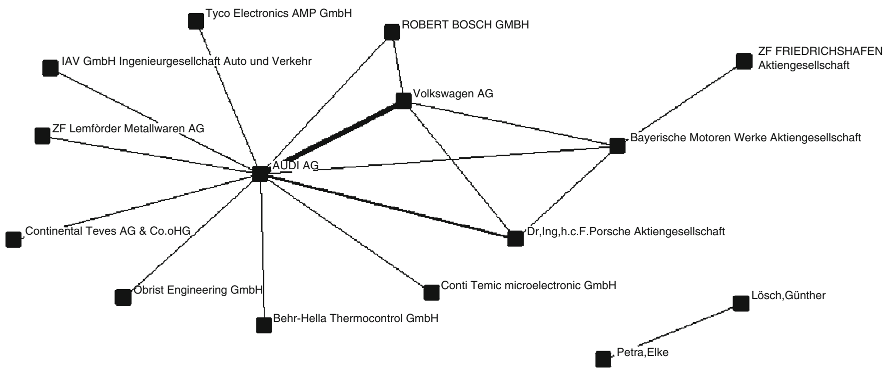



**Fig. 1.46** Relationship network Ingolstadt—2000–2007. *Source*: EIIW calculations

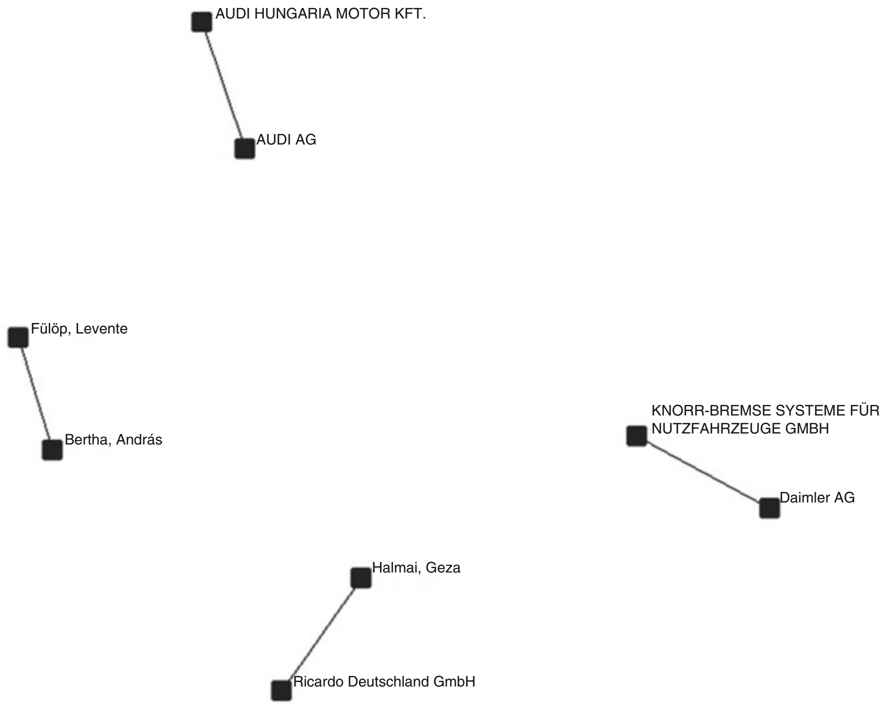



**Fig. 1.47** Relationship network Györ/Budapest—2000–2007. *Source*: EIIW calculations

## Appendix 2: Investigated Regions

**Table 1.10** Investigated regions ICT

| Country | Investigated regions |
|---|---|
| Germany | “DEA18” Remscheid |
| | “DEA19” Solingen |
| | “DEA1A” Wuppertal |
| | “DEA52” Dortmund |
| Austria | “AT130” Vienna |
| | “AT126” Vienna Region/northern part |
| | “AT127” Vienna Region/southern part |
| Netherlands | “NL413” Noordoost-Noord-Brabant |
| | “NL414” Zuidoost-Noord-Brabant |
| Hungary | “HU101” Budapest |
| | “HU102” Pest |
| | “HU212” Komárom-Esztergom |
| | “HU211” Fejér |
| | “HU333” Csongrád |
| Sweden | “SE041” Blekinge län[a] |
| | “SE044” Skåne län[a] |
| United Kingdom | “UKI11” Inner London—West |
| | “UKI12” Inner London—East |
| | “UKI21” Outer London—East and North East |
| | “UKI22” Outer London—South |
| | “UKI23” Outer London—West and North West |

*Source*: Classification taken from OECD Territorial Grid (2008b) and EUROSTAT
[a]The division of the Swedish regions has changed

## Appendix 3: ICT Patents at the NUTS-0 Level

**Table 1.11** ICT patents at the NUTS-0 level

| ICT | Period | | | |
|---|---|---|---|---|
| | P1: 1992–1999 | P2: 2000–2007 | Change between P1 and P2 | Ranking |
| Germany | 236,310,272 | 384,234,209 | 147,923,937 | 1 |
| Netherlands | 51,860,289 | 99,126,885 | 47,266,596 | 2 |
| Austria | 8,992,753 | 19,124,180 | 10,131,427 | 5 |
| Sweden | 3425,5205 | 5186,3735 | 1,760,853 | 4 |
| UK | 9156,9002 | 12855,2671 | 36,983,669 | 3 |
| Hungary | 57,5226 | 201,0377 | 1,435,151 | 6 |

*Source*: Own calculation, EPO PATSTAT

## Appendix 4: Evaluation Scheme for Social Network Analysis (ICT)

**Table 1.12** Evaluation scheme for social network analysis (ICT)

| Social network analysis |
|---|
| (1) Number of actors involved |
| + + +: High number of actors involved (≤60) |
| + + −: Average number of actors involved (40–59) |
| + − −: Low number of actors involved (20–39) |
| − − −: Poor number of actors involved (0–19) |
| (2) Number of connected actors |
| + + +: High number of connected actors (≤60) |
| + + −: Average number of connected actors (40–59) |
| + − −: Low number of connected actors (20–39) |
| − − −: Poor number of connected actors (0–19) |
| (3) The integration of research institutions (relationship network 2000–2007) |
| + + +: Significant involvement of research institutions (<10) |
| + + −: Moderate involvement (more than 5) |
| + − −: Low involvement (less than 5) |
| − − −: No involvement |
| (4) Change of the average degree-centrality |
| + + +: Increasing network over time |
| + + −: Slightly networking |
| + − −: Decrease in networking |
| − − −: Sharply decrease in networking |

*Source*: Own weighting

## Appendix 5: Betweenness Centrality: Relationship Network ICT (Freeman Betweenness)

**Table 1.13** Betweenness Centrality: Relationship Network ICT (Freeman Betweenness)

| 1992–1999 | | 2000–2007 | |
|---|---|---|---|
| Applicant | Value | Applicant | Value |
| Bergisches Städtedreieck | | | |
| Vaillant B.V. | 0.015 | Bayer Aktiengesellschaft | 1.076 |
| Vaillant Ltd. | 0.015 | Bayer HealthCare AG | 0.425 |
| Vaillant S.A.R.L | 0.015 | Bayer Corporation | 0.217 |
| Joh. Vaillant GmbH u. Co. | 0.015 | Bayer Technology Services GmbH | 0.125 |
| | | Change between the two periods | + |
| London | | | |
| Kodak Limited | 6.469 | Imperial College Innovations Limited | 0.237 |
| Eastman Kodak Company | 5.420 | Cambridge Enterprise Limited | 0.200 |

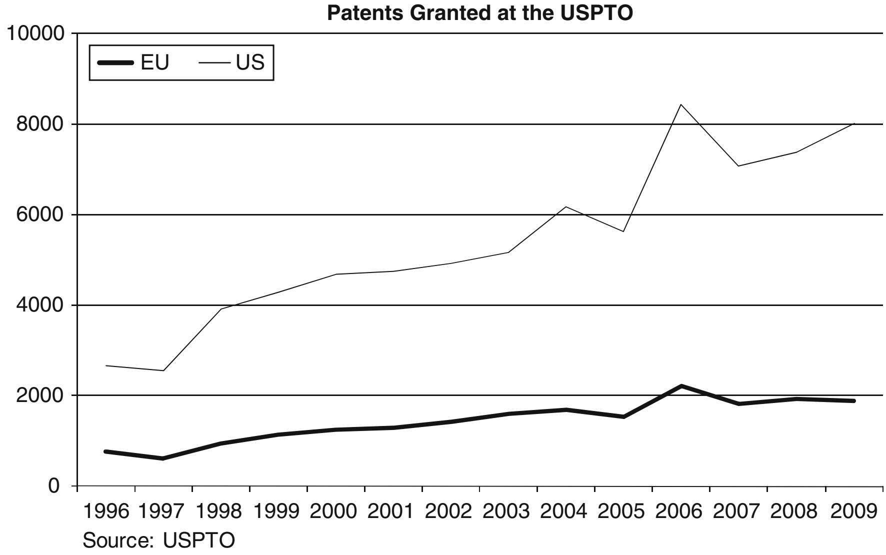
(continued)

Table 1.13 (continued)

| 1992–1999 | | 2000–2007 | |
|---|---|---|---|
| Applicant | Value | Applicant | Value |
| SmithKline Beecham PLC | 4.021 | Kings College London | 0.188 |
| Medical Research Council | 3.846 | University College London | 0.062 |
| | | Change between the two periods | – |
| Dortmund | | | |
| STEAG microParts GmbH | 0.128 | Siemens AG | 0.064 |
| microParts Gesellschaft für Mikrostrukturtechnik mbH | 0.077 | Hentze-Lissotschenko Patentverwaltungs GmbH & Co. KG | 0.021 |
| Siemens AG | 0.051 | ABB Patent GmbH | 0.000 |
| Mannesmann Aktiengesellschaft | 0.026 | ABB Technology AG | 0.000 |
| | | Change between the two periods | – |
| Eindhoven | | | |
| Koninklijke Philips Electronics N.V. | 16.980 | Koninklijke Philips Electronics N.V. | 17.714 |
| Akzo Nobel N.V. | 1.311 | OTB Group B.V. | 1.988 |
| Philips AB | 0.620 | NXP B.V. | 1.493 |
| bioMerieux B.V. | 0.445 | Nederlandse Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek | 1.343 |
| | | Change between the two periods | + |
| Budapest/Györ | | | |
| 3DHISTECH Kft. | 0.000 | Nokia Corporation | 0.504 |
| Elektronika Muszeripari Kft. | 0.000 | Solvo Biotechnology | 0.224 |
| Andrasev, Akos | 0.000 | Nokia Siemens Networks Oy | 0.224 |
| Appaloosa Interactive Corporation | 0.000 | Institute of Enzymology, Biological Research Center, Hungarian Academy of Sciences | 0.126 |
| | | Change between the two periods | ± |
| Wien | | | |
| Siemens AG | 0.706 | Robert Bosch GmbH | 0.462 |
| Infineon Technologies AG | 0.368 | Continental Automotive GmbH | 0.432 |
| Baxter Aktiengesellschaft | 0.318 | Technische Universität Wien | 0.368 |
| IMS Ionen Mikrofabrikations Systeme Gesellschaft m.b. H. | 0.169 | Siemens AG | 0.338 |
| | | Change between the two periods | – |
| Karlskrona | | | |
| Siemens-Elema AB | 2.698 | Telefonaktiebolaget L M Ericsson | 5.225 |
| Maquet Critical Care AB | 2.345 | Sony Ericsson Mobile Communications AB | 2.070 |
| Amersham Pharmacia Biotech AB | 2.345 | Dialog Semiconductor GmbH | 0.747 |
| Telefonaktiebolaget L M Ericsson (Publ) | 1.883 | AstraZeneca AB | 0.727 |
| | | Change between the two periods | + |

*Source*: own calculations; +, Betweenness centrality is increasing; –, Betweenness centrality decreases; =, Betweenness centrality consistently

## Appendix 6: Telecommunication Patents Grated at the USPTO (EU and USA)

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# Chapter 2
# The Hungarian ICT Sector: A Comparative CEE Perspective with Special Emphasis on Structural Change

**Balázs Lengyel**

## 2.1 Introduction

ICT is highly associated with technological development in organizations, companies, regions and countries (EC 2009; Edquist 1997; Lundvall 1992). It contributes to economic and productivity growth with the following effects (OECD 2004): evidence in Denmark, Ireland, Sweden, the USA and the UK shows that ICT investments raised labour productivity acting as capital goods; technological progress in the ICT sector contributes to more rapid multifactor productivity (MFP) growth in the ICT sector; the rapid diffusion of and increased use of ICT in the economy increases overall efficiency.

Regional development is also affected by ICT sector; the related investment can differ across regions within the same country; ICT takes its effects through different channels (Barrios et al. 2008). Technical progress takes place mainly in high-tech sectors; the higher the weight of ICT producing industries in total output, the higher the impact on economic growth via multifactor productivity improvements. ICT capital accumulation provides productivity gains in industries that use ICT and have the largest shares of ICT in total capital. ICT accelerates general technological progress by incorporating horizontal set of technologies. The latter particularly means that all sectors can potentially benefit through knowledge spillovers caused by the presence of ICT industries within the region.

The countries in Central and Eastern Europe (CEE) entered a transition period and faced the challenges of globalization during the same period of time. During the 1990s, accession to the European Union, economic growth and modernization became increasingly crucial objectives for facing the challenges of both transition and globalization. Thus, one must consider two processes when analyzing the dynamics of ICT industry in CEE; foreign direct investment (FDI) and multinational enterprises (MNEs) became decisive in shaping the national and regional innovation systems in outstanding industries (Inzelt 2003; Radosevic 2002). The concentration of industries brought new folds of regional differences related to the presence of ICT (Jakobi 2005).

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This chapter analyses the Hungarian ICT sector from a comparative CEE perspective. In the second section, we introduce the status of the ICT industry of CEE countries. This is followed by a description of the effect of ICT on structural upgrading in the region. In the fourth section, we give an overview of the Hungarian ICT policy. The conclusions will be drawn in the final section.

## 2.2 Current Status and Latest Development of the ICT Industry in CEE

The ICT sector and in particular ICT services are concentrated spatially. This is due to the high knowledge-intensity of the sector that makes localization and urbanization economies and spatially given knowledge and technological spillovers prevail (Jacobs 1969). The knowledge-related agglomeration economies are especially important in the case of ICT services; these can be provided at a large distance and therefore concentrate in large cities (Lengyel 2012). Thus, the ICT sector shares an important part in the specialization of the richest regions of the EU15, while the ICT clusters in the EU10 still do not match this specialization level (Barrios et al. 2008). Concentration in ICT prevails on a higher degree than in medium-tech industries such as the automotive industry (Szalavetz 2012).

Here, we introduce the main country level trends of ICT industry in CEE according to the structure of the sector, the growth in production and foreign trade of ICT manufacturing. After these we show how big the major regional hubs in EU10 countries are compared to the ones in old member states. In the end of the section, we illustrate the Hungarian ICT market in the European and CEE context.

### *2.2.1 ICT Sectors in CEE from 1995 to 2004*

There is a huge gap between EU15 and EU10 countries employment volumes of ICT sector. In the table below, one can observe the employment structure at country and ICT sub-sector levels over the period from 1995 to 2004 (Table 2.1). A substantial share of total ICT employment is located in the EU15 (88.3%); this has also increased slightly over the period 1995–2004. Meanwhile the share of ICT employment in the EU10 decreased slightly, going from 12.6% in 1995 to 11.7% in 2004.

The decrease in the proportion of employment in the new member countries between 1995 and 2004 is probably a reflection of an overall decrease in the percentage of their share of employment in all sectors of the economy. This period is considered the late phase of transition during which time intense economic restructuring was experienced in the new member countries, and the ICT sector has been no exception to this process (Havas 2006). The big state-owned companies went bankrupt or were privatized, which led to a general portfolio cleaning in many

**Table 2.1** Share of employment in ICT in the CEE countries, 1995 and 2004 (%)

| | NACE 30 Office, machinery, computing | | NACE 32 Radio, television and com. eq. | | NACE 33 Medical precision and optical instr. | | NACE 64 Post and telecom | | NACE 72 Computer services | | Total ICT | | Total economy | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1995 | 2004 | 1995 | 2004 | 1995 | 2004 | 1995 | 2004 | 1995 | 2004 | 1995 | 2004 | 1995 | 2004 |
| CZ | 1.9 | 4.9 | 2.4 | 4.0 | 2.9 | 3.2 | 2.8 | 2.4 | 1.8 | 1.4 | 2.6 | 2.4 | 2.9 | 2.4 |
| HUN | 0.6 | 3.9 | 2.1 | 9.4 | 2.0 | 2.0 | 2.6 | 2.2 | 0.8 | 1.2 | 2.0 | 2.6 | 1.9 | 2.0 |
| PL | 1.9 | 2.9 | 5.9 | 3.4 | 4.8 | 4.3 | 6.4 | 5.9 | 1.5 | 2.0 | 4.8 | 4.0 | 6.6 | 5.5 |
| SVK | 0.9 | 1.8 | 1.4 | 1.5 | 1.2 | 0.9 | 1.3 | 1.1 | 0.7 | 0.5 | 1.1 | 0.9 | 1.3 | 1.1 |
| EU15 | 93.8 | 85.4 | 85.1 | 78.7 | 87.3 | 87.9 | 84.6 | 86.2 | 94.3 | 94.1 | 87.4 | 88.3 | 84.9 | 86.9 |
| EU10 | 6.2 | 14.6 | 14.9 | 21.3 | 12.7 | 12.1 | 15.4 | 13.8 | 5.7 | 5.9 | 12.6 | 11.7 | 15.1 | 13.1 |
| EU25 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Source: Author's edition after Barrios et al. (2008), p. 13

sectors (Lengyel and Cadil 2009). Indeed, the decrease in the CEE employment share in total European employment is less pronounced in the ICT sector than in the rest of the economy (see Table 2.1). There are even cases of increase of CEE share in certain countries and sub-sectors, where cost-efficiency and relatively well-educated labour attracted foreign-owned firms (Barrios et al. 2008). Due to the investments of MNEs, EU10 countries tend to have gained employment shares in the manufacturing ICT sub-sectors, with the exception of the medical, precision and optical instruments sectors (NACE 33).

Thus, the CEE countries—and particularly the Czech Republic and Hungary—are somehow exceptions among the new member states; employment in ICT manufacturing performed a notable rise in the manufacturing of office machinery and telecommunication equipment (NACE 30 and NACE 32). The share of Hungary in the total EU employment in the manufacturing of radio, television and communication equipment rose from 2.1% in 1995 to 9.4% in 2004. The Czech Republic has almost 5% of total EU employment in the manufacturing of office, machinery and computing. Slovakian employment in ICT manufacturing increased slightly, while the change in the Polish employment share increased only in NACE 30, while decreasing in all other ICT manufacturing sub-sectors.

### *2.2.2 Development of ICT Manufacturing in CEE Countries, 2000–2008*

In this part, we use the OECD STAN database to analyse growth in production volumes of the ICT manufacturing industry in CEE countries over the 2000–2008 period. The data are available at country level and include NACE 30, 32, 33 sectors. Euro values were calculated from national currency values at the exchange rate on the 1st of January for each year. Slovakia is an exception, because data were available directly in euro (Table 2.2).

Though data were not available for Hungary in 2008, the country has clearly stood out in CEE in terms of the gross output of ICT manufacturing over the decade. The Hungarian volume double the value in Poland. Hungary also overperformed the Czech Republic in this sense; however, the Czech output grew dynamically. ICT manufacturing performed at a much lower level but has grown quickly in the Slovak Republic (Table 2.3).

Large differences are apparent across the CEE countries in terms of foreign trade. Similar to its gross output, Hungary stands out in the region in volume of export and also in the volume of import; these values are at least ten times larger than is the case in the Czech Republic and Poland. The trade balance was positive through the whole period only in Hungary and showed an upgrading trend. However, the high value of export is accompanied by high import values; thus, the large share of export is probably import-related and is likely due to foreign-owned firms. Unfortunately, data on a company level for all CEE countries were unavailable, and

**Table 2.2** Gross output at current prices, 2000–2008 (million Euro)

| | 2000 | 2002 | 2004 | 2006 | 2008 | Growth 2000–2008 (%) |
|---|---|---|---|---|---|---|
| Czech Republic | 10,427 | 17,447 | 21,527 | 30,974 | 44,328 | 325 |
| Hungary | 20,601 | 22,025 | 30,310 | 37,487 | n.a. | 81 |
| Poland | 10,546 | 13,568 | 12,434 | 19,118 | n.a. | 81 |
| Slovakia | 3,133 | 3,824 | 5,918 | 12,066 | 15,333 | 389 |

Source: Author's calculation, OECD STAN database

**Table 2.3** Export and import of goods at current prices, 2000–2008 (million Euro)

| | | 2000 | 2002 | 2004 | 2006 | 2008 | Over production (%) 2008 |
|---|---|---|---|---|---|---|---|
| Czech Republic | Export | 7,377 | 13,360 | 18,917 | 26,878 | 37,084 | 83 |
| | Import | 10,838 | 14,942 | 18,508 | 26,153 | 34,366 | 77 |
| | Balance | −3,461 | −1,582 | 409 | 724 | 2,719 | |
| Hungary | Export | 141,177 | 170,174 | 237,375 | 316,127 | n.a. | 97[a] |
| | Import | 134,235 | 161,212 | 203,060 | 263,410 | n.a. | 81[a] |
| | Balance | 6,942 | 8,962 | 34,315 | 52,716 | n.a. | |
| Poland | Export | 4,830 | 7,753 | 8,353 | 15,108 | 23,893 | 79[a] |
| | Import | 12,874 | 14,596 | 14,684 | 23,674 | 33,006 | 125[a] |
| | Balance | −8,044 | −6,842 | −6,330 | −8,566 | −9,112 | |
| Slovak Republic | Export | 2,300 | 3,114 | 5,660 | 13,352 | 20,273 | 132 |
| | Import | 3,873 | 5,431 | 7,159 | 13,173 | 18,721 | 122 |
| | Balance | −1,573 | −2,317 | −1,499 | 179 | 1,552 | |

Source: Author's calculation, OECD STAN database
[a]Indicator for year 2006, respectively

we also found no statistics concerning ownership structure of ICT firms in all CEE countries. In another paper related to current research, however, it was shown that the cluster formation is highly associated with foreign-owned firms in Hungary (Lengyel 2012). We will illustrate cross-country differences with the help of value added and intermediate inputs in Sect. 2.3.

The trade balance has become positive in the Czech Republic over the decade, and the same happened in the Slovak Republic to a lesser degree. We expect that the relatively high value of Czech ICT manufacturing export also depends on imports, as is that case in Hungary. The increasing Polish export of ICT manufacturing industry has not succeeded in outperforming the growing demand for import ICT goods, and the trade balance remained negative.

### *2.2.3 Regions*

Employment in the ICT sector tends to be rather concentrated geographically around the so-called blue banana of Europe (Southern UK, the Benelux and Denmark, Ile-de-France, the Western regions of Germany and the North of Italy).

**Table 2.4** Regions of ICT concentration in EU10 countries

| Region | ICT sector | | | All sectors | | | GDP per capita |
|---|---|---|---|---|---|---|---|
| | Rank | Share of EU ICT employment | Cumulated shares | Rank | Share of EU total employment | Cumulated shares | |
| Közép-Magyarország (HU) | 12 | 1.29 | 1.29 | 40 | 0.65 | 0.65 | 97.5 (120) |
| Mazowieckie (PL) | 14 | 1.24 | 2.52 | 13 | 1.04 | 1.68 | 73.7 (194) |
| Praha (CZ) | 29 | 0.82 | 3.34 | 92 | 0.38 | 2.06 | 150.8 (12) |
| Slaskie (PL) | 47 | 0.53 | 3.87 | 27 | 0.78 | 2.84 | 54.7 (227) |
| Lietuva (LT) | 50 | 0.50 | 4.37 | 30 | 0.71 | 3.56 | 49.0 (235) |
| Slovenija (SI) | 53 | 0.49 | 4.86 | 74 | 0.45 | 4.01 | 79.9 (179) |
| Severovychod (CZ) | 50 | 0.46 | 5.32 | 106 | 0.35 | 4.36 | 61.1 (218) |
| Jihovychod (CZ) | 66 | 0.41 | 5.73 | 88 | 0.38 | 4.75 | 64.7 (210) |
| Wielkopolskie (PL) | 71 | 0.38 | 6.11 | 45 | 0.61 | 5.36 | 52.3 (231) |
| Dolnoslaskie (PL) | 74 | 0.37 | 6.48 | 75 | 0.45 | 5.31 | 49.6 (234) |

Source: Barrios et al. (2008), p. 17

However, the ICT industry is also concentrated in some of the regions in the new member states. We show here the main ICT regions in terms of employment shares in total EU employment of the EU10, most of these are located in CEE countries. Malta, Kozep-Magyarorszag (HU), Mazowieckie (PL) and Praha (CZ) are the regions that emerged in the new member countries (Barrios et al. 2008).

Table 2.4 above displays the share in total ICT employment of the top ten NUTS2 regions located in the EU10 in terms of share in EU ICT employment. Most notably, Praha (CZ), Közép-Magyarország (HU) and Nyugat-Dunántúl (HU) appear to be relatively highly specialized in ICT activities among all member states. ICT industries can potentially play an important role in industrial specialization and, thus, for regional development in those regions. The specialization indexes in these CEE regions are higher than in bigger hubs of ICT in EU15 countries (Barrios et al. 2008). It is worth noticing that despite the dominance of the Hungarian ICT manufacturing, only one region (Közép-Magyarország) is present in the EU10 countries. Nyugat-Dunántúl is also specialized in ICT, but this region is small according to the volume of employment and has not entered the list in Table 2.4. The Czech and Polish ICT sector is more spread over their country: more regions are in the top ten.

The regional evolution of an industry prevails through different channels in which the location of MNEs and the establishment of SMEs play decisive role (Boschma and Fenken 2006). While MNEs act as gatekeepers between the global and local economy, the dynamics in SME creation is likely to report on the occurrence of knowledge spillover in a region. The following statements are based on maps in the appendix of the report on regional performance of the European ICT industry (Barrios et al. 2008).

The location pattern of MNEs in ICT industry differs according to manufacturing ICT sub-sectors. The manufacturing of office machinery and computers sector has attracted a growing number of multinationals to Poland, Slovakia and the Czech Republic since the early 2000s, although MNEs tended to favour locations in UK, Irish, Dutch and German regions before the 2000s. Hungary lingers behind in MNE attraction, which is probably due to the fact that these firms located their sites to the country in the 1990s. Central and North-West Hungary and West Poland seem to have been more attractive for MNEs in television and communication equipment; medical precision and optical instruments mostly went to Poland. The ICT service sub-sector is still attracting MNEs to invest in the core regions of EU; if these were going to new member states, they would likely to choose their locations in the capital regions.

The location of new SMEs is similar to the case of MNEs, but small companies tend to be much more dispersed geographically than multinationals (Barrios et al. 2008). New SMEs in ICT manufacturing sub-sectors have been numerous in the regions located in the EU10, in particular in Czech regions and to some extent in Poland. Hungary did not perform well in SME establishing in ICT manufacturing. Only six SMEs were formed in the 1995–2000 period and even fewer, only three in the 2001–2004 period in television and communication equipment sub-sector. The number of new SMEs in medical, precision and optical instruments was seven from 1995 to 2000, and new SMEs have not been registered later. The SME creation in ICT services is much more dynamic in the Czech Republic and Poland than in Hungary. Only few companies were established in post and telecommunications, but a higher number in computing services in Budapest. However, this growth does not come anywhere near the Czech and Polish dynamics.

### *2.2.4 The Hungarian ICT Market and Market-Related Indicators in EU Countries*

One might find the domestic Hungarian ICT market much smaller than the value of foreign trade. This is due to the activity of multinational firms that have located their sites there because of the relatively cheap and well-educated labour. These companies are not embedded in the local economy; they produce for the global market and are the main drivers of the Hungarian ICT export.

The consolidated IT market includes transactions only between consumers and suppliers, while cumulated IT market also involves transactions among IT firms. Consequently, the cumulated IT market is a wider category. Euro values in the following tables were calculated from average HUF/Euro exchange rates in 2006 (264 HUF = 1 Euro) and 2007 (253 HUF = 1 Euro).

IT services present the biggest field of consolidated IT market followed by hardware and software products. Transmitted IT hardware—transaction among IT firms—also has a big share in the cumulated IT market. All these fields grew from 2006 to 2007. The domestic market of telecommunication services exceeded the whole IT market in terms of turnover. However, this sector stagnated from 2006 to 2007; the growth one can observe in euro values in Table 2.5 was influenced by the strenghtening HUF.

Micro companies with 1–9 employees accounted for 15.7% of the total turnover (Table 2.6). The turnover volume decreased in companies with 1 or 2 employees and grew slightly in firms with 3–9 employees. Small-sized IT firms had the biggest share of the market (31.6%) and managed to grow at an average pace. Medium-sized companies came in for a smaller share (27.8%), but they were on a shifting wave. Big companies shared 25% of the market and performed at an average speed of growth.

Other indexes connected to the market, like favourable demand for innovation and product competition, reflect cross-country differences in CEE, just as

**Table 2.5** The domestic Hungarian ICT market by product categories, 2006 and 2007 (million Euro)

| Product categories | 2006 | 2007 |
|---|---|---|
| IT hardware | 871 | 914 |
| IT software | 345 | 376 |
| IT services | 924 | 1,044 |
| Consolidated IT market | 2,140 | 2,334 |
| Transmitted IT hardware | 663 | 704 |
| Transmitted IT software | 117 | 150 |
| Transmitted IT services | 254 | 300 |
| Cumulated IT market | 3,174 | 3,488 |
| Telecommunication services | 3,417 | 3,501 |
| Total | 6,598 | 6,988 |

Source: NFGM (2009), p. 7

**Table 2.6** Structure of the consolidated ICT market by company size categories

| Number of employees | Million Euro | Share (%) | Annual growth (%) |
|---|---|---|---|
| 1–2 | 61 | 2.6 | −3.5 |
| 3–9 | 305 | 13.1 | 1.0 |
| 10–49 | 737 | 31.6 | 4.2 |
| 50–249 | 648 | 27.8 | 7.2 |
| 250– | 583 | 25.0 | 4.3 |
| Altogether | 2,334 | 100.0 | 4.4 |

Source: NFGM (2009), p. 10

**Table 2.7** Market indexes related to innovation in selected European countries

| | Favourable demand[a] | Product competition[b] | Effectiveness of IPR system[c] | Existence of industry-related policies[d] |
|---|---|---|---|---|
| Finland | 0.83 | 0.61 | 3.4 | 2.49 |
| The Netherlands | 0.89 | 0.74 | 4.4 | 0.41 |
| France | 0.86 | 0.71 | 3.7 | 0.83 |
| UK | 0.91 | 0.86 | 3.9 | 2.07 |
| Belgium | 0.77 | 0.71 | 3.8 | 0.41 |
| Germany | 0.89 | 0.77 | 4.0 | 0.00 |
| Austria | 0.94 | 0.66 | 4.1 | 0.83 |
| Sweden | 0.79 | 0.21 | 3.8 | 0.41 |
| Denmark | 0.93 | 0.75 | 3.8 | 3.32 |
| Spain | 0.70 | 0.64 | 3.5 | 1.66 |
| Portugal | 0.45 | 0.71 | 2.5 | 0.00 |
| Italy | 0.86 | 0.60 | 3.7 | 0.00 |
| Hungary | 0.81 | 0.60 | 3.3 | 0.00 |
| Poland | 0.78 | 0.41 | 2.7 | 0.41 |
| Czech Republic | 0.82 | 0.61 | 3.0 | 0.24 |
| Slovakia | 0.79 | 0.66 | 2.4 | 0.00 |

Source: Wintjes and Dunnewijk (2009), p. 116
[a]Proportion of firms for which uncertain or lack of demand is not a problem for innovate
[b]Index of product market competition
[c]IPR protection index taken from Gwartney et al. (2006)
[d]Number of policies specially oriented at ICT firms (compared to European average)

policy-oriented indexes do (the effectiveness of IPR system and the existence of industry-related policies). In Table 2.7, we give an overview of selected EU countries in order to compare CEE countries with the ICT sector in leading economies.

The favourable demand for innovation in CEE countries is in the second range in Europe; the share of firms for which demand is not important to innovate is higher in leading countries, but the gap between old and new member states is small. Eighty-one percent of firms are not affected by demand in their intention to innovate in Hungary; the share of these firms is similar in the Czech Republic and a bit lower in Poland and Slovakia. Similarly, product competition varies on a wide spectrum across EU countries, and CEE does not lag behind except in the case of Poland.

The effectiveness of IPR system is significantly lower in CEE countries than in the old member states (Table 2.7). This factor has a huge effect on the level and growth of the innovation in ICT (Wintjes and Dunnewijk 2008). The existence of industry-specific policies oriented to give support to firms in the ICT industry is also significantly associated with the index of innovation performance. Thus, the lack of policy in Hungary and Slovakia may cause the low level of innovation in ICT; this will be elaborated in Sect. 2.3. On the other hand, one might argue that the dynamics in the Czech Republic and Poland in MNE and SME location was the result of their effective ICT policy.

### *2.2.5 Conclusion*

The output of the Hungarian ICT sector stood out from the Central European region over the 2000s. We showed in this section that this is due to the intense export activity of multinational firms of which production is heavily built on imported goods. The domestic market is on a lower level than foreign trade. The Hungarian ICT sector concentrates in Central Hungary, as regions were not able to attract MNEs to a similar degree as the Czech and Polish regions did. Neither was SME formation effective in the Hungarian regions; consequently, knowledge spillover is not likely to occur from MNEs to the local economy.

The Hungarian index of level of competition in the ICT market is below the European average but has a similar degree as in other CEE countries. The IPR protection in Hungary is also below the level of leading economies but exceeds its neighbours in the region. We observed that Hungary is losing the advantages it had in the beginning of the decade, with the ICT sector growing more dynamically in the Czech Republic and in some aspects in Poland as well. The argument on this will be further elaborated in the next section.

## 2.3 Contribution of ICT Industry to Structural Upgrading in CEE

The previous section described the state of the industry in CEE countries in general. We intend to show the contribution of ICT to structural upgrading in this section. Thus, we analyse the volumes and changes of value added and labour costs, R&D and patent activity and the ICT-related socio-cultural characteristics of CEE countries.

### *2.3.1 Value Added and Labour Cost Per Capita in the ICT Manufacturing of CEE Countries, 2000–2008*

We continue our argument from Sect. 2.2 discussing how foreign-owned firms determine production in the Hungarian ICT sector and what follows from this for the local economy. First, we analyse cross-country differences concerning the share of value added in the output and labour cost in the CEE region.

The volume and share of value added in the production vary on a small scale across the four CEE countries we analyse (Table 2.8). The Hungarian value added in absolute terms has been the highest in the region; Hungary has taken Poland over in this sense. Value added over production has been stable in Hungary: it was only 14% in 2000 and has grown to 16% by 2006. The Czech ICT manufacturing has also evolved to this structure after the volume of intermediated inputs almost

**Table 2.8** Volumes of value added and intermediate inputs at current prices and share over production in ICT manufacturing of CEE countries, 2000–2008 (MN Euro, %)

| | | 2000 | | 2002 | | 2004 | | 2006 | | 2008 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Vol. | % | Vol. | % | Vol. | % | Vol. | % | Vol. | % |
| Czech Republic | Inputs | 8,141 | 78 | 15,094 | 87 | 18,556 | 86 | 27,009 | 87 | 39,592 | 89 |
| | Val. add | 2,286 | 22 | 2,353 | 13 | 2,970 | 14 | 3,965 | 13 | 4,736 | 11 |
| Hungary | Inputs | 17,813 | 86 | 18,868 | 86 | 25,205 | 83 | 31,565 | 84 | n.a. | n.a. |
| | Val. add | 2,788 | 14 | 3,157 | 14 | 5,106 | 17 | 5,922 | 16 | n.a. | n.a. |
| Poland | Inputs | 7,379 | 70 | 10,083 | 74 | 9,546 | 77 | 14,977 | 78 | n.a. | n.a. |
| | Val. add | 3,167 | 30 | 3,485 | 26 | 2,887 | 23 | 4,141 | 22 | n.a. | n.a. |
| Slovak Republic | Inputs | 2,331 | 74 | 2,949 | 77 | 4,795 | 81 | 10,044 | 83 | 12,911 | 84 |
| | Val. add | 802 | 26 | 875 | 23 | 1,123 | 19 | 2,022 | 17 | 2,421 | 16 |

Source: Author's calculation on OECD STAN database

**Table 2.9** Wages over labour cost (%) and labour cost over total employment at current prices (Euro) in ICT manufacturing in CEE countries, 2000–2008

| | | 2000 | 2002 | 2004 | 2006 | 2008 |
|---|---|---|---|---|---|---|
| Czech Republic | Wages/labour cost | 75 | 75 | 75 | 74 | 75 |
| | Labour cost/employment | 5,174 | 6,838 | 7,856 | 9,934 | 12,250 |
| Hungary | Wages/labour cost | 71 | 74 | 76 | 76 | n.a. |
| | Labour cost/employment | 7,370 | 7,653 | 8,553 | 10,191 | n.a. |
| Poland | Wages/labour cost | 86 | 87 | 87 | n.a. | n.a. |
| | Labour cost/employment | 8,864 | 10,742 | 7,569 | 10,218 | n.a. |
| Slovak Republic | Wages/labour cost | 76 | 76 | 78 | 79 | n.a. |
| | Labour cost/employment | 6,392 | 7,003 | 7,845 | 9,047 | 10,198 |

Source: Author's calculation on OECD STAN database

doubled from 2000 to 2002. ICT in Poland seems to have had a higher share of value added in the production due to a lower level of inputs. The output of Slovakian ICT depends more and more on the inputs, while output and its factors are on a lower level in absolute terms.

Wages over labour costs inform us about the share of wages that the employees earn in overall labour expenses. The remaining part contains the incremental expenses the companies must pay for social security purposes (Table 2.9).

Cross-country differences prevail first of all in wage/labour cost rates. In the overall ICT manufacturing, the wage of Polish employees accounts for 86–87% of total labour costs, while this share in the Czech Republic and Hungary was only 75–76%, respectively, and 79% in Slovakia for 2006. However, the differences in absolute volume of labour cost per employee seem to equalize in the region. The labour cost per employee has grown dynamically in the Czech Republic over this period, while the strong Zloty made the Polish employees relatively expensive in 2002.

We interpret the case of Hungary as revealing that ICT employees have become relatively expensive over the decade; this trend is even more strengthened by the big share of social welfare costs. One might expect that these differences result in a relatively competitive Polish ICT sector. Actually, this was underlined by R&D

managers of multinational ICT companies located in Budapest (eg. Nokia Siemens Networks) as a huge disadvantage of the Hungarian ICT sector (Barta et al. 2007). According to them, it is much easier to recruit software engineers in Poland where the employees can take almost the double salaries as in Hungary (reduced by income taxes).

### *2.3.2 ICT Innovation in CEE: R&D and Patenting*

The state of innovation in the ICT sector reports on the future dynamics the industry might follow (Lindmark et al. 2008). Thus, we describe cross-country differences in the level of innovation performance and business expenditure on R&D (BERD) and government expenditure on R&D (GOVERD) in the ICT sector. The benchmarking of competitiveness and innovation performance in the ICT sector usually relies on indicators of patenting, total factor productivity and market advantage (Wintjes and Dunnewijk 2008).

Index of patenting advantage has been constituted from the number of EPO patent applications per employee in the ICT industry as the proportion of the total number of EPO patent application in this industry across all countries per employee.

Index of market advantage means a total export volume per employee in the ICT industry divided by total exports in the whole industry per employee.

Total factor productivity has been calculated from value-added data at constant prices, number of hours worked and value of capital stock at constant prices (Crespi and Patel 2007).

Built on these indicators, two composite indexes of innovation performance were established in the report. The first captured the static performance calculating the average levels of the three indicators between 2000 and 2003. The second index reflects the dynamics and includes changes in these variables between 1990 and 2003 for each country. These indexes are presented in the table as they were reported in the report (Wintjes and Dunnewijk 2008).

The leading countries in ICT innovation level in the period 2000–2003 were Finland and the Netherlands followed by France, the UK, Belgium, Germany and Austria. Individual indicators of innovative performance are included in the main index that was used for listing the countries. For example, the overall leadership of Finland in the ICT sector is based on a strong performance with respect to all three indicators (patent advantage, market advantage and total factor productivity).

CEE countries are at the other end of the spectrum, with low levels of innovation performance: Slovakia, Czech Republic, Poland and Hungary (Table 2.10). These countries perform on a much lower level of EPO patent applications; the negative level of the index concerning total factor productivity even made the innovation index negative. Hungary stands out in terms of market advantage; the export from the country is highly specialized in ICT products. The index (total exports per employee in ICT sector divided by total export per employee in the whole industry)

**Table 2.10** Country-level benchmarking of innovative performance in the ICT industry, 1990–2003

| | Index level of innovation | Patenting advantage | Market advantage | Total factor productivity | Index of growth in innovation performance |
|---|---|---|---|---|---|
| Finland | 0.75 | 2.33 | 2.94 | 3.66 | 0.79 |
| The Netherlands | 0.58 | 1.93 | 4.50 | 1.50 | 0.74 |
| France | 0.48 | 0.91 | 0.82 | 3.97 | 0.20 |
| UK | 0.47 | 0.66 | 1.11 | 4.15 | 0.28 |
| Belgium | 0.46 | 0.72 | 2.26 | 3.29 | 0.32 |
| Germany | 0.45 | 1.75 | 1.11 | 1.94 | 0.67 |
| Austria | 0.41 | 0.99 | 1.49 | 2.61 | 0.49 |
| Sweden | 0.25 | 1.55 | 1.66 | −0.46 | 0.57 |
| Denmark | 0.23 | 1.04 | 1.30 | 0.37 | 0.62 |
| Spain | 0.13 | 0.27 | 0.50 | 0.84 | 0.28 |
| Portugal | 0.11 | 0.05 | 0.66 | 0.96 | 0.38 |
| Italy | 0.06 | 0.49 | 0.39 | −0.30 | 0.22 |
| Hungary | −0.13 | 0.12 | 1.69 | −2.66 | 0.35 |
| Poland | −0.19 | 0.04 | 0.19 | −2.53 | 0.20 |
| Czech Rep. | −0.54 | 0.05 | 0.60 | −7.24 | 0.19 |
| Slovakia | −1.18 | 0.03 | 0.20 | −15.08 | 0.14 |
| Ireland | | 0.45 | 7.68 | | |
| Greece | | 0.18 | 0.22 | | |
| USA | 0.50 | 0.97 | 0.56 | 4.19 | 0.35 |
| Japan | 0.43 | 1.45 | 1.24 | 2.20 | 0.18 |
| Average | 0.17 | 0.76 | 1.83 | 0.02 | 0.38 |

Source: Wintjes and Dunnewijk (2009), p. 63

had the fourth highest level in Europe. However, this export is mostly due to MNEs, as we argued earlier (Lengyel 2012). The fact that total factor productivity is low leads us to the statement that MNEs have located their low-value-added activities to the country.

Figure 2.1 was constituted from the first and last column of Table 2.10 and shows that growth of ICT innovation and innovation performance correlate to a high degree, but some of the countries of high innovation performance (France, Japan, the UK, the USA) have been growing at rates well below the median. Clustering of countries according to the two axes shows that Hungary and Poland belonged to average European level of performance and growth in ICT innovation in the 1990–2003 period. Slovakia and Czech Republic had low values for both innovation indexes at this time.

Business R&D expenditure is a widely accepted measure of level of maturity in a given industry and country (Malerba 2002; Török et al. 2005). ICT BERD is heavily dominated by some of the largest economies in the EU, while the new member states (EU12) contribute only 2% (Fig. 2.2). Note that due to the use of purchasing-power parities, the Scandinavian countries Sweden, Finland and Denmark, which have high price levels, have a lower share than they would have under current exchange rates (18.1% together instead of 20.1%). Of greater importance, however,

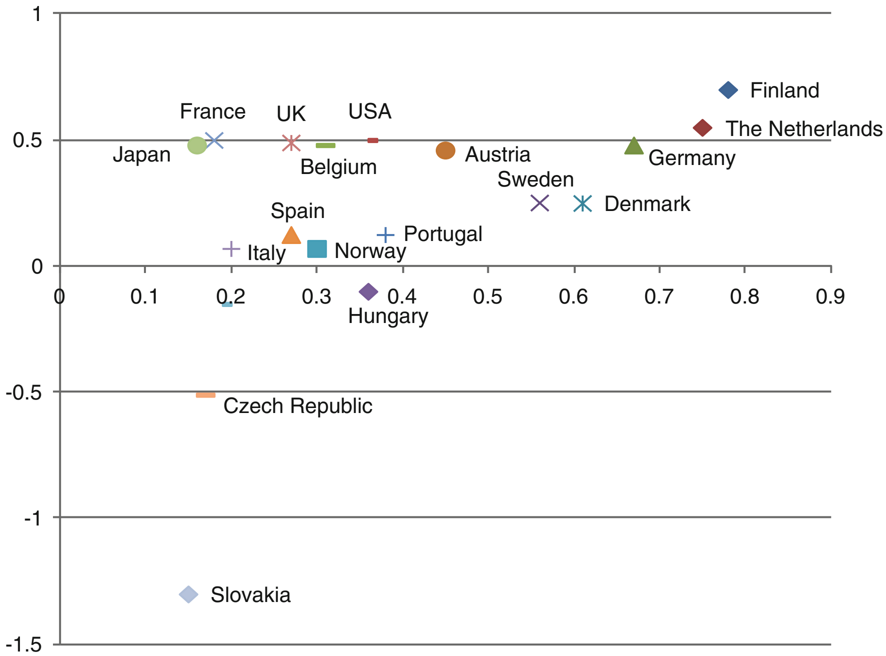


**Fig. 2.1** Level and dynamics of innovation performance. Source: Wintjes and Dunnewijk (2009), p. 64

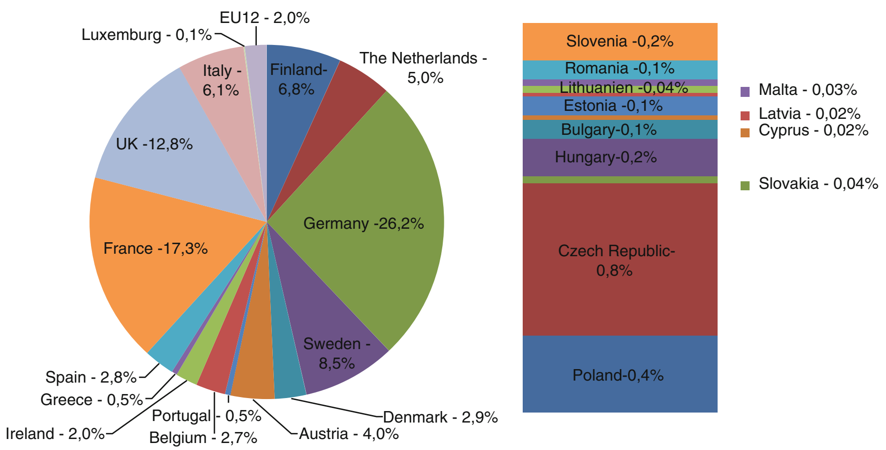


**Fig. 2.2** Distribution of ICT business R&D expenditure in EU27 countries in PPP, 2005 (%). Source: Turlea et al. (2009), p. 41

the share of new member states has been doubled using PPP because of their generally lower price levels (Turlea et al. 2009).

It was pointed out several times that ICT was one of the leading areas of economic development and was concentrated in the most developed regions (reference). Consequently and not surprisingly, the ICT BERD is marginal in new member states compared to the whole EU. However, CEE country shares are interesting in our case. Czech Republic (0.8%) stood out according to the indicator and was followed by Hungary and Poland (0.4%). There was hardly any business R&D in the Slovakian ICT sector in 2005.

R&D employment (measured in full-time employment) follows a similar pattern as in the BERD distribution; Germany, Finland, France, Sweden and the UK made up 69% of the total EU volume (Turlea et al. 2009). The share of new member states is limited to 3–4%; however, large differences prevail among R&D personnel in ICT manufacturing and ICT services. Czech Republic is relatively strong in ICT services and was the 11th on the country list with a share around 2.5%. Czech Republic gained the second largest number of units in business ICT R&D employment (3,200 new jobs), which almost tripled the volume of the sectoral R&D base of the country.

Just like ICT BERD, ICT GOVERD is heavily dominated by the largest economies in the EU; Germany, France, the UK, Spain and Italy represent together 75% of European ICT GOVERD (Turlea et al. 2009). The new member states contribute only 3% to the total EU27 ICT GOVERD. This share is far below their economic weight but higher than their 2% share in ICT BERD. As with the share of new member states in the EU27 GOVERD, single CEE countries have a slightly higher share than in BERD. The Czech Republic accounts for 0.9%, which is higher than the share of Denmark or Greece. Hungary is the second in the region with 0.6%; Poland has a 0.5% share, and Slovakia made up 0.1% of the total EU27 ICT GOVERD (see Fig. 2.3).

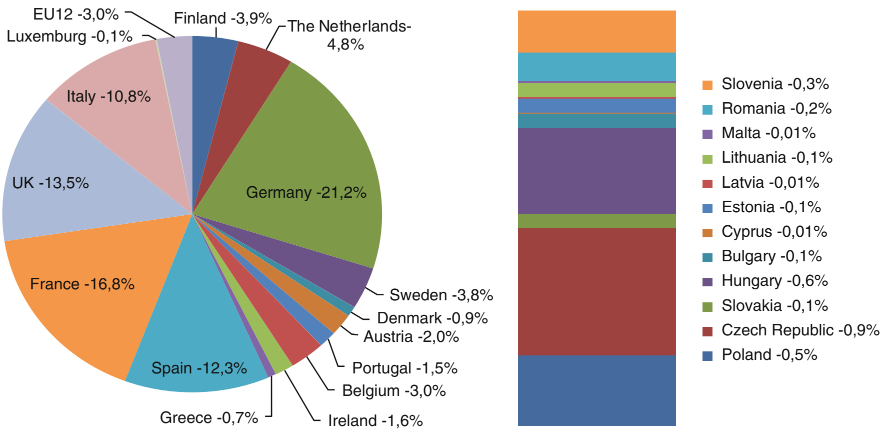


**Fig. 2.3** Distribution of ICT GOVERD in EU27 countries in PPP values, 2005 (%). Source: Turlea et al. (2009), p. 48

These shares include ICT research performed by government establishments or universities and government financial support to ICT R&D that is performed in the business sector. Therefore, it provides a total picture of government participation in ICT R&D.

### 2.3.3 ICT-Related Socio-cultural Environment, E-Business Readiness and Interaction of ICT Companies in CEE Countries

The level of maturity of ICT sector in a given country is a dependent variable of several factors: the demand for ICT products and services, the international openness of the sector, human capital, etc. Foreign participation affects the ICT sector in CEE countries in terms of production and export volumes. However, according to our interviews with leading R&D centres of multinational companies in Hungary, foreign-owned companies are isolated from the local environment (Barta et al. 2007). These companies have very few local connections; the global network in which they take part requires in-depth preparedness from suppliers that local SMEs cannot fulfil. Consequently, foreign-owned firms and local SMEs might form separate spheres, and we expect that this symptom is stronger in CEE countries than in old member states. The fact that most of the MNE decisions are made in the company headquarters that are far from CEE countries strengthens the relevance of our assumptions.

However, knowledge spillovers occur not only along supply chains but also through the mobility of experts and new spin-off firms. The socio-cultural environment is important in the investigated countries, because the more mature the ICT culture, the higher demand one can expect for new ICT services. Similarly, the cultural environment favours new firm formation through the quality of human capital and the level of cooperation among agents. Consequently, the quality of socio-cultural environment helps the value added grow.

Cultural capital, human capital, social capital and organizational capital have to be distinguished in order to measure the specific elements of the environment related to innovation and structural change. Cultural capital encompasses basic attitudes towards science and technology, other cultures, the level of risk taking, etc. The concept of human capital is used in many aspects and means human resources in science and technology and knowledge-intensive services, the provision of higher educated people and job-to-job mobility. The social capital index includes the cooperation behaviour of firms, the main information sources for innovation, level of trust, etc. The index of organizational capital reflects to the company's culture, routines, structure, morality and management styles.

According to these measures, CEE countries lag behind compared to the mean of EU25 countries (Wintjes and Dunnewijk 2008). The Czech Republic exceeds the mean only in terms of social capital, which is very similar in Slovakia, for which the social capital index seems to stand out in new member states. All the four indexes in Poland are far below the EU25 mean. The cultural capital is above the EU mean in

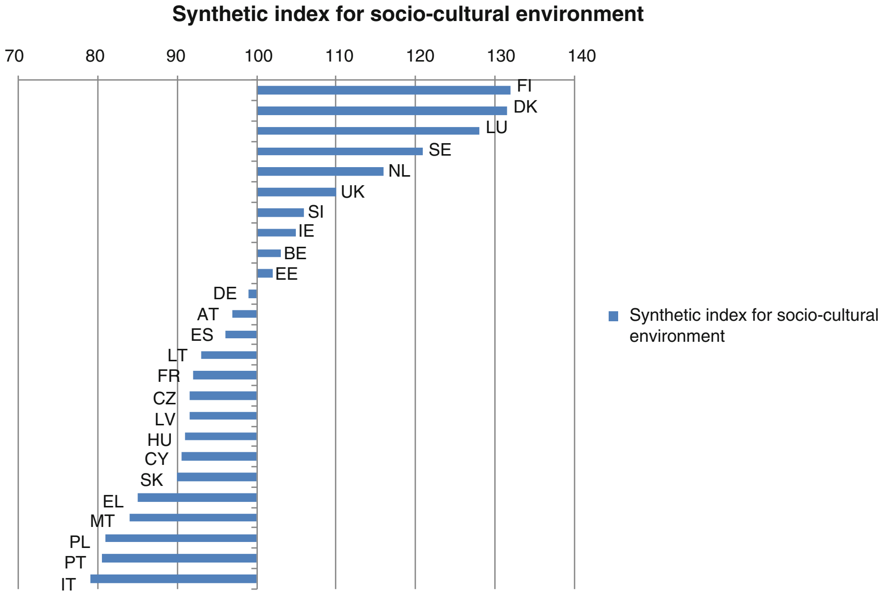


**Fig. 2.4** Socio-cultural environment across EU25 countries. Source: Wintjes and Dunnewijk (2009), p. 69

Hungary, and the same occurs in social capital to a lower extent. However, human capital and organizational capital are under the EU25 mean.

The synthetized index for socio-cultural environment (Fig. 2.4) and also the cluster analysis prepared show that Czech Republic, Slovakia and Hungary constitute one block with Cyprus and Latvia and follow France and Lithuania at close quarters. Poland differs from these three CEE countries, because social networks are closed in the ICT industry. Thus, Poland relates much more to countries like Malta, Italy, Spain and Greece in terms of socio-cultural environment in ICT sector.

The e-business readiness appears to divide CEE countries differently than socio-cultural environment (Fig. 2.5). This index has been constituted from ICT adoption (% of companies that use internet opportunities) and ICT use (% of internet penetration in the population) indexes; it reflects on the state of general ICT demand and special internet-related ICT service supply. Most countries with high scores on the e-business readiness index are countries that have a strong socio-cultural environment. Hungary and Poland belong to the last cluster; share of internet users among citizens and companies is far beneath the EU27 mean, while these rated higher in the Czech Republic and Slovakia.

In our interpretation, both socio-cultural environment and e-business readiness indicators describe the opportunities that enable ICT innovations to prevail. Similar socio-cultural environment provides a similar ground for ICT innovation. As social networks are more closed in Poland, we expect that ICT innovations come off at a lower degree. However, Hungary lags behind according to e-business readiness that signs the low innovation expectations on ICT services. Another index shows the

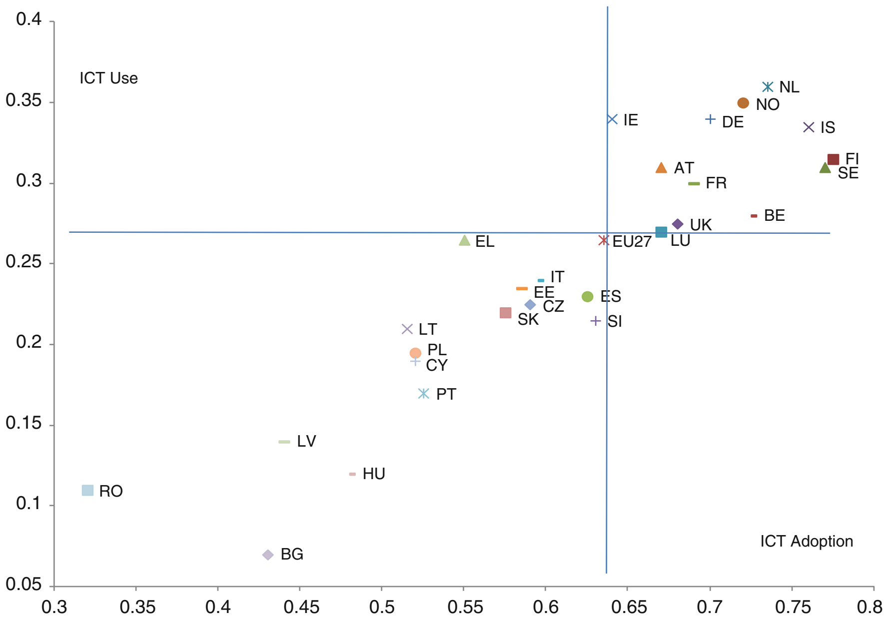


**Fig. 2.5** ICT adoption and ICT use in EU25 countries by budget allocation weighting scheme. Source: Wintjes and Dunnewijk (2009), p. 70

proportion of companies that interact with universities to innovate in ICT. Hungary has a medium value compared to other CEE countries (Table 2.11). Thus, different aspects of agent interactions are embraced by the indicators described above.

The average size of ICT firms is the largest in Hungary among the selected EU countries just like the foreign participation in these sectors (Sweden and the Czech Republic have a similar rate in the latter index). Eighteen percent of Hungarian ICT firms are active in export or cooperate with firms outside Europe. This rate is low in EU comparison but is outstanding in CEE at the same time. Interestingly, the comparison of university-firm cooperation shows adverse contiguity; Hungary has a medium value in the region but exceeds most of the old member states.

To sum up, different aspects of innovation and R&D show slightly different results for our comparative study. For example, R&D expenditure is low in Slovakia, but they perform well in the e-business readiness indicator. However, the ICT dynamics in the Czech Republic prevail on a higher level, which is proved by almost every indicator.

### 2.3.4 Conclusion

The Hungarian value added in ICT sector has been the highest among CEE countries over the decade, though its share in output was low. However, indicators

**Table 2.11** Interactions among agents in ICT industry in selected EU countries

| | Average size[a] | Foreign participation[b] | International orientation[c] | Cooperation universities[d] |
|---|---|---|---|---|
| Finland | 4.04 | 0.01 | | 0.55 |
| The Netherlands | 0.97 | 0.01 | 0.20 | 0.12 |
| France | 1.26 | 0.01 | 0.31 | 0.14 |
| UK | | | | 0.12 |
| Belgium | 1.05 | 0.01 | 0.26 | 0.36 |
| Germany | 1.21 | 0.01 | 0.28 | 0.23 |
| Austria | | | | 0.29 |
| Sweden | 0.95 | 0.03 | 0.28 | 0.13 |
| Denmark | | 0.02 | 0.35 | 0.12 |
| Spain | 1.48 | 0.01 | 0.19 | 0.12 |
| Portugal | 0.83 | 0.01 | 0.41 | 0.17 |
| Italy | 2.25 | 0.01 | 0.09 | 0.11 |
| Hungary | 0.45 | 0.03 | 0.18 | 0.16 |
| Poland | 0.95 | 0.01 | 0.13 | 0.12 |
| Czech Republic | 0.74 | 0.03 | 0.07 | 0.21 |
| Slovakia | 0.50 | 0.01 | 0.10 | 0.24 |

Source: Wintjes and Dunnewijk (2009), p. 66
[a]Average size—the larger the index the smaller the average size of firms in the industry
[b]Proportion of companies that have a foreign office
[c]Proportion of firms that sell products to international markets and cooperate with firms outside Europe
[d]Proportion of ICT firms that cooperate with universities to innovate

reporting on the dynamics and opportunities for further growth reflect that the ICT sector in other CEE countries might be more competitive. ICT labour costs are lower in the Czech Republic and Slovakia, and the wages are still low due to high social welfare expenses and income taxes in Hungary.

ICT R&D values are also higher in the Czech Republic both in the private and the public sectors. Though Hungary had performed well and grew dynamically in the 1990s, the Czech innovation system is likely to overcome it. In particular, ICT service innovations are expected to prevail on a higher level in the Czech Republic because a higher share of people have access to the internet as do Czech companies. The university-industry relations in the Czech Republic are also stronger than in Hungary.

## 2.4 Policy Measures to Promote Expansion and Quality Upgrading in the Hungarian ICT Industry

In this section, we look through the parallels in the Czech and Hungarian innovation policies and the Hungarian ICT policy.

### *2.4.1 Innovation Policies and FDI Attraction in the Czech Republic and Hungary*

Innovation policies have followed similar paths in the Czech Republic and Hungary (Havas 2006; Szanyi 2012). R&D expenditures of foreign-owned firms have become an important factor of innovation systems since the beginning of the 1990s. However, the Czech policy reacted faster than the Hungarian one (Lengyel and Cadil 2009). The first Czech policy was launched in 2000, while the innovation strategy was accepted only in 2007 in Hungary. The Czech system concentrated on the economical perspectives of R&D: FDI attraction had a major role in innovation policy. Universities were in the focus of Hungarian innovation policy. We argue that the main institutions of innovation systems had a decisive impact in the late 1990s on the development of the innovation system: the Ministry of Industry and Trade in the Czech Republic and the Ministry of Education in Hungary (Table 2.12).

Although Structural Funds could be attractive for MNEs' R&D in the Czech system, and national sources in Hungarian system, innovation policies were likely to play only a marginal role. The investment was attracted by inherited factors like the quality and scope of domestic R&D, capacity of public and private R&D institutions, universities, quality of human resources as well as the geographical availability.

### *2.4.2 The ICT Action Plan in Hungary*

The Hungarian government accepted the ICT Action Plan in September 2009. This includes all the directions of appropriation of EU Structural Funds for the 2010–2013 period that relates to ICT demand and supply, to ICT industry and to socio-cultural environment and the like. The aim of the Action Plan is to strengthen the role of ICT sector in the economy in order to increase competitiveness, productivity, employment and provide equal chances for the whole economy. Numerical aims are to increase the volume of employment by 32,000 new jobs and reach 5–8% annual market growth by the year 2013. The aim structure, though, is quite diverse; 16 aims are named subordinated to three pillars. We look through these before introducing the concrete programmes:

- Pillar 1—Human capital
  - Aim 1: Safekeep the existing ICT jobs, training for ICT experts
  - Aim 2: Decrease the lack of ICT experts by making the software-engineering university programmes attractive, by enhancing the quantity and quality of graduated ICT workforce, by re-training programmes
  - Aim 3: Develop the IT knowledge transmission in the secondary and higher education

**Table 2.12** FDI attraction in the Czech and Hungarian innovation policies

| | Czech Republic | Hungary |
|---|---|---|
| Major institutions | Ministry of Industry and Trade<br>Ministry of Education, Youth and Sport | 1965–1999 National Committee for Engineering and Development<br>2000–2004 Ministry of Education<br>2004–2006 National Office for Research and Technology controlled by the Ministry of Education<br>2006–2008 NORT controlled by the Ministry of Economy |
| Legislation | 2002—Act 130/2002 Coll. on the Support of Research and Development from Public Funds | 2003—Act on Research and Technological Innovation Fund<br>2005—Innovation Act |
| Indirect incentives | 2005—Deduction of tax base | 2005—Innovation tax, deduction of tax base |
| Strategies | 1999—Action Plan for Supporting the Competitive Ability of Czech Industry<br>2000—National Research and Development Policy 2005—National Innovation Policy<br>2004–2006 Operational Programme Industry and Enterprise<br>2007–2013 Operational Programme Enterprise and Innovation | 1999—Innovation Strategy for Competitiveness<br>2000—Science and Technology Policy<br>2004–2006 Operational Programme Economical Competitiveness<br>2007—Innovation Strategy<br>2007–2013 Operational Programme Economic Development |
| Direct R&D related FDI attraction | 2003–2008 Framework Programme for the Support of Technology Centres and Centres of Business Support Services | 1999–2002 High-Tech Equipment Programme |
| Programmes for university cooperation | EU Structural Funds financed programmes:<br>2004–2006 sub-programmes INOVACE (innovation) and KLASTRY (clusters)<br>2007–2013 sub-programmes SPOLUPRACE (cooperation), INNOVACE (innovation) and POTENCIAL (potential) | 1999–2005 Cooperation Research Centres<br>2005—Regional Knowledge Centres, Focus Sector Innovation Programme<br>2007–2013 Structural Funds |

Source: Authors edition in close co-operation with Vladislav Cadil

- Aim 4: Phase the demand for ICT experts and the university output
- Aim 5: Enhance the level of motivation and the number of university entrants in the primary and secondary education

• Pillar 2—R&D and innovation

- Aim 6: Develop the innovation culture, patenting activity, the openness for R&D applications in companies
- Aim 7: Strengthen relationships among universities, research institutes and companies, build clusters, operate platforms
- Aim 8: Help the dispersion of open-source softwares
- Aim 9: Develop the R&D activity of ICT firms, re-structure R&D tenders in cooperation with the industry

- Pillar 3—Investment incentives, finance
  - Aim 10: Anticipate the breakdown threats for ICT companies with finance support
  - Aim 11: Enhance the investments of ICT companies by providing the finance conditions
  - Aim 12: Increase the venture capital and FDI attraction of ICT companies with special focus on the re-location of high-value-added activities that occur due to the financial crisis
  - Aim 13: Develop the entrepreneurial culture and marketing skills
  - Aim 14: Enhance the performance and exportability of knowledge- and technology-intensive ICT SMEs; develop the opportunities of the Hungarian software and ICT service export
  - Aim 15: Develop the accession infrastructure: NGA and wireless services
  - Aim 16: Liquidate the bottlenecks in telecommunication infrastructure

This complex aim system is further developed into actions and programmes that already contain the time frame and amount of resources (see Table in Appendix 1). The programmes are directly linked to the pillars we introduced before. Interestingly, 16 aims in the strategy are followed by 16 programmes. This means, in our interpretation, that the programmes are general, which enables flexible adaptation to current circumstances. If this is the case, one has to assume a certain degree of uncertainty in the ICT policy, because the aims of the programmes are too general.

The amount of government support of each programme clearly underscores the importance of state intervention. Two types of funds are named in the programmes: EU Structural Funds (SF) and national funds; the Research and Technological Innovation Fund (RTIF) is of prime importance as national source. This fund was established by the Hungarian Innovation Act with the introduction of a new funding scheme based on a special innovation tax in 2004. According to the provision, every enterprise (except micro- and small enterprises) must pay 0.3% of its turnover into the RTIF. The direct R&D expenditures, both intramural and ordered from public R&D units, can be deducted from this tax. Furthermore, companies can deduct R&D expenditures from the tax base, and special expenses (R&D projects with universities) can be counted twice in this deduction. The other half of the funding comes from the Hungarian government, which contributes to the fund with an equivalent amount to the payments of the enterprises.

In the financing of ICT programmes, EU Structural Funds dominate at €319,600,000, of which €180,000,000 will be spent on ICT infrastructure. RTIF will share the support with €19,840,000. Categorizing the expenses, we found that ICT infrastructure will receive the highest value of support: €180,000,000 from SF and national indirect incentives that count for around 32,000,000 tax reduction per year. €93,600,000 will go to human capital development, and another €8,240,000 to enhance IT and entrepreneurial skills in SMEs. New job creation will be enhanced with €8,000,000. €16,000,000 is to help the export of ICT services through the whole planning period. ICT-related R&D will be assisted though excellence centres with €7,200,000. €500,000 will be spent on the coordination and planning of these actions.

## 2.5 Conclusion

Hungarian ICT manufacturing output has stood out in the Central European region over the 2000s. This is due to the intense export activity of multinational firms, which production is heavily built on imported goods. The domestic market is at a lower level than foreign trade. The level of competition in the Hungarian ICT market is below the European average but is on par with other CEE countries. The IPR protection in Hungary is also below the level of leading economies but exceeds neighbours in the region.

The Hungarian value added in ICT sector has been the highest among CEE countries over the decade, though its share in output was low. However, indicators of the dynamics and opportunities for further growth demonstrate that the ICT sector in other CEE countries might be more competitive. ICT labour costs are lower in the Czech Republic and Slovakia, and the wages are still low due to high social welfare expenses and income taxes in Hungary. Similarly, the country was not able to attract MNEs in the 2000s to the same degree as was the Czech and Polish regions. Neither was SME formation effective in the Hungarian regions; consequently, knowledge spillover is not likely to occur from MNEs to the local economy.

ICT R&D values are also higher in the Czech Republic both in the private and the public sectors. Though Hungary had performed well and grew dynamically in the 1990s, the Czech innovation system is likely to surpass it. In particular, ICT service innovations are expected to prevail at a higher level in the Czech Republic, because a higher share of people have access to the internet as do Czech companies. Consequently, Hungary might lose the advantages it had in the beginning of the decade, as the ICT sector continues to grow more dynamically in the Czech Republic and in some aspects in Poland as well.

Economic policy is likely to be responsible for the above outlined trends. For example, the Czech innovation policy reacted faster to the challenges of FDI attraction than the Hungarian one. The Czech system concentrated on the economical perspectives of R&D, and FDI attraction had a major role in innovation policy, while universities were the focus of Hungarian innovation policy. The Hungarian ICT Action Plan has a very complex aim system, though the concrete programmes might be too general. The plan concentrates half of the resource on ICT infrastructure building, which will probably have demand side effects. The programmes aim to strengthen the supply side of ICT industry with investing in human capital that will affect the industry over the long run. Entrepreneurial skills, export activity and R&D will have smaller shares from the pubic ICT resources.

## Appendix 1: Programmes in the Hungarian ICT Action Plan

| | Title | Time frame | Amount of resources | Fund | Output indicators |
|---|---|---|---|---|---|
| 1.1 | Analysis of the skills-gap and implement the results in the higher education and special education programmes | 2009 Q4–2010 Q2 | 40,000 € | Labour market fund | Growth of number of students graduated in programmes that fit to industry needs |
| 1.2 | Re-training of IT experts | 2010 Q1- | 4,000,000 € per year | EU Structural Funds | 2,600 participants in basic (70% graduation), 1,400 participants in advanced level programmes (80% graduation) |
| 1.3 | Re-training for employees who change career | 2010 Q1- | 1,200,000 € per year | EU Structural Funds | 800 participants in basic (70% graduation), 200 participants in advanced level programmes (80% graduation) |
| 1.4 | Enhance the level and attractiveness of IT engineering education | 2010 Q1–2013 Q4 | 4,000,000 € per year | EU Structural Funds | 4% annual growth in university application; re-trained teachers, modernized curriculums |
| 1.5 | Enhance the conditions for IT expert supply in primary and secondary education | 2009 Q4–2013 | 22,000,000 € per year | EU Structural Funds | Number of schools and pupils joined; number of teachers re-trained (8,000 per year) |
| 2.1 | Estimate and develop the entrepreneurial skills in SMEs | 2009–2011 | 200,000 € | Research and Technological Innovation Fund | Growth in the ICT BERD; development in IPR; growth in the number of innovations |
| 2.2 | Entrepreneurial development and incubation programme for innovative SMEs | 2009–2013 | 8,000,000 € | Research and Technological Innovation Fund | Growth in the number of innovative ICT SMEs |
| 2.3 | Development in ICT excellence centres | 2010 Q1–2013 | 4,000,000 € | EU Structural Funds | Participating researchers (200 per year), participating institutes |
| 2.4 | Supporting open-source excellence centres | 2009–2013 | 400,000 € | Research and Technological Innovation Fund and EU Structural Funds | Growth in the number of OSS centres; growth in the utilization of OSS in the public and private sector |

| | Title | Time frame | Amount of resources | Fund | Output indicators |
|---|---|---|---|---|---|
| 2.5 | Strengthen the international R&D performance of outstanding sectors | 2009–2013 | 3,200,000 € | Research and Technological Innovation Fund | Growth in the number of successful international tenders, growth in the number of projects led by Hungarian partners |
| 2.6 | Phasing R&D tenders to the needs of outstanding sectors | 2009–2013 | 20,000 € | Ministry for Development and Economy | Successful ICT tenders, participating firms |
| 3.1 | Promotion of seed capital to ICT sector | 2009–2013 | 40,000 € | Research and Technological Innovation Fund | Growth in the number and volume of seed capital investments |
| 3.2 | Supporting new knowledge-intensive, high-value-added jobs | 2009–2013 | 8,000,000 € | Research and Technological Innovation Fund and EU Structural Funds | Number of new jobs |
| 3.3 | Investment tax incentives for NGA infrastructure | 2009–2013 | About 32,000,000 € per year | | Length of the network |
| 3.4 | Development in optical network | 2009–2013 | 180,000,000 € | EU Structural Funds | Number of settlements where optical networks are available |
| 3.5 | Enhancement of software and ICT service export | 2009–2013 | 4,000,000 € per year + 8,000,000 € per year | EU Structural Funds; bank loans | Share of ICT sector in total export; share of software and ICT service export in total ICT export |
| 4.1 | Principle of partnership | 2009–2013 | Finance is not needed | Ministry for Development and Economy | Number of ICT regulation project that contained impact analysis |
| 4.2 | Monitoring and ex-post evaluation of ICT Action Plan | 2009–2013 | 40,000 € | Ministry for Development and Economy | Monitoring and evaluation report |
| 4.3 | Introduction of open-source softwares into the work methods of in the public sphere | 2009 Q4- | Savings from the software licences | Ministry for Development and Economy | Number of computers covered by the programme |

Source: Authors' edition after NFGM 2009

## Appendix 2: Euro Exchange Rates of National Currencies in CEE on 1st of January

| | 2000 | 2002 | 2004 | 2006 | 2008 |
|---|---|---|---|---|---|
| Czech Korún | 35.98 | 31.53 | 32.42 | 29.09 | 26.50 |
| Hungarian Forint | 253.98 | 243.79 | 266.24 | 252.72 | 252.97 |
| Polish Zloty | 4.14 | 3.51 | 4.69 | 3.84 | 3.60 |
| Slovakian Korún | 42.28 | 42.53 | 41.54 | 37.83 | 33.55 |

Source: Authors edition after the historical exchange rates on https://www.xe.com

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# Chapter 3
# Industrial Clusters: Concepts and Empirical Evidence from East-Central Europe

**Miklós Szanyi**

## 3.1 Introduction

Clusters have attracted much attention in the recent past. Other than ever growing academic interest, clusters have also become primary targets of development policy. Various documents of the EC[1] expressed strong confidence in clusters being exceptionally suitable drivers of economic growth, innovation, and competitiveness. National governments in addition to the EC supported policies designed to promote the process of clustering and the establishment of cluster organizations. Another important string of literature and policy practice is foreign direct investment (FDI) attraction and the development of local linkages (most importantly supplier networks) of foreign investment enterprises (FIEs). Both structures, clusters as well as widespread supplier networks, have common features. Most importantly, both need sufficient numbers of potential collaborators. Both can be developed most successfully in regions where economic activity is vivid and within which enterprising and cooperation have traditions. Clustering processes seem to be especially strong in businesses producing complex products. Labor division has large potential also internationally in the most globalized industries, like electronics-ICT or the automotive industry. Hot spots of these industries may effectively attract firms and investments from a fairly wide geographic area.

Agglomeration of economic activity is a phenomenon which has occurred as long as human history. Centers of active and vibrant economic development and welfare have attracted various businesses for centuries. As early as the work of Marshall (1890), there has been an awareness of the importance of geographical proximity in determining the location of industrial activity. Marshall argued that clusters develop as a consequence of three factors (a) the presence of a skilled local labor market, (b) key inputs from suppliers, and (c) rapid know-how transfer

[1] EC (2003); EC (2007); EC (2008a), (b).

P.J.J. Welfens (ed.), *Clusters in Automotive and Information & Communication Technology*, 87
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between firms leading to technological spillover. Hence, regional concentration is not a new phenomenon. What is then new to the discussion of clusters?

The industrial clustering work of Porter (1990, 1998, 2003) is regarded as seminal. PORTER emphasized that firms' competitiveness was determined by multiple factors only partly endogenous to them. In his "diamond model," four sets of interrelated forces were brought forward to explain industrial dynamics and competitiveness. These were associated with factor input conditions, sophisticated local demand conditions, related and supported industries, and firm structure, strategy, and rivalry. A core notion arose around his model, stressing that collaborative, mutually supportive groups of actors could enhance regional competitiveness in global markets and thus create growth and other benefits. Also, the significance of face-to-face contacts and personal demonstration, exchange of experience, and the role of geographical proximity for knowledge transfers and innovation have been explored and emphasized. Another string of related economic thought elaborated on knowledge creation and innovation as a social process engaging individuals that exchange tacit and explicit knowledge. Trust-based relationships and social capital may thus be important for enabling horizontal cooperation between individuals within and across firms and institutions (Pouder and St. John 1996; Saxenian 1994). Clusters are spatial concentrations of business and related institutions with activity specialization and active cooperation linkages among cluster members.[2] Clusters' activity may be facilitated by cluster organizations (cluster initiatives), yet the latter are institutions rather than economic phenomenon, and we must therefore make a clear distinction between these. The essence of clusters is the cooperation of members, with the main benefits they realize stemming from joint actions; this goes beyond the mere colocation of firms.

One important feature of globalization is the grooving importance of large transnational companies (TNCs) in organizing international cooperation networks in global industries. Foreign investment enterprises (FIEs) may also benefit from cooperation with clusters related to their core activity. Nevertheless, the linkage is more often the opposite. Local companies and more importantly governments promote joint actions sometimes organized as clusters in order to facilitate cooperation with FIEs. One of the main FDI-related policy aims is to promote a greater embeddedness of these within the local economic environment and a loosening of their island-like appearance in the host economy. Developing local linkages, however, requires actions from both sides, FIEs as well as local firms. Governments usually have greater influence on local small- and medium-sized firms and can better facilitate their efforts to become suppliers of FIEs. An interesting new tool in

[2] Michael Porter's original definition for clusters is as follows: "Clusters are geographic concentrations of interconnected companies, specialized suppliers and service providers, firms in related industries, and associated institutions (for example universities, standards agencies, and trade associations) in particular fields that compete but also co-operate" Porter 1990, (1998). The main aim of this cooperation is enhancing competitiveness of regions and actors in the region.

this effort is cluster promotion and their potential role in facilitating FIE local supplier networks.[3]

We can approach clusters on different levels. Since colocation of business in close geographical proximity is an organic development, we can focus on the real economic clustering process, that is, how spatial concentrations of certain activities evolve or show up in a given time of observation. This is an important aspect since benefits of close cooperation among firms are expected to arise when cooperating agents exceed a certain number, the so-called "critical mass."[4] We can make observations using statistical analysis of activities at the local level. First, such an extensive "cluster mapping" exercise was carried out in the USA by Michael Porter's team at Harvard Business School. Since then, several similar calculations were made using Porter's original method. In this chapter, we review previous mapping exercises and introduce our own results for Hungary. Other studies approach existing cluster organizations and try to draw conclusions using survey data. One of the first larger-scale empirical surveys of cluster initiatives was carried out at the Stockholm School of Economics by Sölvell et al. (2003). The research work that has been carried out in Stockholm ever since has strongly determined the European view of clusters. This influence has been expressed in European papers' strong emphasis on clusters' role in curbing the innovation process. This idea has become part of the reemerging industrial policy concept of the European Commission as well.

## 3.2 Clusters' Role in the Organization of Supplier Networks of Multinational Companies

Clusters are flexible production platforms with some kind of activity specialization. Cluster operation can be targeted directly not only to consumer markets but also to supplies of specific intermediate products. In some cases, clusters are organized as an alliance of equal parties (i.e., firms with similar size and importance); in other cases, organization is more satellite-like, and there is one or a few large companies which determine cluster activities according to their input demands. In this latter case, cluster participants and activities are organized in order to enhance the

[3] For more details on supplier network promotion programs in Hungary, see Sass and Szanyi (2004); ICEG (2006); Sass et al. (2009).

[4] One main precondition of successful cluster operation is the presence of a fairly large and diverse pool of economic agents specializing on similar or supportive activities. The sufficiently large, specialized local economic activity is crucial for knowledge generation and transfer, for the internal stability of cluster organizations, for the "visibility" of clusters, and for the self-sustaining development of cluster activities. For more general descriptions and about various interpretations of the cluster concept, see Porter (1998); Sölvell et al. (2003); ICEG (2007); Sölvell (2008); EC (2008b); Szanyi (2008b).

competitiveness of the whole value chain on top of which usually there are multinational companies. It is important to emphasize that FIE-centered clusters may work properly only on the basis of mutual benefits. Cluster cooperation, which is largely sponsored by the FIE, must bring benefits for suppliers in terms of technological upgrading, market access, and sometimes even financial support. Benefits of FIEs may range from access to less expensive and flexible local supplies to better labor force pool and technology assistance.

Clusters' essence is mutually beneficial cooperation of various economic actors. Hence, true clusters expand beyond the mere FIE supplier networks. They include nonbusiness participants, and their activity goes beyond technical organization of supplies. Most common is technology and knowledge transfer to facilitate small suppliers' technical and managerial capabilities. There is also financial support to undertake necessary investments. However, in this type of cooperation, there is relatively little emphasis on innovation and technological cooperation, at least for the time being.

Potentially, FIEs may be also important players in the innovation process of clusters. They were always regarded as primary sources of technology to the host transition economy. Whenever their local involvement increases, interfaces of technological spillovers also widen. Hence, clusters may serve as good platforms of knowledge transfer between FIEs and local actors. The concept of dynamic clusters[5] emphasizes innovative cooperation among partners rather than one-way transfers of knowledge. It is not self-evident that FIEs' strategies exceed the technical minimum of knowledge transfer toward suppliers. Their links to local universities or research laboratories also depend on many factors that are independent from cluster policies (Sass and Szanyi 2004).

TNCs are desired participants of clusters (Sölvell et al. 2003). They may support cluster development in several ways. They are in direct contact with world markets and can potentially bring breaking news to the cluster first hand. Through their widespread international linkages, these companies may support international activities of the cluster and smaller cluster members. They may even lobby for their partners' interests. Another potential support area is technology. Transnational companies have usually cutting-edge technology and are able to provide technology and knowledge transfer to strategic partners. In case of stable supplier contacts, technology transfer and enabling policies provided for suppliers are rather usual. The intensity of such linkages very much depends on their level of inclination for supplier network development with nationality and global strategy as perhaps the

[5] Sölvell et al. (2003) run the first major questionnaire-based empirical survey on clusters worldwide. Using the survey results, they described a typical or best practice cluster type: the most common appearance of clusters. Because of overrepresentation of clusters from developed market economies, this model, which they called "dynamic cluster," reflected basically those characteristics, cooperation forms, and structures that were found typical in more-developed economies. Later research (e.g., Ketels and Sölvell 2005; Ketels et al. 2006) revealed the fact that in emerging market economies or developing countries, clusters may substantially differ concerning their focus of activity and working models.

strongest determinants. Another technology-related area is R&D. One of the essential cluster functions, especially in the case of dynamic clusters, is knowledge generation and distribution within the clusters. Should there be intensive R&D linkages within the cluster members, including research institutions and universities, it is likely that also transnational companies participate in this collaboration. Related to knowledge generation is training and education. This is also based on cooperation of heterogeneous partners, including transnational companies.

We think that at least for the time being, emerging market economies do not offer strong conditions for knowledge-based dynamic clusters or innovation systems that could provide strategic innovation inputs for transnational corporations, though many of them possess strong innovation communities that could potentially serve as knowledge-generating network with international importance. Thus, TNCs' interest in developing deep cooperation networks including cluster participation is weaker in emerging market economies than in developed countries. Nevertheless, similarly to conditions for developing supplier networks, also cluster participation is plausible and desirable, albeit the likelihood and modes of participation may vary greatly. In the next section, we compare conditions of supplier network development with those of cluster establishment from the angle of TNCs using the Hungarian experience. This comparison will also highlight possible ways of organizing clusters based on existing supplier networks of TNCs.

In general, we can expect that factors increasing the likelihood of supplier network development also increase propensity of cluster involvement. However, the two phenomena are not identical, and in some cases, interests may substantially differ. It is therefore necessary to consider these determinants also from the cluster viewpoint. These are the following: spatial concentration, specialization, heterogeneity of actors, simultaneous competition and cooperation, critical mass, and typical cluster activities.

As far as geographic concentration is concerned, we can immediately realize that in Hungary, the main areas for FDI are identical with those of intensive cluster development. It is mainly the capital city and the Northern and Western Transdanubia region where both clusters and FDIs accumulate. In fact, investments started to settle in important agglomerations already in the 1990s; meanwhile, cluster development (meaning formal cluster initiatives) started only after 2000. Causal relations are rather unclear; hence, these regions used to be rather developed industrial centers already prior to the transition period, and their production potentials very much contributed to FDI attraction. Later, this attraction potential was further strengthened by the TNCs themselves. Leading original equipment manufacturers (OEMs) attracted their traditional suppliers to invest in the same region in order to ensure easy and smooth cooperation. This FDI pattern itself contributed to large extent to the creation of sufficient pools of specialized firms within close vicinity. OEMs also exercised strong pulling effect on local suppliers. While many of them had their premises in these historic industrial districts, new firms also settled into them. This process was strengthened by some policy measures as well. For over a decade or so, special industrial zones enjoyed special privileges in form of tax and customs relief, provided they exported their output entirely.

Tax-free zones became hubs for greenfield investments that also incorporated many Hungarian suppliers (Antalóczy and Sass 2001; SASS 2003).

Much of the export-oriented greenfield investment was carried out in the tax-free zones; however, we also have to note that some 100 such zones were created in Hungary since regulations for the establishment were rather easy to meet. Therefore, the likely pattern of spatial concentration was one OEM and its traditional first-tier suppliers, furthermore local second- and third-tier supplier companies. Only in rare occasions settled OEMs with similar final product into the same hub. They separated themselves from their competitors and seemed to prefer separation of their supplier network as well (Szalavetz 2001).

Consequently, significant concentrations of specialized firms were created in Hungary's more developed areas. These networks consisted of technologically dependent suppliers of the value chain of single OEMs. The types of cooperation also served the smooth functioning of the chain. Technology and knowledge transfer were provided by the OEMs and other major firms to Hungarian smaller suppliers in the areas and to the extent it was necessary to improve their supply capabilities. The knowledge transfer, but generally speaking, all cooperation links, was vertical: the OEM being in the center and other firms depending on them as satellites. Not only OEMs avoided contacting other OEMs of their branch, but also horizontal linkages of suppliers were curtailed (at least not promoted). This means contacts to other TNCs, but also linkages among suppliers (e.g., in the case of Electrolux[6]). There is some evidence that TNCs liked sporadic suppliers also because they could bargain lower prices when handling with separated, individual companies (Szanyi 2008a). Summing up, FDI created hot spots for potential cluster development, but TNCs were not really interested in creating cooperation and communication platforms among supplier firms, which would be an essential cluster function.

We must emphasize the role of the tax-free zones in spatial development of industrial districts in the first phase of the transition period. The advantageous regulation was however lifted while joining the European Union since it was not regarded as compatible with competition rules. Also, in this period, there was another pattern of FDI in Hungary which was more connected with the privatization process and was regarded as more likely leading to the development of supplier networks. From the point of view of the development of horizontal linkages, or the possibility of becoming suppliers of several firms and various OEMs, there is anecdotal evidence proving that the linkages were more frequent in these cases. However, TNCs were in many of the privatization cases not more interested in the further development of suppliers' horizontal linkages. Nevertheless, "inherited from the past," cooperation among some of the local-based suppliers might remain intact. Hence, propensity around these OEMs can be more likely than in the case of greenfield investments.

[6] See for details: ICEG (2006).

Another aspect of cluster development is the heterogeneity of members. It is rather clear that supplier networks around TNCs serve primarily the business interests of the integrating company. Anything which is beyond this interest must be initiated by other parties. The day-to-day interest of TNCs is simple: they must run their production facilities smooth efficiently (many of them are efficiency seeking). They need reliable business partners in the value chain. But basically, and especially in the early years of their investments, they do not care much about the broader background. Many TNCs regard investment projects as one off deal that lasts until favorable conditions prevail, but do not intend to get involved in supporting the longer-term provision of the conditions. Therefore, institutions of the broader production background (education, infrastructure development, etc.) remain outside of their attention. Therefore, the usual early phase local production networks usually lack diversity, which would be an important feature of clusters.

This situation is changing with the age and development of investment projects. There is much empirical evidence that shows how even greenfield investments changed their nature and behavior (Szalavetz 2005; Szanyi 2003; Hunya 2001). For it is in their own efficiency seeking interest to tap cheap opportunities in (almost) the whole value chain. Therefore, FIEs expand activity from final assembly of imported parts to increasing local component supply, to increasing local participation in corporate functions (from accounting through logistics even to R&D). This expansion of affiliates' activity in the global corporate networks is in line with the current wave of concentrating on core competences and outsourcing/offshoring much of the activities (Sass 2008). The more activities are carried out locally, the more likely business and cooperation links are developed in various directions exceeding the simple technological cooperation of suppliers. Whenever there is more room for contacts among heterogeneous market actors, potentials also increase for organizing these contacts and actors in some formal ways. Clustering process may get started from the bottom too.

Recent experiences with labor shortage in some industrial bases in Hungary opened up new frontiers of cooperation with TNCs. National Instruments in Debrecen, Siemens in Budapest, Nokia in Szeged, and Audi in Győr are just a few examples when TNCs participated in shaping and also financing education programs of universities. Of course, they do this because they need further high-quality labor supply. Another welcomed development pattern is the increasing participation of TNCs in financing and partly also carrying out R&D projects in Hungary. Some of the leading investors in Hungary established R&D laboratories in the country. This also substantially increased clustering potentials of some cities where sufficient educational and innovation background was present. We do not think that dynamic clusters will soon play important role in Hungary's economic development. It is good if TNCs at least realize that they may also benefit from cluster cooperation in Hungary and become active members of clusters. Nevertheless, the mere fact that universities, R&D facilities, and maybe also other actors raised their interest also supports the cluster idea and increases chances for proper cluster actions.

Concerning the coexistence of cooperation and competition, Hungarian clusters may play positive role. TNC supplier networks always supported intensive competition among local firms. Cooperation was rather lacking, though it was very much in the interest of local firms to improve their abilities in joint actions rather than individually. Clusters may play important role in organizing various programs for the development of participating SMEs. This is also in the interest of the TNCs heading the value chain. Other forms of cooperation, most importantly technology and knowledge transfer and maybe even generation, are also plausible in supplier-based clusters, especially if cluster members can change their way of thinking of vertical flows, but recognize that there is also room for joint horizontal actions. The empirical evidence indicates that this is most difficult task of cluster managers since many of the potential cluster members are competitors and compete for contracts of the top OEMs or first-tier foreign suppliers. Finding ways of making TNCs interested in cluster cooperation is sometimes not more difficult than trust building among competing local suppliers.

As far as the critical mass of clusters is concerned, there is very little information on this issue in Hungary. Empirical surveys indicated that formal cluster organizations do not set such targets (Szanyi 2008a). Many are in their early stage of development; thus, the question is not yet relevant for them. Nevertheless, we can draw some general conclusions using guidelines of the literature (Sölvell et al. 2003; ECOTEC 2003; Cloe 2006). Achieving of a critical mass is important for three reasons. One is stability (against potential dropouts of large, dominating firms), the second is self-sustaining cluster (financially and also in terms of new entry attraction), and the third is achieving also a critical mass of information flow and activity (a kind of density of cluster actions that provides the desired synergies). TNC supplier networks alone have little chance to achieve these goals. Membership of competing OEMs is not likely. However, there may be clusters that are not initiated and dominated by OEMs but are established by other parties, building on suppliers to TNCs. In this case, the initial favorable condition of the supplier network is utilized, namely, that there is a pool of potential cluster members. Using this pool, a cluster can be organized with or without the participation of the TNC itself. The case of the oldest and largest Hungarian cluster the Pannon Automotive Cluster (PANAC) is a good example for this. However, even this cluster could not develop activities away from simple supplier network support for many years. It took time and some setback in the cluster's activity until cluster management realized that proper cluster functioning cannot be based solely on supplier network development programs (Grosz 2006). Representing the cluster's own interests as separate organization is crucial and cannot be subordinated to one company's business interests. Also, professional cluster management is necessary to be employed so that regular cluster functions are developed.

## 3.3 Cluster Mapping

While the origins of clustering included mostly bottom-up organizations, increased interest in cluster development as policy tool resulted in large numbers of clusters that did not have traditional or organic spatial development roots. Many times, it was governments that boosted the organization of cluster initiatives. If countries wish to launch a thoroughly designed program, information has to be gathered and evaluated first. For the purpose of promotion of clustering process, or the foundation of cluster organizations, it is necessary to check if conditions for clustering are given or not. Two characteristics are crucial. First is spatial concentration, and the second is specialization on some core competence. It is rather obvious that in the case of a top-down initiative, these characteristics can be controlled in advance. It is quite surprising that cluster mapping has not yet become a general practice by governments. It is only the USA, where nationwide effort was made in the late 1990s. Some countries also calculated spatial concentration measures, but even these efforts were not always given the right attention by policy makers. For example, in Hungary, there was such an effort in 2003, but it was conducted when the cluster promotion program has already been opened for applications (Ravn and Petersen 2005). An ex post survey compared the identified clusters with the list of existing cluster initiatives. Only 10 of the then 22 Hungarian cluster initiatives matched the hot spot map which identified 24 examples of above-average spatial concentration of industries (Gecse 2004).

The above-mentioned weak result of match by actual cluster initiatives and statistically registered spatial concentrations raises the question of how to explain this failure. Was it the inappropriate analytical framework that created distortions in the mapping procedure? Or rather, was it due to a high number of “virtual cluster initiatives”? Or maybe, and most likely, do both explanations contribute to an overall explanation?

Without going into detail, a brief overview of methodological problems is due here. The cluster mapping procedure tries to identify spatial locations where the representation of certain industries or economic activities is higher than average, i.e., where they seem to concentrate. The logic is simple; in these places, there must be some kind of a competitive advantage that is perceived by economic actors, and they tend to colocate. There are three types of industries that have different reasons to colocate. A large number of manufacturing branches and even more service providers (typically personal services) are located right at their markets. The dispersion of such industries is roughly even in all regions. Per capita measures, for example, are very close to each other in the various geographic regions of a country. Natural resource–based industries on the other hand tend to concentrate mainly at the location of the valuable asset. These industries may serve the global market, but they do not have much locational choice. The third group of activities is most important for us, for these are industries that concentrate at locations; hence, they choose among many potential sites. These industries are regarded as cluster industries. In the case of the US economy, their proportional share in employment was close to one third, but they recorded higher than average wages, productivity, and innovation (Ketels and Sölvell 2005).

Ketels and Sölvell (2005) run a comprehensive statistical survey of cluster mapping in the ten new member states of the EU. Their methodology was based on the methods of a survey that was conducted at the Institute for Strategy and Competitiveness at Harvard Business School led by Michael Porter.[7] The European survey used the amended American industrial classification method when identifying those business activities which belonged to cluster industries. Spatial concentration was calculated for the European NUTS-2 level regions. Only employment data were readily available at this level of both sectoral and geographic disaggregation (38 businesses), and for two more recent comparative years (2000 and 2004). Thus, concentration was measured with this single data set. However, the authors calculated three different measures in order to limit some of the distortions stemming from the special features of employment data. They wished to obtain a balanced picture of regions reaching sufficient specialized critical mass to develop the type of spillovers and linkages that create positive economic effects and can serve as a base for cluster initiatives.

The first measure expressed the size if employment reached a sufficient absolute level that may trigger strong economic effects of clusters. This level was set for each NUTS-2 region and every of the 38 branch at 15,000 employees at a location. The second measure expressed specialization if a region was more specialized in a specific cluster category than the overall economy across all the regions; this was thought to provide enough strength for the regional cluster to attract related economic activity from other regions. This notion was operationalized by regarding fit those concentrations that reached a specialization quotient of more than 1.75, i.e., which had at least 75% more employment within the given cluster, than the average of all regions would suggest given their size. The third measure expressed dominance if branches employ a high share of the given region's overall employment. The measure was set at the level of 7% of overall regional employment. The level of all three measures was set to separate the highest 10 percentile of all regional clusters.

As expressed also by the authors, the measurement method had several shortcomings. First, being the usage of solely employment figures, this created bias toward labor-intensive sectors. Another problem is the level of disaggregation in both dimensions. The 38 activity groups or businesses contain many that are rather heterogeneous. A deeper level of disaggregation was not possible, since the original grouping pattern (which was based on more detailed surveys of the US economy) could be transformed from the American SIC classification structure to European NACE only at this level.

As concerns NUTS-2 regions, they are also too big in at least some countries and for some activities. In Hungary, for example, NUTS-2 regions were artificially

[7] See http://data.isc.hbs.edu/isc/index.jsp.

created as requested by the EU, but they consist of usually three former comitats which used to be the integrating geographic and administrative unit historically. The new NUTS-2 regions are so young that their economies could hardly amalgamate. On the other hand, there is no convincing evidence on clusters spreading according to administrative borders either. Thus, maybe some clusters escaped mapping because they spread over two or even more NUTS-2 regions.

A further problem comes from the inheritance previous industrial structures. In most socialist countries, production was heavily concentrated in large state-owned companies. In some cases, these huge combinates were located in places of arbitrary choice; in other cases, firms were created in the strive of these countries for self-supply in practically all commodities in the middle of nowhere. In many cases, these giants or the remnants of them survived the turmoil of the transition process. In other cases, the least mobile production factor labor stayed at places where they were settled during the years of socialist industrialization. All this experience seriously distorted spatial concentration patterns from the hypothetical optimum, and the old patterns still exercise influence on spatial differences in the supply of production factors. Thus, we may have strong reservations as far as the applicability of the results of current cluster mappings is concerned.

Ketels and Sölvell's survey found nevertheless interesting results. We summarize them in the following. 367 regional clusters met at least one of the three hurdle rates for absolute size, specialization, and dominance. They represented 5.86 million employees, about 58% of total employment in the cluster sector of the ten new member states. The capital regions of the largest countries lead the ranking of regions by cluster portfolio strength: Budapest first, Warsaw second, and Prague fourth place. The largest seven cluster categories were food processing, heavy construction services, transportation and logistics, financial services, hospitality and tourism, metal forming, and building fixtures, equipment, and services, and accounted for 50% of all cluster sector employment across the EU 10. As is seen, it is mainly labor-intensive branches with relatively lower level of productivity: a clear indication for sample bias (automotive or ICT employed much less people, albeit they used to be considered as leading sectors for many clusters).

The research confirmed existing hypotheses concerning the development gap between developed country and transition member states in the EU. The EU 10 economies had a specialization profile distinct from more advanced economies. Specialization was found to have far stronger natural resource-driven sector (20% share in employment) than developed countries. Within the cluster sector (32% share in employment), there was a stronger bias toward labor-intensive and manufacturing-driven cluster categories, while these countries were relatively weak in advanced services and knowledge-intensive cluster categories. Exceptions were the strongest clustering centers around capital cities. Also, in case of the Hungarian clusters, the above-mentioned bias was less pronounced, and specialization toward high value-added services and industries was stronger (see the attached list below) (Table 3.1).

There may be several factors affecting the results of the above table, which seems to be rather rigorous. For example, no Slovenian cluster qualified itself in all

**Table 3.1** Strong regional clusters and their specialization 2004 (clusters qualifying for the top 10% in all three measures)

| Regions | Field of specialization |
|---|---|
| Czech Republic | |
| Liberec | Automotive |
| Liberec | Textiles |
| Ostrava | Metal manufacturing |
| Praha city | Education and knowledge generation |
| Praha city | Entertainment |
| Praha city | Financial services |
| Praha region | Automotive |
| Hungary | |
| Győr | Automotive |
| Szeged | Food processing |
| Székesfehérvár | Information technology |
| Lithuania | Apparel |
| Latvia | Entertainment |
| Poland | |
| Gdansk | Transportation and logistics |
| Katowice | Automotive |
| Lodz | Apparel |
| Warszawa | Financial services |
| Wroclaw | Automotive |
| Slovakia | |
| Bratislava | Financial services |
| Kosice | Apparel |
| Kosice | Metal manufacturing |

Source: Ketels and Sölvell (2005), pp. 62–65

three dimensions. Ketels and Sölvell (2005) found convincing evidence on the correlation of spatial concentration and economic performance using the data of developed countries. However, spatial concentration had different historic reasons in practically all the EU 10 countries, and these traditions seem to have much weaker causal link to economic growth and performance today. For example, in the case of the strong position of the Kosice region in the Slovak Republic, we must not forget that this is one of the poorest regions of the EU 25. The Kosice steel mill and very few other industrial facilities are the single most important employer of the region where unemployment rates are extraordinarily high. Thus, we may observe cases for which spatial concentration of business is the result of an overall meltdown of business activity in some regions, and not the beneficial outcome of deliberate colocation decision of independent cluster actors.

It is perhaps more useful to look at regional centers' overall clustering performance. The next table contains the list of regional centers that attracted the largest cluster portfolio, i.e., businesses that qualified in one or more aspects of cluster measures (Table 3.2).

There are large differences within the EU 10 across regions and cluster categories regarding their level of specialization and spatial concentration. These countries show much lower specialization on specific regional clusters within

**Table 3.2** Regional clusters with strongest portfolio in EU 10, 2004

| Region | Total number of qualifications | Average qualification per regional cluster | Share of qualified clusters in total regional cluster employment (%) |
|---|---|---|---|
| Budapest | 23 | 1.53 | 77 |
| Warsawa | 22 | 1.38 | 77 |
| Katowice | 21 | 1.4 | 81 |
| Praha city | 19 | 1.9 | 78 |
| Lithuania | 19 | 1.58 | 70 |
| Krakow | 18 | 1.29 | 68 |
| Liberec | 17 | 1.55 | 62 |
| Lodz | 16 | 1.6 | 71 |
| Wroclaw | 16 | 1.45 | 60 |
| Poznan | 15 | 1.15 | 72 |
| Nitra | 14 | 1.4 | 60 |
| Bydgoszcz | 14 | 1.27 | 58 |
| Slovenia | 14 | 1.27 | 56 |
| Olomouc | 14 | 1.4 | 45 |
| Latvia | 13 | 1.44 | 62 |
| Gdansk | 13 | 1.44 | 59 |
| Praha region | 13 | 1.63 | 43 |
| Bratislava | 12 | 1.5 | 65 |
| Brno | 12 | 1.2 | 56 |
| Miskolc | 12 | 1.09 | 51 |
| Kosice | 12 | 1.71 | 45 |

Source: Ketels and Sölvell (2005), p. 26

regions and much lower spatial concentration on specific regions within cluster categories than the original benchmark US economy. If as is suggested by the authors, higher levels of specialization and concentration enable higher productivity and innovation, this is a serious concern. The same concern arises with regard the EU 15 countries in comparison with the USA, which is fully consistent with the performance gap relative to the USA.

The European Union picked up Porter's idea and its extension by Sölvell and addressed dynamic clusters (in EC terms "innovative clusters") one cornerstone of the more concrete and operative implementation plan of the Lisbon targets by the mid-2000s. The emphasis on cluster development via European means gave new impetus for cluster research as well. Based on previous works at the Stockholm School of Economics, new research institutions were created. The European Cluster Observatory started to work in 2005. One main research output of this institution is its cluster mapping database.[8] The database contains employment data broken down according to Porter's original categorization of "traded clusters" for the European NUTS-2 level regions. The same types of measures are calculated than what was used in Ketels and Sölvell (2005). Thus, the problem of using only one

[8] See http://www.clusterobservatory.eu.

indicator (employment), as well as the too broad and rather rigid separation of regions, still remained in this database. Nevertheless, the availability of methodologically comparable data for the whole territory of the EU is an important new feature in cluster research. Also, the database contains some basic evaluation of the registered clusters' exports and innovative activities that helps readers identifying the "true innovative clusters."

As far as the actual results are concerned, data of the observed Hungarian clusters are summarized in the next table. As is seen, none of the spatial concentrations in Hungary qualified in all three measurement aspects in 2007 (in 2004, there were three). The number of two-star clusters also declined. Some of the 2004 two-star clusters lost one star, but in two cases (building fixtures and business services in Central Hungary), the 2004 clusters were not mentioned in the 2007 table. On the other hand, 6 "new" two-star clusters appear in 2007 table. They are certainly not new in the sense that these spatial concentrations have been rather known, since they used to have rather solid and traditional background, and qualified from one- to two-star levels (Table 3.3).

Looking at the 2007 list of Hungarian clusters, we can observe the still strong positions of traditional sectors. This is despite of the less favorable development tendencies during the 1990s and 2000s. Strong path dependency is observed here. Despite of massive foreign investments in some global industries, like automotive and electronics and communication technology, important features of the Hungarian economy prevailed: food industry, construction, and light industry still retained important positions despite of heavy contractions during the past 15 years.

Another important message of the table is that innovation was found strongest mainly in sectors that did not export much and did not belong to traditional high-technology activities. The loose relationship of high technology, innovation, and exports calls for caution when designing cluster promotion tools aiming at "export-oriented innovative clusters," which is at the heart of the current Hungarian but, to some extent, also the European innovation policy (see, e.g., EC 2008a, b; European Cluster Observatory 2007). Porter stressed the importance of innovation in cluster activity but never mentioned that clusters were "reserved" for high-technology activities, or for export-oriented industries. Heart of his concept is joint action for increasing regional competitiveness in general. One tool of this strive is supporting innovative cooperation in a wide range of industries and activities. Equally important in the cluster concept is its basing on traditional regional sources and areas of competitiveness. These should be promoted by cluster cooperation. Clusters should not be regarded as means of "capitalist industrialization."

The results of the Ketels and Sölvell (2005) study suggest further research in mapping spatial concentrations of business activity in the "traded cluster" sectors. It seems to be necessary to use alternative indicators like sales turnover, investments, or paid salaries (instead of the number of employees). Also, strict administrative boundaries of NUTS-2 regions should be treated more flexibly to allow the observation of "cross-border" clusters, or less-spread spatial concentrations that "disappear" from calculations when comparing them with aggregated figures of larger areas. Such refinements in methodology will enhance a more reliable comparison of

**Table 3.3** Evaluation of Hungarian clusters (2007)[a]

| Region | Cluster category | Employees | Size | Spec. | Focus | Stars | Innovation | Exports |
|---|---|---|---|---|---|---|---|---|
| Kozep-Magyarorszag | Transportation | 50,163 | 0.81% | 1.23 | 4.00% | ** | High | Weak |
| Kozep-Magyarorszag | Education | 44,476 | 1.00% | 1.89 | 3.00% | ** | High | N/A |
| Del-Alfold | Food | 34,101 | 0.68% | 2.89 | 7.00% | ** | Low | Weak |
| Kozep-Magyarorszag | IT | 30,735 | 1.00% | 2.26 | 2.00% | ** | High | Strong |
| Kozep-Dunantul | Automotive | 17,091 | 0.66% | 2.85 | 4.00% | ** | Low | Strong |
| Nyugat-Dunantul | Automotive | 16,741 | 0.64% | 2.98 | 4.00% | ** | Low | Strong |
| Kozep-Magyarorszag | Biopharma | 14,197 | 1.00% | 2.61 | 1.00% | ** | High | Weak |
| Kozep-Dunantul | IT | 12,535 | 0.61% | 2.64 | 2.00% | ** | Low | Strong |
| Kozep-Dunantul | Building fixtures | 11,702 | 0.50% | 2.17 | 2.00% | ** | Low | Strong |
| Nyugat-Dunantul | IT | 10,995 | 0.54% | 2.47 | 2.00% | ** | Low | Strong |
| Nyugat-Dunantul | Lighting | 6,888 | 1.00% | 6.17 | 1.00% | ** | Low | Very strong |
| Kozep-Magyarorszag | Lighting | 6,832 | 1.00% | 2 | 0.56% | ** | High | Very strong |
| Del-Dunantul | Leather | 3,086 | 1.00% | 10.32 | 0.95% | ** | Low | Weak |
| Kozep-Magyarorszag | Finance | 43,439 | 0.61% | 0.92 | 3.00% | * | High | Weak |
| Kozep-Magyarorszag | Entertainment | 28,559 | 1.00% | 1.96 | 2.00% | * | High | Very strong |
| Eszak-Alfold | Food | 22,460 | 0.45% | 1.73 | 4.00% | * | Low | Weak |
| Eszak-Alfold | Construction | 18,230 | 0.28% | 1.07 | 3.00% | * | Low | N/A |
| Kozep-Dunantul | Metal | 17,403 | 0.44% | 1.92 | 4.00% | * | Low | Weak |
| Kozep-Magyarorszag | Publishing | 16,886 | 1.00% | 1.55 | 1.00% | * | High | Weak |
| Eszak-Magyarorszag | Food | 16,116 | 0.32% | 1.51 | 4.00% | * | Low | Weak |
| Kozep-Dunantul | Construction | 16,020 | 0.24% | 1.06 | 3.00% | * | Low | N/A |
| Eszak-Magyarorszag | Construction | 15,650 | 0.24% | 1.11 | 3.00% | * | Low | N/A |
| Kozep-Dunantul | Food | 15,246 | 0.31% | 1.32 | 3.00% | * | Low | Weak |
| Nyugat-Dunantul | Food | 14,718 | 0.29% | 1.36 | 3.00% | * | Low | Weak |
| Del-Dunantul | Food | 14,374 | 0.29% | 1.63 | 4.00% | * | Low | Weak |
| Del-Alfold | Construction | 13,783 | 0.21% | 0.89 | 3.00% | * | Low | N/A |
| Eszak-Magyarorszag | Metal | 13,190 | 0.34% | 1.57 | 3.00% | * | Low | Weak |
| Nyugat-Dunantul | Construction | 12,918 | 0.20% | 0.91 | 3.00% | * | Low | N/A |

(continued)

**Table 3.3** (continued)

| Region | Cluster category | Employees | Size | Spec. | Focus | Stars | Innovation | Exports |
|---|---|---|---|---|---|---|---|---|
| Kozep-Dunantul | Transportation | 12,078 | 0.20% | 0.85 | 2.00% | * | Low | Weak |
| Nyugat-Dunantul | Hospitality | 11,702 | 0.32% | 1.47 | 2.00% | * | Low | Strong |
| Del-Dunantul | Construction | 11,151 | 0.17% | 0.96 | 3.00% | * | Low | N/A |
| Del-Dunantul | Finance | 9,012 | 0.13% | 0.72 | 2.00% | * | Low | Weak |
| Eszak-Magyarorszag | Chemical | 6,130 | 0.64% | 2.97 | 1.00% | * | Low | Weak |
| Eszak-Magyarorszag | Communications | 5,910 | 0.74% | 3.47 | 1.00% | * | Low | Very strong |
| Kozep-Dunantul | Communications | 5,890 | 0.74% | 3.21 | 1.00% | * | Low | Very strong |
| Nyugat-Dunantul | Heavy machinery | 5,341 | 0.64% | 2.97 | 1.00% | * | Low | Weak |
| Eszak-Alfold | Heavy machinery | 4,362 | 0.52% | 2.02 | 0.92% | * | Low | Weak |
| Del-Dunantul | Communications | 4,333 | 0.54% | 3.09 | 1.00% | * | Low | Very strong |
| Del-Alfold | Construction, materials | 3,863 | 0.64% | 2.72 | 0.89% | * | Low | Weak |
| Nyugat-Dunantul | Communications | 3,475 | 0.44% | 2.01 | 0.87% | * | Low | Very strong |
| Kozep-Magyarorszag | Jewelry | 3,445 | 1.00% | 1.75 | 0.28% | * | High | Weak |
| Eszak-Magyarorszag | Lighting | 3,357 | 0.65% | 3.04 | 0.85% | * | Low | Very strong |
| Eszak-Alfold | Lighting | 3,084 | 0.60% | 2.3 | 0.65% | * | Low | Very strong |
| Eszak-Alfold | Footwear | 3,066 | 0.70% | 2.71 | 0.64% | * | Low | Weak |
| Del-Alfold | Oil and gas | 2,372 | 0.67% | 2.84 | 0.55% | * | Low | Weak |
| Del-Dunantul | Fishing | 1,369 | 0.38% | 2.16 | 0.42% | * | Low | Weak |
| Eszak-Alfold | Leather | 1,167 | 0.69% | 2.65 | 0.24% | * | Low | Weak |
| Nyugat-Dunantul | Leather | 1,041 | 0.61% | 2.83 | 0.26% | * | Low | Weak |

All regional clusters in Hungary (1-, 2-, and 3-star regional clusters)

[a]A brief description of the calculation method is provided in the text. In case of the size, one star was given to clusters that belonged in this regard to the top 10% of all clusters in the EU concerning this feature. The % figure in this table shows the actual share of the given Hungarian cluster in Europe's total (total employment in the given sector in all European clusters). In the case of specialization, values over 2 earned one star. For the notion of focus, those clusters got one star, which belonged to those 10% of clusters that contributed the most to total local cluster employment. The % figure in the table shows the actual share of the cluster in employment of the region

Those clusters that also appeared in Ketels and Sölvell 2005) table are bold

Source: http://www.clusterobservatory.eu functioning cluster organizations and their background, which in turn would also contribute to a better formulation of cluster policies.

## 3.4 ICT and Automotive Industry Clusters in Central Europe

As it has already been argued, ICT and automotive industries have strong potentials for cluster building. The main reason of this is that both industries' production structure is rather complex and can easily be sequenced, thus allowing the participation of many specialized suppliers. Pavlinek and Janak (2007) described the process of vertical disintegration during the 1990s in the car industry, with special regard to the Czech case as well. He stressed that Czech car production was traditionally strongly integrated vertically, with over 50% added value share of the final assembler. This situation changed already prior to the privatization of Skoda Auto in the early 1990s. Outsourcing to local and foreign suppliers gained momentum after VW's purchase of the firm. Similar processes took place in many other globalized industries and firms also in Central Europe. Local suppliers, but to even a greater degree, traditional foreign suppliers, settled near to the main assemblers. Pavlinek and Janak (2007) found evidence that first-tier component suppliers (usually other large TNCs) settled close to the Mlada Boleslav center of Skoda Auto; meanwhile, second- and third-tier suppliers (most of the local firms in the supplier chain) tended to remain in their spatially more distant locations. Thus, a special kind of clustering process was detected in the Czech car industry. Thus, Pavlinek and Janak (2007) described four clustering centers in the Czech Republic's automotive industry. However, the authors did not define precisely what they understood under clusters.

The chapter itself called simple colocation (industrial districts) clusters and concentrated on the elaboration of supplier chain development. As we argued previously, the existence of colocated supplier chains may form the potential base of Porterian clusters. Pavlinek and Janak did not check whether true cluster functions, especially horizontal cooperation linkages, developed among the over 200 supplier companies. This chapter does not mention the existence of a formal cluster organization (cluster initiative) either. Hence, we assume that the VW-based Czech automotive cluster exists mainly in the sense of a large potential pool for the essential horizontal cooperation and is in reality rather a huge, well-organized production platform. Nevertheless, new booklets of CzechInvest (the Czech FDI promotion agency) also include potential R&D facilities and universities that are readily available for innovative cooperation in the automotive sector. This information also substantially improves chances of the establishment of a Porterian cluster; hence, it provides options for the necessary heterogeneity of the participants.

Soviar (2009) briefly summarizes the results of an international research project on clusters in the Zilina region. Cluster mapping calculations showed strong specialization on traditional industries like timber and wood and textiles. However, given the small scale of the Slovak ICT industry, high LQ value was obtained for this branch as well (albeit at a fairly low-size level: only 3,000 employees). Heavy industry, especially military production (trucks and heavy guns), also had traditions in this region and based on these Slovak researchers also found likely that an automotive cluster can be developed. Two OEMs settled near to the region (Kia and Hyundai in the neighboring Czech city Ostrava). Based on the activity of the regional development agency, a cluster organization was established in the ICT branch. The activity of this young cluster initiative concentrates on establishing linkages among ICT firms and local educational institutions. The cluster has only seven business members, and given the low size of this industry in general, it is not very likely that it would reach a critical mass that would be necessary for self-sustaining, independent functioning.

On the other hand, more recent calculations of Cluster Observatory (2009) indicated that there is a significant concentration of activity in the automotive sector of Bratislava region. This city has traditionally been regarded as supplier background area of Skoda. During the privatization process of Skoda, also facilities in the later Slovak Republic were sold. Hence, VW became a significant investor of Slovakia. Supplier chains were maintained to a large extent like in the Czech parts, also in Slovakia. Thus, a potential automotive cluster is present. Without further in-depth analysis, it is impossible to state if the Zilina facilities could join a larger international automotive cluster with the center in Ostrava, or rather there should be a Slovak "national" automotive cluster merging firms from the Bratislava and Zilina region together. Since however clustering process is influenced by national industrial and regional development policies (top-down development) rather than by organic bottom-up development process, it is more likely that there will be one main Slovak autocluster.

As it has already been emphasized, cluster policies do matter in the establishment of cluster organizations. EU made explicit cluster policies even a cornerstone of its industrial policy strategy. Hence, also substantial financial support can be obtained for the purpose of cluster development. This increases governments' appetite for industrial clusters and cluster organizations. Hungarian government moved early into this direction and started with cluster policies already in 1998 (Szanyi 2001). Other countries of Central Europe did not follow this path (ICEG 2007), at least up until the first EC budget chapters were not opened up for projects of cluster development. Hence, there are only very few formal cluster organizations in the region, although their number has increased at high speed during the past 2–3 years. The Hungarian experience clearly showed that there has been a kind on cluster inflation. Many organizations were established without strong potential background and could not become self-sustaining organizations (Szanyi 2008a, b). Unfortunately, Hungarian policy never tested a priori the conditions for cluster development. No systematic cluster mapping was carried out. Even today, responsible authorities rely on the (very questionable valued) Cluster Observatory database. More in-depth analysis is sometimes carried out by regional development agencies, but their studies are usually very much biased by strong self-interest.

**Table 3.4** Automotive and IT clusters in East Central Europe[a]

| | Employees | Size | Specialization | Focus | Stars | Innovation | Exports |
|---|---|---|---|---|---|---|---|
| Automotive clusters | | | | | | | |
| Severovychod CZ | 31,578 | 1.22 | 3.40 | 4.80 | *** | Low | Strong |
| Strední Cechy CZ | 29,511 | 1.14 | 4.02 | 5.68 | *** | Medium | Strong |
| Zapadne Slovensko SK | 21,261 | 0.82 | 2.03 | 2.86 | ** | Low | Very strong |
| Jihozapad CZ | 17,203 | 0.66 | 2.30 | 3.25 | ** | Low | Strong |
| Közép-Dunántúl H | 17,091 | 0.66 | 2.86 | 4.03 | ** | Low | Strong |
| Nyugat-Dunántúl H | 16,741 | 0.64 | 2.98 | 4.21 | ** | Low | Strong |
| Podkarpackie PL | 13,367 | 0.51 | 2.65 | 3.75 | ** | Low | Strong |
| Bratislavsky kraj SK | 11,468 | 0.44 | 2.79 | 3.95 | ** | High | Very strong |
| IT clusters | | | | | | | |
| Közép-Magyarország H | 30,735 | 1.50 | 2.27 | 2.53 | ** | High | Strong |
| Közép-Dunántúl H | 12,535 | 0.61 | 2.65 | 2.96 | ** | Low | Strong |
| Nyugat-Dunántúl H | 10,995 | 0.54 | 2.48 | 2.77 | ** | Low | Strong |

[a]For methodological descriptions see Table 3.4
Source: http://www.clusterobservatory.eu

There is only one systematic database for international comparisons that can compare the spatial concentration of PORTER's traded clusters in the EU region. As concerns automotive and ICT industries, the precondition, the necessary minimum level of size, concentration, and dominance, only a few locations were found significant. As it is seen in the next table, ICT industry shows significant concentration in three NUTS-2 digit regions in Hungary, and nowhere else in East-Central Europe. The automotive industry seems to be stronger, with three locations in the Czech Republic, two in both Hungary and the Slovak Republic, and one in Poland. If we stick to the earlier strong statement, that a significant threshold level of activity accumulation is precondition of successful cluster development, we can conclude that most probably there should be one automotive cluster in each of the four East-Central European countries and one or two clusters in Hungarian ICT branch (Table 3.4).

## 3.5 Hungarian Cluster Mapping Evidence

In Szanyi et al. (2009), we analyzed the 1998 and 2005 database of the Hungarian Tax Office using Porter's measurement method, which was described in the previous section. When transforming the industry categories of the database to the one that was defined in the HBS cluster mapping project, we could separate 37 out of the original 38 traded cluster activities.[9] Out of the three measures that were used by

[9] For a thorough description of the traded cluster category, see http://data.isc.hbs.edu/isc/index.jsp.

Ketels and Sölvell (2005), we used only one, the specialization quotient.[10] We found that the statistical content of other two measures was very much similar. We also found the other two measures strongly biased by the absolute differences between firms, branches, and spatial units. Relative concentration is at the heart of the clustering process, and this requires relative measures. Comparisons that are based on the use of absolute values are therefore less applicable since they reflect size biases.

The calculations were new and more precise in two aspects. We could disaggregate our database in spatial terms from NUTS-2 level (regions) to NUTS-3 level (comitats).[11] This is important because on regional level important concentrations can be neglected due to differences in terms of varying significance levels of the different economic activities. But finer spatial focus also allows the observation of activity concentrations that do not follow the artificial boundaries of the regions. The other novelty of our calculation method was the usage of various measures of economic activity, not just employment data. We used employment (number of employed persons), number of enterprises, and value-added and cumulated investment data (investments of the 1998–2005 period). Thus, the final product of the calculations was four measures for each traded cluster branch in each NUTS-3 level spatial unit for the year 2005, and three for the year 1998, since for the starting year, no cumulated investment figure was available.

The total number of calculation results was 740 (20 spatial units, 37 branches) for each of the four measures. For an easier overview and better analysis, we followed the evaluation method found in Ketels and Sölvell (2005). We gave one point for all those branch-comitat pairs that belonged in terms of the given measure to the upper 15% of the calculation values. Thus, every branch-comitat pair could get maximum 4 points (3 points in 1998).[12] We considered those pairs where at least two measures proved to be significant (belonged to the highest 15% and got therefore two points). We also calculated Gini coefficients. This measure helps us determining whether activity concentration is caused by one or just a few large companies, or rather by a number of medium- or several small-sized firms. This is a very important aspect since we want to measure the pool of potential cooperators,

[10] The design of the locational quotient is similar to Bela Balassa's RCA measure (revealed comparative advantage). It expresses the relative weight of one single sector in a region to the total weight of the region, compared to either the national economy or a larger geographical area. The calculation is as follows:

$\mathrm{LQ}_{ij} = \frac{e_{ij}/E_i}{e_j/E} = \frac{s_{ij}}{x_j}$, where

$e_{ij}$: number of employees in area $j$ in branch $i$,

$e_j$: the total number of employees in area $j$,

$E_i$: number of employees in branch $i$ in the whole country (spatial unit of comparison), and

$E$: total number of employees in the whole country (spatial unit of comparison), and therefore

$S_{ij}$: shows the share of area $j$ in total employment of branch $i$, and

$x_j$: shows the share of area $j$ in total employment.

[11] The database allowed even deeper NUTS-4 level calculations.

[12] We also evaluated the branch-comitat pairs at a lower 30% level.

and therefore, the actual size structure is highly relevant for us. The Gini coefficient was calculated from employment figures. Values over 0.9 reflect very uneven structure. If the number of firms (observations) is high (100 or more), then values as high as 0.7–0.8 already indicate that a number of medium-sized firms should also be present. Thus, cooperative structures like clusters or supplier networks would have sufficiently broad pool to be based on.

We could spot significant concentration at least in one comitat only in 22 of the 37 traded cluster branches for the year 2005. In the remaining 15 traded cluster branches no branch-comitat pairs received at least two points. The results are summarized in the next table. Interestingly, no services-centered cluster was captured by our calculations, although there is much anecdotal evidence on the existence of even formal cluster organizations based on various services activities (financial services, education, entertainment). Of course, it is possible that this failure is related to the shortcomings of the measurement method. However, the absolute lack of indication in the whole country may also mean that either these clusters operate in an inappropriate environment (too few related companies), or they may be very young organizations that are not yet measurable statistically. In case of the capital city, Budapest a further option is also likely. This city is simply too big and has too heterogeneous business activity that does not allow statistically outstanding concentrations. The large overall size limits the relative importance of sectors that would produce sufficiently large size in many aspects; still, the large denominator makes them unnoticed. Due to this measurement problem, Budapest and Pest comitats did not show significant concentrations at all. Since however, we could also provide the total number of firms in the given branch; high values of these data may still deliver the necessary information on spatial concentration (Table 3.5).

As is seen in the table and also on the amended maps, in many cases we included several comitats together to form a potential cluster. This idea stems from the logic that the spatial dispersion of clusters should not necessarily follow administrative boundaries. The lower spatial observation level (i.e., NUTS 3) allows us to better localize the potential spread of clusters in neighboring comitats. We treated comitat-branch pair that showed significant concentration on 15% level as gravity centers and added to them those neighboring comitats that showed concentration on at least 33% level. In some branches, we could identify two in some cases even three centers the nucleus of potential cluster formations.[13] Such examples are presented on the amended cluster maps. The last two columns of the table provide an evaluation of the branch-comitat pairs concerning the likelihood that they may become real clusters. Whenever we made objections, these are included in the last

[13] We must notice here again that spatial concentration is just one important condition of cluster formation. Hence, even if we call the observed concentrations clusters or potential clusters, it does by no means mean that there is an actual cluster organization present. HBS documents, as well as the European Cluster Observatory, also uses the term "cluster" for spatial activity concentrations.

**Table 3.5** Hungarian cluster mapping results

| Sector | Comitats | Number of firms | Gini coefficient | Qualification | Note |
|---|---|---|---|---|---|
| Automotive | Győr, Komárom | 29, 17 | 0.81, 0.77 | Yes | One center |
| Leather products | Vas, Baranya, Szolnok, Szabolcs | 6, 17, 6, 3 | 0.66, 0.65, 0.58, 0.66 | ? | Two centers, spatially disperse |
| Footwear | Vas, Baranya, Tolna, Bács-Kiskun, Szolnok, Szabolcs | 10, 15, 15, 19, 14, 27 | 0.64, 0.70, 0.56, 0.54, 0.73, 0.67 | ? | Two centers, few firms |
| Processed food | Bács-Kiskun, Csongrád, Békés, Szabolcs | 262, 135, 141, 201 | 0.78, 0.85, 0.79, 0.79 | Yes | Two centers |
| Building fixtures, equipment, and services | Veszprém, Komárom, Nógrád | 238, 319, 119 | 0.82, 0.76, 0.68 | Yes | One center |
| Furniture | Zala, Vas, Győr, Békés | 170, 124, 186, 117 | 0.71, 0.78, 0.81, 0.73 | Yes | Two centers |
| Metal manufacturing | Fejér, Nógrád | 179, 49 | 0.91, 0.75 | Yes | Two centers |
| Motor-driven products | Zala, Szolnok | 62, 63 | 0.80, 0.86 | Yes | Two centers |
| Biopharmaceuticals | Hajdu | 6 | 0.82 | ? | One center, few firms |
| Communications equipment | Nógrád, Heves, Szolnok | 18, 30, 36 | 0.79, 0.89, 0.89 | Yes | One center |
| Aerospace | Heves | 3 | 0.57 | ? | One center, few firms |
| Agricultural products | Veszprém, Baranya, Bács-Kiskun, Borsod | 61, 59, 141, 93 | 0.81, 0.73, 0.65, 0.76 | ? | Three centers, dispersed activities |
| Plastics | Bács-Kiskun, Borsod | 106, 74 | 0.78, 0.87 | Yes | Two centers |
| Analytical instruments | Pest | 87 | 0.77 | Yes | One center |
| Medical devices | Hajdu | 57 | 0.83 | Yes | One center |
| Publishing and printing | Komárom | 16 | 0.73 | ? | One center dispersed activities |
| Apparel | Vas, Békés, Hajdu | 40, 54, 115 | 0.76, 0.68, 0.89 | Yes | Two centers |
| Sporting, recreational, and children goods | Baranya, Nógrád | 17, 6 | 0.61, 0.75 | ? | One center, few firms |
| Information technology | Veszprém, Komárom, Baranya, Pest | 13, 25, 23, 127 | 0.77, 0.91, 0.94, 0.92 | ? | Quickly changing spatial location |
| Construction materials | Veszprém, Békés | 12, 10 | 0.84, 0.63 | No | One center dispersed location |
| Chemical products | Vas, Borsod | 5, 18 | 0.70, 0.70 | No | One center dispersed location |
| Lighting and electrical equipment | Tolna | 6 | 0.62 | No | Dispersed location , few firms |

Source: Author's calculations

column; too wide spatial dispersion and too few companies present were the usual objections.

Fifteen concentrations were found to be strong enough to form clusters. In many cases, cluster organizations work already in these centers. In another 14 cases, we put a question mark indicating that either strong concentration was not supported by sufficiently high number of potential cooperating firms, or because the relatively strong counties were not in each others close neighborhood, that would have limited frequent personal contacts of cluster members, which would be also an important aspect of successful cluster operations. In a few cases, we found that the original traded cluster categorization was not perfectly suitable for the Hungarian economy. For example, in the case of the branch "agricultural products," Porter's original category included not only all types of farm products, including the crops and animal products, but also equipment repair and other services. This is highly relevant for large and complex American farms but does not really apply for much smaller, more specialized Hungarian producers. In this case, another categorization could have reflected more precisely those activities along which Hungarian agricultural producers could potentially cooperate.

Summing up the lessons of our cluster mapping exercise, we can draw some important conclusions. It is necessary to highlight that most spatial concentrations (potential clusters) are located in areas where there similar industrial activity had been carried out before the transition. This means that despite of the tremendous structural changes of the two decades of transition, some basic characteristics of spatial and activity structure of the Hungarian economy remained in place. This is an important evidence that supports an important aspect of the cluster-related literature, namely, that there is strong path dependency in economic development. Path dependency also means, however, that cluster policies can and should not be treated as means of a new "capitalist industrialization." The main aim of clustering is to further develop traditional regional strength in order to gain regional competitiveness. We do not want to deny the possibility of creating new structures on the long run. Actually, in the case of automotive industry and ICT production, development in Hungary by far exceeded previous levels. In these cases, existing capacities and expertise played relatively little role. However, these cases seem to be more the exception than the rule.

Another interesting result of the survey follows from the previous argument. We found ample evidence on the existence of activity concentrations in branches and regions which have strong FIE influence, like the automotive and ICT sectors. There is much empirical evidence that shows the impact of important supplier networks.[14] Strengthening the clustering process in such vertically integrated networks would require support for horizontal linkages among cluster members. However, we also found branches where FIE involvement was much weaker.

[14] For car industry and the role of PANAC, and the Hungarian automotive cluster, see Grosz (2006).

We can conclude, therefore, that cluster development in such regions and branches where there is no FIE dominance is also possible. But the structure and functions of these clusters may be very much different. They have stronger horizontal cooperation and are less vertical. Also, the power relations are different in such clusters.[15] In this second type of clusters, the main activity is rather small business and regional development. This variation of cluster types calls for more refined and not uniform solutions in cluster development policy.

## 3.6 Conclusions

The concept of industrial clusters is different, most importantly broader than that of multinational firms' supplier networks. The latter can form the nucleus of a potential cluster, but this is the case only if certain conditions, most importantly horizontal linkages as well as a heterogeneous structure of collaborating actors, are provided.

The spatial concentration of supplier networks around multinational companies is reflected in the cluster mapping exercise. Therefore, one of the most important precondition of forming a cluster, achieving the critical mass, is usually given in the vicinity of the largest investments. Foreign firms however are neutral at best concerning the organization of networks among suppliers. Their primary interest is organizing the supplies chain's smooth cooperation.

Foreign companies can be made interested in contributing to the work carried out within clusters. Their primary interests in cluster activity is improving regional labor force supply, enhancing suppliers' technical capabilities. They are of course also interested in fiscal incentives. The cluster literature lays great emphasis on big firms' essential role in successful cluster operations.

Clusters may evolve, however, without the participation of foreign multinationals. In certain industries and markets, SMEs enjoy substantial advantages, and big firms are not strong. Clusters are not reserved for technology-intensive manufacturing activities (where multinationals are strong). Cluster organizations may be valuable drivers of regional economic development which is based on more traditional activities. An important aspect of such clusters is path dependency: traditional local competitive advantages are at their bottom.

Despite of the role of path dependency, structural changes that the new techno-economic paradigm carries provide opportunities for emerging market economies to take new roles in international labor division. This relates mainly to most globalized industries and services, where global sourcing has produced massive relocations in the recent past.

[15] For evidence and case studies, see Szanyi (2008a, b).

Nevertheless, neither multinational firms' penetration in emerging market economies nor cluster development can/must be treated as a tool of "capitalist industrialization." Development (industrial) policy shall continue focusing on improving economic conditions and the sources of future growth and prosperity.

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# Chapter 4
# Regional Clustering Tendencies of the Hungarian Automotive and ICT Industries in the First Half of the 2000s

**Balázs Lengyel**

## 4.1 Introduction and Overview

In Porters' definition, a regional cluster is a territorial concentration of competing and co-operating companies in certain industrial sectors. In this sense, a cluster is more than the value chain of producing activities; supporting financial institutions, business, infrastructural, and university services, and enterprise associations also belong to them (Porter 1990). The measurement and mapping of regional clusters draws first of all on indicators of regional specialization and concentration of industries (Brenner 2004). In this chapter, we intend to draw up the regional clustering tendencies in Hungary in the field of automotive and ICT sectors. Though qualitative methods are also essential to map regional clusters (Carter 2007), we focus solely on regional concentration and analyse concentration patterns of these industries over the first half of the decade.

Greenfield investments by large multinational companies were realized after the change of the regime both in the automotive and in telecommunication and computer industries. On the one hand, Audi, Suzuki, Opel, etc., as well as, on the other hand, Ericsson, Nokia, Siemens, IBM, and the like, decided to relocate their production sites to Hungary due to the relatively cheap and well-educated labour force. After a climatization period, these companies started to relocate their R&D functions to these Hungarian sites (Lengyel and Cadil 2009). In the period 1995–2003, the growth of shares in business R&D spending by foreign affiliates was among the highest in Hungary (UNCTAD 2005, p. 127), with the share of foreign affiliates in business R&D being around 80% (EC 2005).

As a consequence, foreign-owned companies play a crucial role in cluster formation; however, their regional networks are bound by the dictates of their corresponding headquarters. One can hardly find Hungarian firms in their suppliers (Grosz 2006). Still, we expect an effect on the local economy through the mobility of labour. For example, although IBM relocated its site from Fejér county to China, according to the leader of the Association for ICT Companies, the ICT industry still seems to be strong in that region. This might be because software engineers could

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establish SMEs and find the market niche after the big company had left. Audi has also likely had this effect on the local automotive industry, as during its long presence plenty of experts left the company and now work for other firms in the same industry and region.

Theoretically speaking, regional clusters emerge in agglomeration economies where positive externalities occur between companies. As Marshall (1920) recognized, these externalities consist of thick markets for specialized labour, the occurrence of knowledge and technology spillover among companies, and the emergence of subsidiary trades. In this view, externalities occur among companies from the same industry because specialized labour and knowledge flow need similar technological and cultural backgrounds. On the other hand, urban agglomerations provide the possibility for inter-industrial knowledge spillover effects as well through the dense social networks and the diverse economy in big cities (Jacobs 1969). Thus, the externality effects of localization agglomeration economies and urbanization agglomeration economies are distinguished in the literature. Localization externalities originate in local specialization of industries, as was reported many times in Third Italy (Antonelli 1994), in Silicon Valley and Route 128 (Saxenian 1994), and in the UK (Oxford and Cambridge, particularly) (Miller 2001). Meanwhile, urbanization externalities originate much more in the diversity of economic activity and labour division in spatial concentrations as seen in metropolitan areas (Florida 2002).

Clustering tendencies are often viewed from a life-cycle perspective, in which the emergence and decline of regional clusters generally last for decades. The archetype of clusterization process (EC 2002) follows six phases: (1) pioneer enterprises, (2) evolution of cluster-specific environment and attraction of special suppliers and service providers, (3) new organization for cluster services, (4) attraction of new entrants and specially educated labour, (5) non-market relations with local institutions and NGO’s facilitating knowledge flow in the local society, and (6) stagnation or decline of key enterprises. The cluster life cycle mainly depends on the life cycle of the key products and technologies; thus, external market conditions are decisive for them.

Previous research on regional clusters showed that north-western Hungary stands out as a leading area in automotive industry concentration (Grosz 2006). However, the clustering of automotive industry is still in its initial phase because the headquarters of the key German, Japanese, and US companies make it very difficult for domestic firms to enter their global supplier and R&D networks. It was also pointed out that telecommunication and computer equipment manufacturing spread on a larger scale over the country with the exception of Budapest agglomeration (Szanyi 2008). Another analysis on Hungarian regional innovation systems showed that high-tech and medium-tech industries are led by foreign-owned companies in Hungary and that location matters in those manufacturing sectors (Lengyel and Leydesdorff 2011). On the other hand, knowledge-intensive services do not need physical proximity, as these services can be provided from a bigger distance as well. Clustering, in the first case, builds on supply chains, while the ICT services counteract on the concentration trends of the ICT manufacturing.

Consequently, the automotive industry is more likely to form regional clusters in areas with localization externalities than the ICT industry. Urbanization externalities might lead to the concentration of ICT in big city regions; clustering thus happens faster than in other regions and other industries in Hungary. As such, large multinational companies (Nokia-Siemens Networks, Ericsson) have located their R&D sites to Budapest.

In this chapter, we give an introduction to the regional clustering tendencies within the Hungarian automotive and ICT sectors. We show the regional concentration patterns of these two sectors using various measures (number of firms, number of employees, value added, export) and also calculate the regional location quotient (LQ) in order to select those regions within which clustering might happen. Furthermore, we analyse these locations over the first half of the decade and show the ownership structure for every region in the beginning and end of the given period.

## 4.2 Data and Method

We have access to a unique database based on the dataset of the Hungarian Tax Office. Company level data are available for the 2000–2005 period in terms of company balance. In our set, companies are categorized into industrial sectors by four-digit NACE codes and into LAN 1 regions. Thus, our data enable us to show the regional concentration patterns of the automotive and ICT industries and to analyse them over the first half of the decade.

Regional industrial clusters contain interconnected industries, supporting institutions, local demand and supply, and competitors (Porter 1990). Thus, NACE codes and sectors defined by statistical data collections need to be revised. We follow—while slightly altering, however—a widely accepted perspective to define the industrial clusters (Ketels and Sölvell 2005; Szanyi 2008). Our automotive cluster contains manufacturing activities of all the equipment and components for all kinds of transport vehicles. The ICT cluster includes the manufacturing and service sides of all communication fields (Table 4.1).

The first step in mapping regional clusters of a given industry is to count the regional concentration and agglomeration patterns of it. Regional concentration arises if the industry has a high share in the region. Agglomeration is something more, as it informs us about inter-regional patterns and comes into being when certain industries are "concentrated" in neighbouring statistical regions. In this chapter, we only focus on concentration patterns and trends of the above outlined clusters in the Hungarian LAN 1 regions and do not operationalize agglomeration patterns.

Hungary as a whole is considered a NUTS 1 unit according to the Eurostat classification. There are seven regions (NUTS 2), 19 counties (NUTS 3), and 174 subregions (LAN 1) in Hungary. However, the number of subregions is changing due to the reforms in territorial development, and in the time frame of our analysis, there were only 168 subregions. As such, our data reflect the 168 subregions.

**Table 4.1** Industrial sectors in automotive and ICT clusters

| Cluster | NACE code | Industrial sectors |
|---|---|---|
| Automotive | 2511 | Manufacture of rubber tyres and tubes |
| | 2512 | Retreading and rebuilding of rubber tyres |
| | 3161 | Manufacture of electrical equipment for engines and vehicles n.e.c. |
| | 3410 | Manufacture of motor vehicles |
| | 3420 | Manufacture of bodies for motor vehicles, manufacture of trailers and semi-trailers |
| | 3430 | Manufacture of parts and accessories for motor vehicles and their engines |
| | 3541 | Manufacture of motorcycles |
| | 3550 | Manufacture of other transport equipment n.e.c. |
| ICT | 3001 | Manufacture of office machinery |
| | 3002 | Manufacture of computers and other information processing equipment |
| | 3130 | Manufacture of insulated wire and cable |
| | 3162 | Manufacture of other electrical equipment n.e.c. |
| | 3210 | Manufacture of electronic valves and tubes and other electronic components |
| | 3220 | Manufacture of television/radio transmitters, apparatus for line telephony/telegraphy |
| | 3230 | Manufacture of television/radio receivers, sound/video recording/ reproducing apparatus, and associated goods |
| | 6411 | National post activities |
| | 6412 | Courier activities other than national post activities |
| | 6420 | Telecommunications |
| | 7133 | Renting of office machinery and equipment, including computers |
| | 7221 | Publishing of software |

Source: Self-edited

Budapest is the only metropolitan district in Hungary and must therefore be considered a special category in regional surveys; data from Budapest are generally collected at the NUTS 3 level.

One of the most accepted indicators of regional concentration, and surely the most simple, is the location quotient (LQ) measure. It compares the share of the industry in the region to the share of the industry in the country with the following formula: $\mathrm{LQ}_{ij} = \frac{e_{ij}/E_i}{e_j/E}$, where

$e_{ij}$ is the number of employees in industry $i$ of region $j$,

$e_j$ is the number of employees in all industries of region $j$,

$E_i$ is the number of employees in industry $i$ in the country,

$E$ is the number of employees in all industries in the country.

The value of LQ informs us about the relationship between the share of industry in the region and the share of industry in the country. If the regional LQ value is higher than 1, the share of industry is higher in the region than in the country average. Thus, the first step one has to take in mapping regional clusters is to count the LQ values and exclude all the regions where LQ is lower than 1.

In the following sections, we will show country-level data for the automotive and ICT industries for the period 2000–2005. The general overview will be followed by the regional analyses. These sections will present regional data (number of firms, number of employees, value added, net export income) with the help of maps. After that, we select the subregions where the LQ of automotive or ICT industries is higher than 1 and show how the major measures of companies changed over the first half of the decade. The analysis will be summarized by showing the regional features of stock structure and long-term asset accumulation within these clusters.

## 4.3 Trends of Hungarian Automotive and ICT Industries in the First Half of the 2000s

Many different sectors are included in our automotive ICT clusters that are not necessarily connected in other statistical typologies. For example, our ICT cluster definition contains national postal activities as well that relate to ICT only in the broad sense of the term but present competitors for telecommunication services. Thus, postal activities and employees are part of regional ICT clusters and must be included in regional concentration analyses. However, the presence of national postal activities limits the following country-level demonstration that is rather an introduction to the regional sections and not a sectoral analysis.

### *4.3.1 Automotive Industry*

The number of firms in automotive industry grew slightly from 421 to 456 (8% growth) between 2000 and 2005 with a solid yearly fluctuation. Labour growth was much faster, increasing by 26%, from 40,198 to 50,848, and showing similar yearly fluctuation. Thus, the average company size in terms of number of employees rose from 95 to 112, a rather large change (Table 4.2).

Gross labour costs, including wages and related taxes, more than doubled in the automotive industry in this period. This means that an average company booked €779,000 in year 2000 as personnel costs, which rose to €1,550,000 by 2005. The annual cost of an average employee was €8,156 in the beginning and €13,900 in the middle of the decade. The main reason why labour costs jumped is due to a raise of labour-related taxes; total taxes paid increased by 177%. During this time, the performance of companies improved significantly but undeniably more moderately than labour costs increased. The gross value added increased by 15% in the sector, and the average value added per company rose from €2,975,000 to €3,154,000. However, this represented a fall from €31,000 to €28,000 per employee in the period. Long-term assets accumulation also showed a monotonic and fast rate of growth, specifically 88%.

Turnover increased by 55%, in which net export plays a decisive but slightly weakening role; export turnover rose by 50%. From another perspective, export sales produced 92% of turnover in year 2000 and 89% of turnover in year 2005. Automotive companies booked 9% of their net revenues as net result in 2000, which decreased to 7% by 2005. Total tax reduction fell from 115,471 to 9,441 over the course of the period under consideration.

The issued capital registered in automotive companies showed a big jump in the beginning of the period, probably due to the large number of market entries, growing moderately however after that. The average stock per companies was €1,245,000 in 2000 and €1,987,000 in 2005. The change in the structure of the company stock shows a growing role of foreign interest in automotive industry. State and municipal stock grew in absolute terms, but this type of ownership was marginal throughout the period. Stock owned by domestic individuals and companies decreased monotonically even in absolute terms by 40%, its share in total stock decreasing from 27% to 9% in the first half of the decade. Foreign-owned stock rose by 117% and determined the sector with its 90% share in 2005.

### *4.3.2 ICT Industry*

Surprisingly, the number of firms (at 5%) and number of employees (at 12%) had declined in the ICT sector in the first half of the decade. The average company size was 532 in year 2000, which fell to 494 by 2005. One has to consider the effect the National Post Office (NPO) on these figures, as it had 44,500 employees in the beginning and 32,182 in the end of the period. Taking out the NPO from the sector, it turns out that the size of remaining companies even rose slightly from 362 to 366.

Labour costs grew by 60%, while the number of employees decreased; average worker costs were €7,325 in 2000 and €13,327 in 2005. This growth, similar within the automotive industry, is highly connected to the growth of personnel-related tax; the total tax to pay increased by 48%, while the value added increased only by 1.3 %. The value added per employee was €19,224 in 2000, growing to €22,028 by 2005. Long-term assets showed a monotonic 33% growth rate, which is much slower than we experienced in the automotive cluster. Turnover increased by 64%, while export increased by 80%. In other words, exports represented 53% of turnover in 2000 and 58% in 2005 for the whole cluster (Table 4.2).

The ownership structure shows huge annual fluctuation among the three main categories. The total stock registered in the industry showed a more or less stable growth rate of 15% in the period. Foreign-owned stock is decisive in the cluster but to a much weaker degree than in the automotive cluster, and stock grows linearly in none of the ownership categories. State-owned stock jumped from €89,109,000 (2000) to €233,912,000 (2002) in the first half of the period, then it again fell to €59,294,000 (2005), remaining only on the margins of ownership: 5% in 2000, 13% in 2002, and 3% in 2005. In addition to this, the National Post Office is only solely by the state, and its registered stock is around €54,000,000. Domestic stock grew in

**Table 4.2** Country-level data of the Hungarian automotive and ICT industry, 2000–2005 (1,000 Euros)

| | Year | Number of firms | Number of employees | Labour costs | Value added | Long-term assets | Net result | Turnover | Export turnover |
|---|---|---|---|---|---|---|---|---|---|
| Automotive | 2000 | 421 | 40,198 | 327,872 | 1,252,543 | 1,522,468 | 611,123 | 6,829,363 | 6,258,410 |
| | 2001* | 269 | 51,977 | 474,535 | 1,094,813 | 1,676,530 | 272,225 | 7,409,181 | 6,661,599 |
| | 2002 | 461 | 48,032 | 528,679 | 1,087,490 | 1,741,092 | 4,855,078 | 7,500,123 | 6,808,475 |
| | 2003 | 449 | 51,376 | 603,306 | 1,277,023 | 2,046,205 | 656,412 | 8,745,104 | 7,891,346 |
| | 2004 | 462 | 51,203 | 645,572 | 1,214,814 | 2,391,316 | 656,460 | 9,054,281 | 8,170,176 |
| | 2005 | 456 | 50,848 | 706,810 | 1,438,133 | 2,864,616 | 782,639 | 10,618,125 | 9,409,276 |
| ICT | 2000 | 260 | 138,542 | 1,014,800 | 2,663,312 | 4,857,623 | 506,859 | 10,118,433 | 5,363,178 |
| | 2001* | 257 | 131,346 | 1,239,877 | 1,797,648 | 4,313,984 | 619,121 | 12,695,049 | 7,792,665 |
| | 2002 | 243 | 125,399 | 1,349,383 | 2,107,101 | 5,592,912 | 374,159 | 12,595,479 | 6,940,341 |
| | 2003 | 254 | 128,572 | 1,498,569 | 2,406,104 | 5,932,263 | 1,228,839 | 13,565,192 | 7,409,513 |
| | 2004 | 252 | 129,371 | 1,573,482 | 2,520,462 | 6,049,536 | 954,687 | 14,570,506 | 7,670,958 |
| | 2005 | 248 | 122,531 | 1,633,038 | 2,699,022 | 6,503,372 | 1,288,117 | 16,596,401 | 9,681,528 |

| | Year | Tax to pay | Total tax reduction | Total stock | State and municipal stock | % | Domestic stock | % | Foreign-owned stock | % |
|---|---|---|---|---|---|---|---|---|---|---|
| Automotive | 2000 | 17,711 | 115,471 | 523,986 | 1,758 | 0.3 | 140,924 | 26.9 | 374,324 | 71.4 |
| | 2001* | 22,225 | 91,014 | 933,714 | 1,782 | 0.2 | 118,687 | 12.7 | 809,900 | 86.7 |
| | 2002 | 21,039 | 82,479 | 820,205 | 5,437 | 0.7 | 92,176 | 11.2 | 722,164 | 88.0 |
| | 2003 | 52,943 | 82,354 | 869,998 | 5,203 | 0.6 | 89,049 | 10.2 | 775,513 | 89.1 |
| | 2004 | 41,860 | 9,642 | 856,271 | 3,429 | 0.4 | 92,312 | 10.8 | 759,902 | 88.7 |
| | 2005 | 49,183 | 9,441 | 906,211 | 3,518 | 0.4 | 85,105 | 9.4 | 815,366 | 90.0 |
| ICT | 2000 | 61,953 | 83,255 | 1,752,902 | 89,109 | 5.1 | 419,856 | 24.0 | 1,202,723 | 68.6 |
| | 2001* | 56,523 | 55,655 | 1,252,307 | 88,079 | 7.0 | 276,665 | 22.1 | 872,693 | 69.7 |
| | 2002 | 90,656 | 50,785 | 1,749,924 | 233,912 | 13.4 | 378,000 | 21.6 | 1,117,580 | 63.9 |
| | 2003 | 131,201 | 46,671 | 1,881,720 | 218,522 | 11.6 | 472,417 | 25.1 | 1,186,632 | 63.1 |
| | 2004 | 83,086 | 34,544 | 1,783,834 | 85,885 | 4.8 | 452,003 | 25.3 | 1,214,235 | 68.1 |
| | 2005 | 91,436 | 54,422 | 2,013,119 | 59,294 | 2.9 | 379,190 | 18.8 | 1,552,976 | 77.1 |

Source: Self-edited on the basis of Tax Office data

Note: For unknown reasons, the number of firms is significantly lower in the whole dataset in years signed with * the middle of the period after a slight decrease in the beginning and fell again in year 2005, numbering 19–25% of the total stock. Foreign-owned stock presents the highest share with a 29% growth throughout the period, reaching 77% of total stock in 2005.

Some major features of structural change have to be underlined. Foreign-owned firms are decisive in automotive and ICT clusters. The share of this type of ownership in total issued capital covers 90% in the automotive and 77% in ICT clusters, and this also rose in absolute terms over the period. Total tax paid by the companies rose quickly as well, and total tax reduction fell in both clusters. Labour unit costs grew much more rapidly than value added per employee. These points might lead us to a conclusion that cost-efficiency became less significant for firms in both automotive and ICT clusters.

## 4.4 Regional Clusters in the Automotive Industry

In this section, we give a brief overview of the regional distribution of the main indicators of automotive clusters: number of firms, number of employees, value added, and export turnover. Then, clustering tendencies in the first half of the decade will be introduced in selected regions. Regional features of ownership structure will be discussed in the end of the chapter.

The regional distribution of key indicators of automotive clusters is illustrated by ranges in the map of Hungary (Fig. 4.1). In the case of each indicator, one outstanding region composes a separate category on the maps presented in this chapter. Budapest stands out in terms of number of firms: 96 companies were registered in the capital within the automotive cluster. This is followed by a range of 16–20 companies in the regions Győr (location of Audi) and Kecskemét (location of Knorr-Bremse) as well as the Ráckeve region with the Budapest agglomeration. More than ten companies were located in the regions of Székesfehérvár (Ford car components) and Szeged. In all other indicators, Győr is the outstanding region with much higher values than the other regions; the seats of foreign-owned companies are probably in Budapest, while their production sites are in other regions.

Győr is followed by six locations within which the number of employees is between 2,000 and 3,000: Budapest, Székesfehérvár, Mosonmagyaróvár (components for rail vehicles), Esztergom (location of Suzuki), Nyíregyháza, Veszprém (location of Continental Teves). Veszprém is a traditional region for the chemical industry, with specialized university education. Value added is three times higher in Győr than in Esztergom and Szombathely (location of LUK). Export value was highly connected to Audi, which made the value in Győr more than four times higher than the Szombathely and Szentgotthárd (location of Opel) regions. Knorr-Bremse export activity also put Kecskemét on the map.

When selecting regions to show automotive clustering tendencies for the first half of the decade, we calculated location quotient (LQ) of the number of

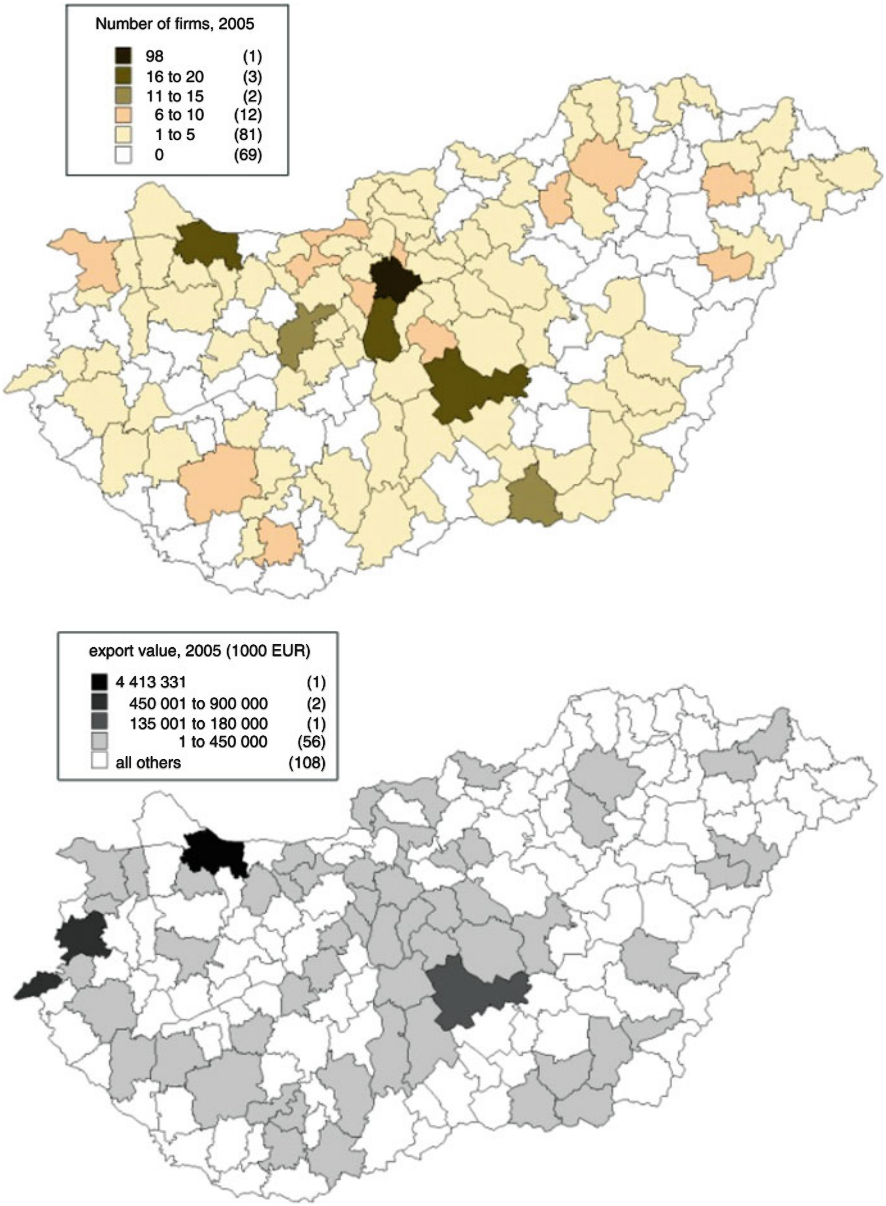


**Fig. 4.1** (continued)

employees for all regions and each year from 2000 to 2005. This measure shows how the share of industry in a region relates to the share of industry in the country. If the value of LQ is higher than 1, the industry concentration is higher in the region than in the country average. As a first step, we removed regions for which the LQ

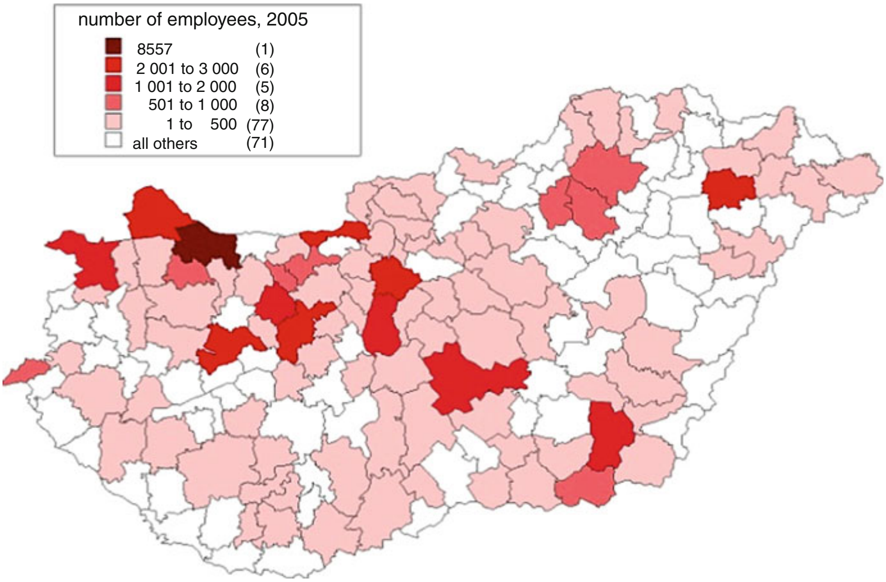


**Fig. 4.1** Regional distribution of key figures of the Hungarian automotive cluster, 2005

was lower than 1 in 2000 and 2005. As a second step, we sorted out regions within which the LQ did not reach 1 in at least two other years in the period. Finally, we left out regions where number of companies did not reach 3 in all of the years presented,[1] and the regional automotive clusters can be found in Table 4.3.

Only Budapest and Szentgotthárd were sorted out of the regions that were presented as outstanding ones in Fig. 4.1. The LQ of automotive cluster was lower than 1 in Budapest. Consequently, the automotive cluster hardly has a concentration force within the city. As a matter of fact, one can expect that an urbanization effect occurs in the capital, with a higher probability for services to concentrate. Only two companies were present in Szentgotthárd through the whole period, which cannot be interpreted as a clustering tendency, however high the export activity of of Opel was in that region. We sorted the 16 regions in terms of change in the number of companies and configured groups of high growth (+3-6 companies), moderate growth (+1-2 companies), stagnating, and moderate fall (-1-2 companies).

Regions where automotive clustering showed a *high growth* are Győr, Komló, Mór, and Tatabánya. Clustering occurs in these regions that are attractive enough for new companies to enter.

- *Győr* region is the emergent area of automotive clustering, being the location of Audi and the base of PANAC Automotive Cluster Organization. Five new

[1] The Hungarian Statistical Act allows data publication only if a minimum of three companies exist in certain industries and regions.

**Table 4.3** Trends of Hungarian automotive cluster in selected regions (1,000 Euros)

| Subregion | *n* | Employees | Labour costs | Value added | Export | Long-term asset |
|---|---|---|---|---|---|---|
| 2000 | | | | | | |
| Eger | 7 | 1,904 | 14,597 | 24,614 | 135,748 | 20,634 |
| Esztergom | 8 | 1,688 | 14,206 | 15,499 | 325,558 | 96,817 |
| Godollo | 5* | 3,760 | 26,079 | 61,531 | 176,807 | 30,585 |
| Gyor | 14 | 8,685 | 90,934 | 540,327 | 3,600,138 | 750,392 |
| Kalocsa | 3 | 186 | 906 | 1,267 | 342 | 501 |
| Kecskemet | 16 | 1,142 | 8,933 | 16,937 | 50,901 | 13,744 |
| Komlo | 5 | 343 | 1,942 | 3,200 | 3,875 | 1,791 |
| Mor | 4 | 2,635 | 19,854 | 49,149 | 175,238 | 26,869 |
| Mosonmagyarovar | 6 | 1,188 | 8,016 | 40,684 | 145,032 | 15,446 |
| Nyiregyhaza | 7 | 1,210 | 11,364 | 24,660 | 83,971 | 34,342 |
| Rackeve | 17 | 681 | 4,475 | 13,049 | 27,838 | 15,675 |
| Sopron-Fertod | 5 | 873 | 5,468 | 11,350 | 16,093 | 9,473 |
| Szekesfehervar | 14 | 3,626 | 30,229 | 102,824 | 307,729 | 154,926 |
| Szombathely | 5 | 3,162 | 21,292 | 67,899 | 348,320 | 54,219 |
| Tatabanya | 3* | 685 | 4,162 | 5,846 | 37,975 | 43,401 |
| Veszprem | 6 | 2,194 | 15,518 | 43,215 | 106,179 | 52,698 |
| 2002 | | | | | | |
| Eger | 9 | 1,908 | 19,335 | 27,370 | 162,994 | 25,378 |
| Esztergom | 8 | 1,705 | 20,748 | 55,379 | 351,538 | 88,980 |
| Godollo | 5 | 4,946 | 47,255 | 90,110 | 335,185 | 134,918 |
| Gyor | 17 | 8,441 | 127,786 | 443,890 | 3,552,182 | 600,671 |
| Kalocsa | 4 | 169 | 1,115 | 1,233 | 211 | 522 |
| Kecskemet | 18 | 1,235 | 14,019 | 20,632 | 81,856 | 17,117 |
| Komlo | 7 | 497 | 3,756 | 4,659 | 6,245 | 3,221 |
| Mor | 3 | 1,694 | 17,288 | 45,355 | 217,412 | 21,763 |
| Mosonmagyarovar | 7 | 1,652 | 15,816 | 31,846 | 166,832 | 26,369 |
| Nyiregyhaza | 7 | 2,233 | 31,002 | 28,156 | 163,874 | 41,926 |
| Rackeve | 16 | 787 | 6,645 | 14,463 | 33,384 | 17,113 |
| Sopron-Fertod | 6 | 1,166 | 10,372 | 12,135 | 21,528 | 11,798 |
| Szekesfehervar | 14 | 3,315 | 34,411 | 50,696 | 263,952 | 103,605 |
| Szombathely | 5 | 3,333 | 33,300 | 76,257 | 343,933 | 60,354 |
| Tatabanya | 4** | 869 | 8,754 | 15,145 | 86,696 | 43,196 |
| Veszprem | 5 | 2,241 | 22,407 | 39,124 | 133,739 | 55,446 |
| 2005 | | | | | | |
| Eger | 6 | 819 | 14,018 | 16,209 | 180,056 | 39,517 |
| Esztergom | 9 | 2,905 | 44,102 | 126,514 | 921,632 | 276,556 |
| Godollo | 4 | 4,533 | 56,869 | 58,616 | 365,663 | 256,514 |
| Gyor | 19 | 8,557 | 159,856 | 456,729 | 4,413,332 | 1,289,196 |
| Kalocsa | 4 | 195 | 1,666 | 1,822 | 334 | 1,900 |
| Kecskemet | 17 | 1,334 | 21,854 | 33,382 | 144,027 | 24,544 |
| Komlo | 10 | 397 | 3,671 | 4,226 | 5,728 | 4,177 |
| Mor | 10 | 1,729 | 20,655 | 45,507 | 230,749 | 34,973 |
| Mosonmagyarovar | 4 | 2,093 | 27,609 | 37,366 | 288,608 | 37,716 |
| Nyiregyhaza | 9 | 2,132 | 45,353 | 81,232 | 257,087 | 45,645 |
| Rackeve | 18 | 1,080 | 12,044 | 26,390 | 54,599 | 25,496 |

(continued)

**Table 4.3** (continued)

| Subregion | *n* | Employees | Labour costs | Value added | Export | Long-term asset |
|---|---|---|---|---|---|---|
| Sopron-Fertod | 6 | 1,425 | 14,166 | 15,370 | 23,915 | 14,696 |
| Szekesfehervar | 12 | 2,282 | 29,663 | 34,402 | 231,775 | 70,277 |
| Szombathely | 5 | 3,238 | 41,303 | 149,071 | 521,292 | 70,967 |
| Tatabanya | 8 | 824 | 11,773 | 25,832 | 98,654 | 34,583 |
| Veszprem | 4 | 2,614 | 33,560 | 100,729 | 350,430 | 78,237 |

Source: Self-edited, based on Tax Office data
Note: Data available in year 1999 signed with *; in year 2001 signed with **; in year 2003 signed with ***

companies entered the region in the first half of the decade; export turnover and long-term asset accumulation also showed a positive shift. However, other indicators presented had fallen. The number of employees decreased, and value added also went down. The latter is really interesting because labour costs almost doubled, and this contributes to value-added creation. A similar tendency can be found in *Mór*, albeit to a lower degree. The number of companies and export climbed, long-term asset accumulation continued unabated, but the number of employees decreased sharply, and value added also fell.

- *Komló* experienced fast growth in terms of number of firms, but the five entrants provided only 50 new jobs throughout the period. A similar trend occurred in *Tatabánya*, where five new companies established 140 jobs. However, firms in Komló are hardly expected to join cluster organizations, as the physical proximity of Tatabánya to other automotive locations provides fields for localization economies.

Regions with *moderate growth* are Esztergom, Kalocsa, Kecskemét, Nyíregyháza, Ráckeve, and Sopron-Fertőd. These regions are probably less attractive to enter, but localization externalities still exist.

- *Esztergom* region is the settlement for Suzuki where only one company entered, but the number of employees grew by 1,200, as value added likewise climbed by 716% and became the third in this sense in the country. *Nyíregyháza* and *Sopron-Fertőd* followed similar concentration patterns but lower levels of value added and growth in export.
- *Kecskemét* and *Ráckeve* regions have a high number of companies but a low number of employees, and the entrance of one firm made the number of employees increase by 100 in Kecskemét and by 400 in Ráckeve. Knorr-Bremse might perform well in value added and export, which pulled the indicators of the region up; this did not happen in Ráckeve.
- *Kalocsa* is in the inner periphery, where 3–4 automotive companies and 186–195 employees were successful at producing an LQ larger than 1.

The only region within which the number of firms *stagnated* was *Szombathely*, where five located firms increased the number of employees moderately. However, this region did not attract new companies to the cluster; these companies raised their value added and export to levels which are among the highest within the country.

The number of firms saw a *moderate fall* in five regions: Eger, Gödöllő, Mosonmagyaróvár, Székesfehérvár, and Veszprém.

- The fall in the number of firms happened together with the sharp fall in the number of employees in the *Eger* and *Székesfehérvár* regions. Companies were relocated or might have fallen in Székesfehérvár since value added, export, and long-term assets also decreased. In Eger, there might still be successful companies that could raise their export.
- The decrease in the number of firms was accompanied by a moderate increase in labour volume in *Veszprém*, but this has almost doubled in *Gödöllő* and *Mosonmagyaróvár* regions. Long-term asset accumulation occurred in all three regions, export volume also grew, but value added increased only in Veszprém. This latter region saw the fourth highest value added and export volumes.

One cannot find the wide variety that was visible in terms of concentration in automotive clusters in the picture of ownership structure (Fig. 4.2). A decisive share of capital registered in the automotive clusters is owned by foreign companies. This concentrates in Northern and Western Transdanubia and in regions like Esztergom, Győr, Szombathely, Székesfehérvár (ordered by size of hub), etc. The value of registered capital stands out from its surroundings in Eger and Nyíregyháza in the northeast. Hardly any dynamics can be found in regional distribution, and only one new region emerged as capital concentration—Bicske—which is part of the Budapest agglomeration and neighbours Esztergom to the south.

## 4.5 Regional Clusters in the ICT Industry

Similar to the previous chapter, we present here a brief overview of the regional distribution of main indicators in ICT clusters: number of firms, number of employees, value added, and export. Then, clustering tendencies in the first half of the decade will be introduced in selected regions, and regional features of ownership structure will be discussed in the end of the section.

The role of Budapest stands out clearly in every indicator in the ICT cluster; only Komárom (location of Nokia) and Székesfehérvár (former location of IBM) outperform it in export volume (Fig. 4.3). As national postal activities are included in our ICT cluster definition, one should be careful in analysing performance indicators; these might represent a large share of employment in regional centres.

In terms of number of firms, the capital is followed by regions of the Budapest agglomeration (Budaörs, Pilisvörösvár) and university centres like Debrecen, Miskolc, Pécs, Szeged, and Székesfehérvár. Regions with smaller universities, like Győr, Kecskemét, Nyíregyháza, and several subregions from the Budapest agglomeration, are in the third tier. The Komárom region (Nokia) has less than ten firms in the ICT cluster and does not show up on the first map in Fig. 4.3. The number of employees already shows a different picture, and one might notice that other locations jump to the second group like Budaörs, Hatvan, Komárom, Mór,

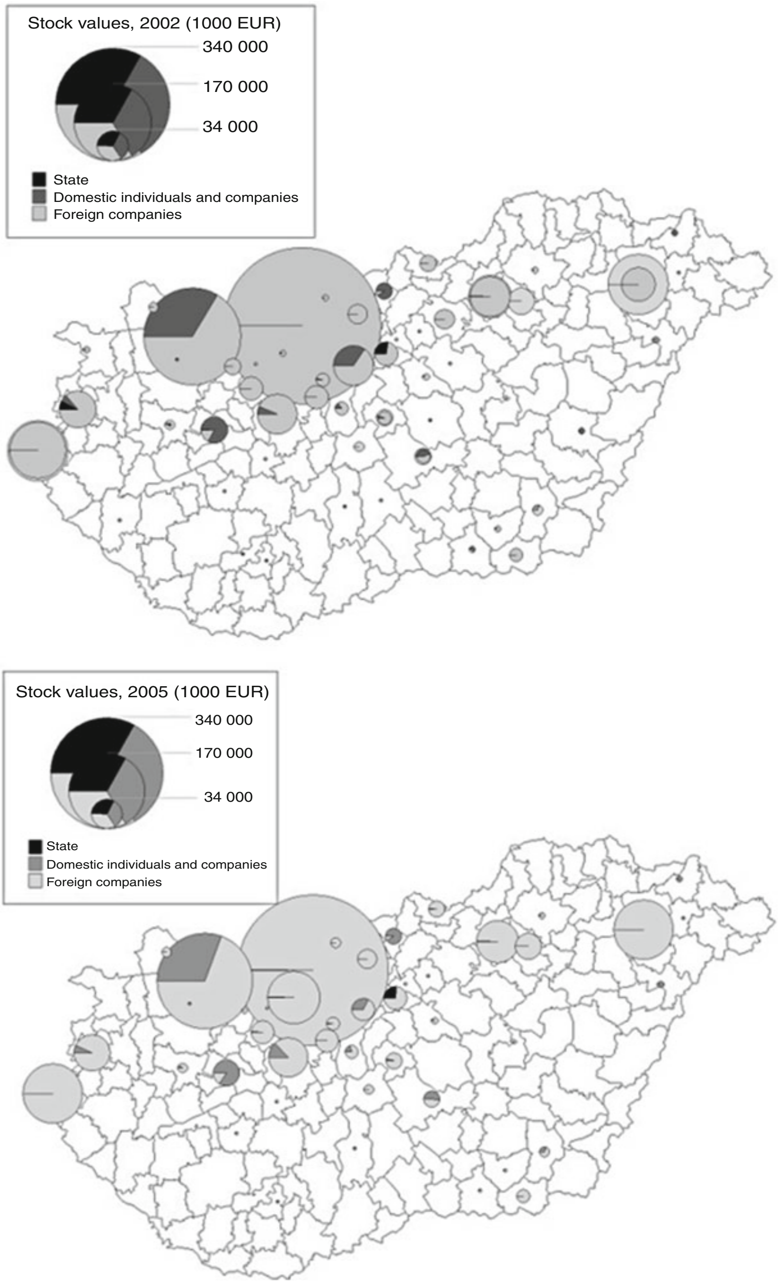


**Fig. 4.2** Values of registered capital by owner categories in the Hungarian regional automotive clusters, 2002 and 2005

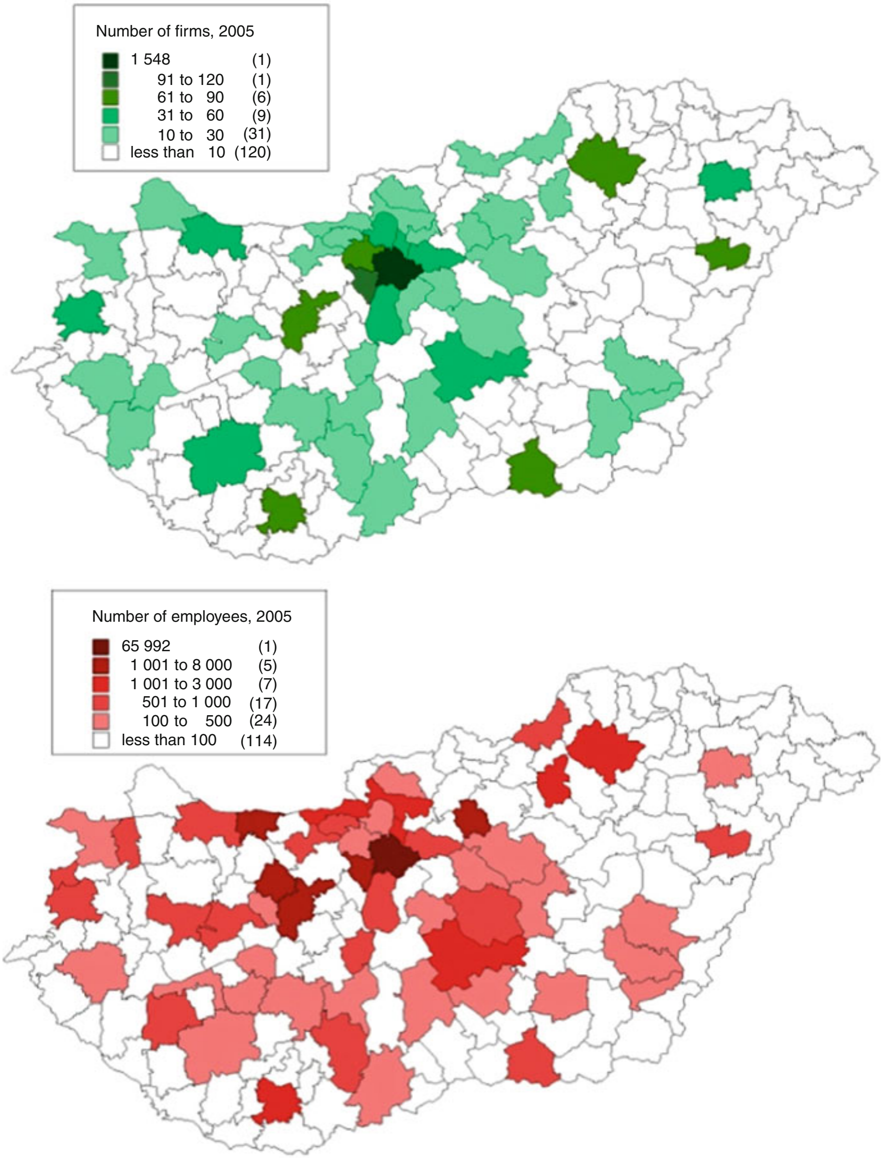


**Fig. 4.3** (continued)

and Székesfehérvár, where the size of labour exceeds 3,000 employees. These possible ICT clusters are followed by agglomeration and university regions in the third group: Dunakeszi, Eger, Esztergom, Kecskemét, Miskolc, Pécs, and Vác.

Regional distribution of value added shows a very similar picture to labour distribution. However, two regions stand out from the others, Budaörs and Komárom. The third group contains various types of regions, and it is therefore hard to distinguish between the effects of national post activities in value-added creation. As was

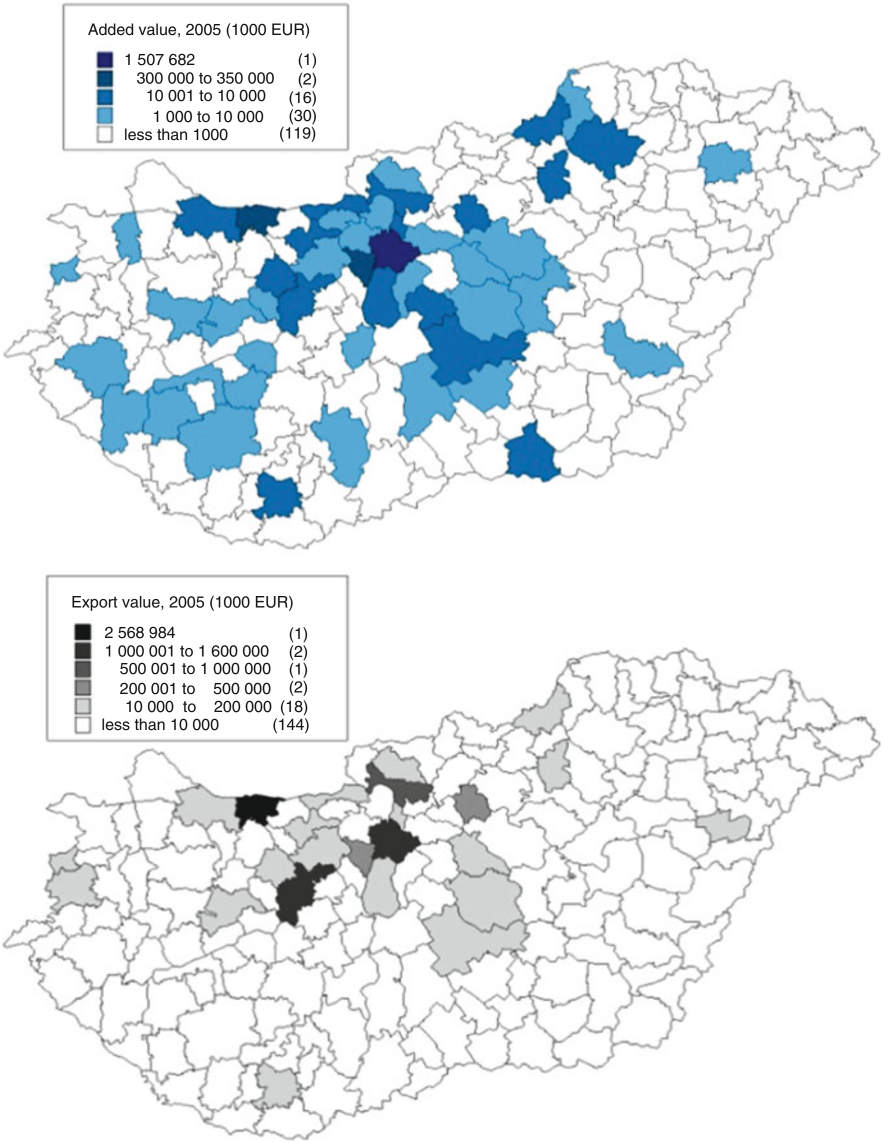


**Fig. 4.3** Regional distribution of key figures in Hungarian ICT industry, 2005

mentioned before, Komárom and Székesfehérvár regions outperform Budapest in terms of export. These three locations are followed by Vác, Hatvan, and Budaörs.

To show the clustering tendencies over time, we followed a similar process as in the case of the automotive cluster. We calculated the location quotient (LQ) for the number of employees for all regions and each year from 2000 to 2005. As a first step in selecting the regions, we eliminated regions within which the LQ was lower than 1 in 2000 and 2005. In the second step, we sorted out regions where the LQ did not reach 1 in at least two other years in the period. Interestingly, we found 2003 as a local maximum for most indicators in most of the regions. Lastly, we left out regions for which the number of companies did not reach 10 or the number of employees did not reach 500. Despite all of these steps, it is necessary to analyse some of the regions where the LQ was lower than 1 in 2000; these locations are present in Table 4.4.

The number of firms increased in almost all of the locations from 2000 to 2003; this number decreased again from 2003 to 2005 in all regions but one. An interesting case is Komárom, for which the number of firms decreased throughout the whole period while labour volume grew dynamically.

The listed regions present various and complex dynamics. As such, we decided to sort them by size and dynamics of labour between 2003 and 2005, giving us four groups: dynamic big, falling big, raising small, and stagnating small. We show how ICT clusters changed in absolute terms and how the indicators shifted relative to the size of labour.

The volume of labour in dynamic big ICT clusters has more than 1,000 employees per region and grew between 2003 and 2005. Three locations fulfilled these requirements: Budaörs, Hatvan, and Komárom. All of these were really small in the beginning of the period with a LQ lower than 1. In fact, ICT hardly even existed in Budaörs in 2000. Consequently, a significant amount of greenfield investment pulled up these locations.

- *Komárom* performs the best export values in absolute terms and per employee in 2005. Volume of export doubled, though export per employee fell by half in 2 years from 2003. Though the number of companies increased through the whole period, labour volume grew dynamically with a higher intensity than did value added and export activity.
- *Hatvan* showed a similar pattern, to a lower degree however; all indicators grew dynamically in absolute terms. Both value added and export level grew faster than the number of employees.
- *Budaörs* saw the slowest growth in ICT, as labour and the number of firms fell sharply there. However, value added and export grew rapidly.

Regions that represent large but decreasing size of ICT labour formulate the group of falling big clusters. These are Budapest, Esztergom, Pécs, Székesfehérvár, and Vác. The regions differ in many ways, but both the number of firms and employees decreased in all of them.

- *Budapest* is the biggest agglomeration of both ICT firms and labour. The number of firms fell by half from 2003 to 2005, and labour size also decreased by 12,000 (although a significant share of this fall is due to cuts in national postal activities). However, the decrease in value added was moderate, and a small growth in export and long-term assets occurred. Budapest produces the second largest amount of ICT export.

**Table 4.4** Trends of Hungarian ICT cluster in selected regions (1,000 Euros)

| Subregion | *n* | Employees | Labour costs | Value added | Export | Long-term asset |
|---|---|---|---|---|---|---|
| 2000 | | | | | | |
| Budaors | 3* | 15 | 26 | 20 | 0 | 99 |
| Budapest | 1,080 | 74,788 | 650,553 | 1,472,592 | 598,164 | 3,308,297 |
| Cegled | 4* | 15 | 37 | 86 | 0 | 25 |
| Dorog | 2* | 5 | 15 | 27 | 0 | 0 |
| Dunakesz | 2* | 6 | 10 | 61 | 0 | 147 |
| Esztergom | 1* | 0 | 0 | 0 | 0 | 0 |
| Hatvan | 6 | 885 | 6,040 | 11,969 | 52,426 | 39,867 |
| Komarom | 21* | 146 | 964 | 2,164 | 2,852 | 1,381 |
| Ózd | 12* | 36 | 111 | 147 | 64 | 106 |
| Pecs | 59 | 3,323 | 12,776 | 21,409 | 35,914 | 53,532 |
| Szekesfehervar | 64 | 18,508 | 89,767 | 546,873 | 3,083,761 | 293,921 |
| Tatabanya | 32* | 1,033 | 5,502 | 8,910 | 11,600 | 3,957 |
| Vac | 25 | 3,114 | 25,167 | 53,780 | 64,587 | 40,383 |
| 2003 | | | | | | |
| Budaors | 208 | 4,246 | 90,524 | 240,894 | 176,269 | 720,814 |
| Budapest | 3,545 | 74,777 | 961,267 | 1,537,721 | 1,386,669 | 3,805,295 |
| Cegled | 29 | 1,112 | 8,096 | 8,208 | 40,687 | 19,514 |
| Dorog | 14 | 666 | 3,694 | 3,805 | 5,569 | 241 |
| Dunakesz | 81 | 858 | 12,752 | 17,249 | 85,799 | 5,884 |
| Esztergom | 38 | 1,486 | 14,418 | 27,888 | 83,601 | 39,632 |
| Hatvan | 17 | 1,959 | 18,448 | 33,112 | 181,480 | 20,228 |
| Komarom | 12 | 1,827 | 20,020 | 114,949 | 2,311,114 | 73,596 |
| Ózd | 11 | 663 | 4,162 | 10,885 | 50,050 | 5,877 |
| Pecs | 129 | 3,410 | 32,301 | 39,134 | 67,421 | 41,984 |
| Szekesfehervar | 127 | 10,893 | 99,964 | 109,698 | 1,858,013 | 160,758 |
| Tatabanya | 42 | 1,110 | 11,764 | 10,108 | 48,701 | 16,484 |
| Vac | 48 | 3,223 | 47,020 | 30,719 | 630,603 | 263,811 |
| 2005 | | | | | | |
| Budaors | 115 | 4,331 | 96,478 | 326,274 | 234,593 | 1,104,572 |
| Budapest | 1,549 | 65,993 | 1,002,768 | 1,507,682 | 1,546,767 | 3,822,191 |
| Cegled | 18 | 814 | 5,947 | 3,564 | 18,198 | 10,111 |
| Dorog | 19 | 691 | 3,665 | 3,432 | 6,048 | 260 |
| Dunakeszi | 44 | 1,380 | 19,029 | 27,778 | 107,496 | 4,650 |
| Esztergom | 25 | 1,471 | 17,183 | 30,614 | 102,401 | 2,404 |
| Hatvan | 10 | 3,347 | 41,695 | 71,630 | 548,322 | 145,562 |
| Komarom | 7 | 5,565 | 70,019 | 341,233 | 4,224,860 | 186,880 |
| Ózd | 10 | 691 | 4,777 | 10,802 | 53,471 | 6,626 |
| Pecs | 69 | 2,846 | 34,460 | 42,166 | 108,408 | 55,835 |
| Szekesfehervar | 82 | 7,207 | 77,831 | 40,701 | 1,841,017 | 141,845 |
| Tatabanya | 36* | 533 | 4,450 | −5,162 | 39,295 | 160,059 |
| Vac | 26 | 2,643 | 27,305 | 31,785 | 46,186 | 59,102 |

Note: LQ is lower than one in the cases when company number is signed with *

- *Székesfehérvár* is a very important location for ICT; however, its role is diminishing in terms of labour volume and long-term assets. The region produces the highest share of ICT export and still has the second largest volume of ICT labour.
- *Pécs* and *Vác* show similar patterns in size of labour and its change over time, as well as added value and long-term assets accumulation dynamics. On the other hand, Pécs follows an upgrading curve in terms of export, while this fell in Vác.

Esztergom and Dunakeszi regions are *small* but *probably raising* locations of ICT in 2003–2005, while almost no ICT existed there in 2000. *Esztergom* is a new location for ICT that has still a smaller volume of labour and would be difficult to forecast from the 2003 and 2005 indicators because export activity increased but long-term accumulation fell sharply. The same happened in *Dunakeszi*, where a jump in the number of employees by 500 was accompanied by export growth. However, long-term assets accumulation also stopped there.

*Stagnating small* locations of ICT are Cegléd, Dorog, Ózd, and Tatabánya. These locations are very similar to the previous group but produced much lower levels of export growth accompanied by a decrease in labour volume.

The size of registered capital indicates an explicit concentration of ICT industry in the Budapest agglomeration. The big hub of Budapest is followed by Budaörs, Komárom, and Székesfehérvár in 2000, although the order changed by 2005, with Dunakeszi overtaking Székesfehérvár. The ownership structure varies among regions; ICT capital in Komárom and Dunakeszi is almost fully owned by foreign companies. More than half of the stock in Székesfehérvár was owned by domestic companies and individuals in 2005. One sixth of stock is in domestic hands in Budapest and Budaörs; Budapest also represents a significant but decreasing volume of state-owned stock (which probably is the result of the National Post Office) (Fig. 4.4).

## 4.6 Conclusion

In this analysis, we presented a brief overview of industrial dynamics and regional distribution of Hungarian automotive and ICT clusters in the first half of the 2000s. Our data show that sectors related to the automotive cluster grew in all terms throughout the period, while sectors related to the ICT cluster had a local maxima of indicators in the middle of this period. Labour unit costs grew much faster than value added per employee in both industries, which leads us to the conclusion that cost-efficiency grew less relevant for foreign firms in both automotive and ICT industries.

The cross-sectoral difference we expected and introduced in Sect. 4.1 is visible in the regional distribution of the two clusters. Automotive industries tend to cluster in areas where foreign-owned firms located their sites, and new firms that enter those regions are attracted by localization externalities. On the other hand, ICT concentrates in Budapest and its agglomeration; urbanization externalities might occur when new firms come off and enter ICT clusters.

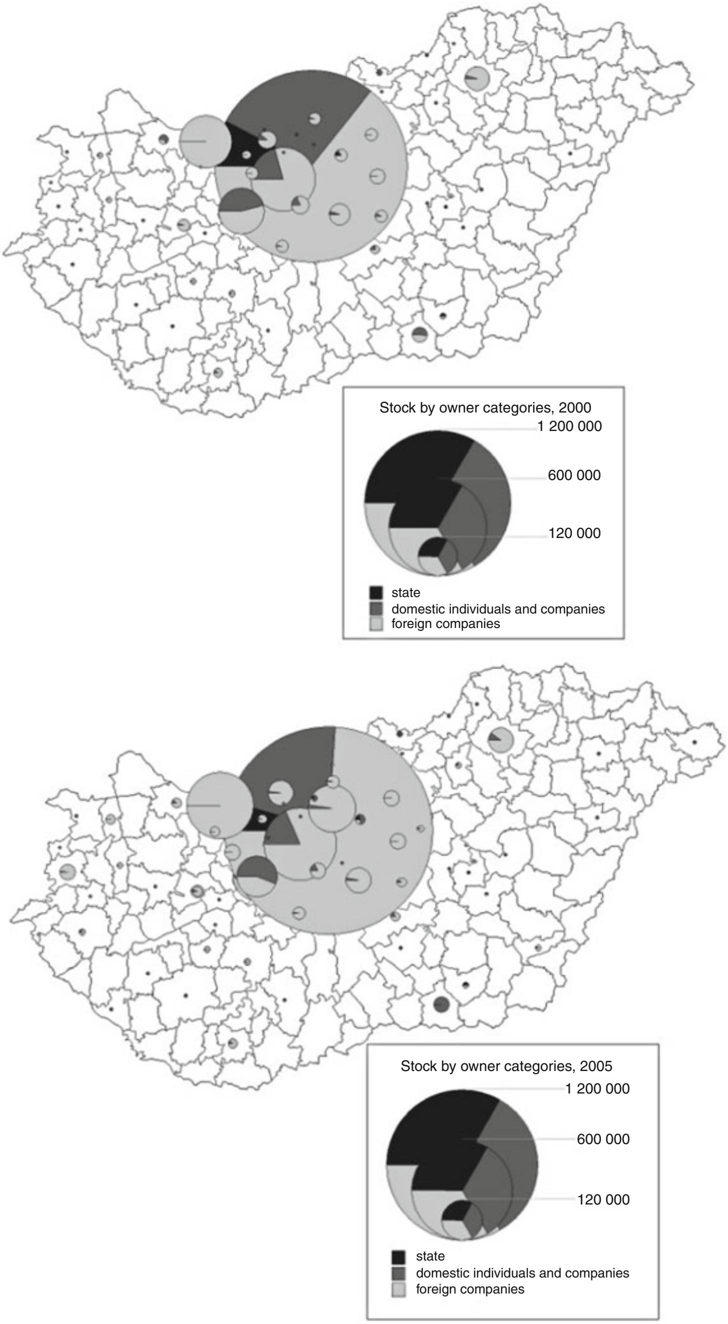


**Fig. 4.4** Values of registered capital by owner categories in the Hungarian regional ICT clusters

We also demonstrated that the number of firms, labour size, value added, and export changed over time in selected regions where automotive and ICT sectors were concentrated. The patterns of growth and decline in regional concentrations vary among regions in both industries. Major indicators like the number of firms, number of employees, value added, and export value changed considerably over time. This means that clustering is a long-term process and that the concentration of firms depends on their strategy and the global market of their products.

Győr saw a growing concentration within the automotive industry. New companies entered the region, the number of employees also grew, and there was likewise growth in value added and exports. Localization externalities attracted a smaller number of new firms to Esztergom, with labour volume increasing moderately there. Szombathely stagnated in terms of number of firms. Though the period we investigated is very short with respect to analysing cluster formations, we might conclude that the automotive cluster in Győr was in the phase of attracting new companies in the first half of the decade. Esztergom and Szombathely, where localization externalities are weaker, are probably on the periphery of the automotive cluster.

The picture of ICT clustering is a bit more complex in Hungary than is the case for automotive clustering. Indicators in Budapest fell, but other hubs emerged in its agglomeration. Our interpretation of this finding is that big companies moved from Budapest to industrial parks that are close to the city but which offer lower rental prices and overhead costs. The number of firms and labour volume also fell in other traditional clusters, like Székesfehérvár, as IBM relocated its production site to Asia. Firms in Székesfehérvár increased their exports, but the region is losing its attractiveness. Komárom emerged as a new location for ICT industry with the greenfield investment of Nokia, but it has hardly attracted any new firms after that.

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# Chapter 5
# Differences Between High-Growth and Low-Growth ICT Firms in Germany

**Christian Schröder**

## 5.1 Introduction

It is essential for developed economies to bring forth innovation-driven businesses and to promote growth opportunities for them in order to ensure sustained economic growth. Small- and medium-sized companies, the traditional mainstay of the European and, in particular, the German economy, play a key role in this respect. As a rule, radical innovations and inventions were brought about more often by small companies. Big companies often concentrate on incremental innovations, that is, the improvement of existing products, and produce economies of scale through high production numbers.

One explanation for the differences in growth between the USA and Europe or Germany is found, among other things, in the successful implementation of new technologies by young businesses. The latter promote a dynamic structural change and adjustment processes and accordingly overall macroeconomic higher growth rates. The arguably most important technological innovations of the past decade were initiated by information and communication technology (ICT). Thus, the ICT sector, compared to the overall value creation development, grew very quickly. At the same time, the implementation of ICT technology and infrastructures increased productivity in nearly all other sectors of the economy. Hence, a vital ICT sector is of great importance for Germany and is likely to enhance its international competitive position even further.

The information and communication industry (information industry) is already one of the largest economic sectors of Germany. At the same time, it is an important motor for innovation, growth, and employment in other areas of our economy. It is a sector with currently about 830,000 employees and a turnover of nearly EUR 150 billion, notwithstanding the fact that the prices of many ICT products have shown a continuous decline in effective prices for a long time. The German ICT sector accounts for approximately 6% of the worldwide market in information and communication technology. This makes Germany the fourth largest national market in the world, following the USA, Japan, and China, and the most important market

P.J.J. Welfens (ed.), *Clusters in Automotive and Information & Communication Technology*, 135
DOI 10.1007/978-3-642-25816-9_5, 

for ICT in Europe. The European Commission estimates that ICT contributed with approximately 40% to the increase of productivity in the European Union in recent years and, thus, was the single most important source of productivity growth.

The revitalizing effect of ICT on other sectors of the economy and the growth of the ICT industry are mutually interdependent. The domestic ICT services industry plays an important role for SMEs. The presence of nearby ICT service providers enhances the competitiveness of local SMEs and makes it possible to provide solutions tailored to the needs of each business. A highly developed domestic ICT services sector essentially reduces dependency on suppliers abroad and any deadweight effects. Lively competition with regard to digital solutions for local SMEs will either tend to increase innovative capacities of ICT businesses or result in declining prices for such services. This, in turn, may lead to increased export activities and reinforce e-government activities in the public sector with an ensuing enhanced efficiency of public services. There are numerous other positive (welfare) effects of ICT, such as the development of "green IT," an extension of available educational and training facilities and positive impacts on the health sector.

In view of the significance of ICT businesses, it is rather astonishing that there are only comparatively few studies on the specific regional and company-specific impact factors for high corporate growth dynamics in the ICT sector (e.g., Van Oort and Atzema 2004; Lasch et al. 2005). This may be due—as so often—to the dearth of data available to carry out such an analysis. At the same time, identification of factors that support the positive growth effects of ICT businesses would be of great importance in the context of a targeted economic policy. Even in a single European economic area, businesses still find themselves, due to differing national institutions and economic structures, in differing country-specific environments, which contribute to the success or failure of their economic activities. This aspect has an even greater relevance for sector-specific analyses.

To be able to make meaningful recommendations for future actions, the present analysis interviewed ICT businesses in Germany. The information gained was evaluated by means of a probit model and provides insight into regional and company-specific impact factors that are factually relevant to enhance the growth opportunities in each specific case. More than 200 businesses returned the completed electronic questionnaire. The information submitted provides answers to the question on how knowledge spillover, capital structure, company age and size, and export activities have an impact on growth dynamics. "Knowledge spillover," the intentional or unintentional "spillover" of know-how between economic actors, is considered to be an important phenomenon for the dispersion of knowledge, in particular in innovation-driven sectors. According to (recent) economic geography and/or location theories, spatial mobility theories, and regional growth and development theories, clusters are considered to be beneficial for stimulating an exchange of knowledge. Accordingly, a cluster development strategy—the formation of networks of closely cooperating companies that are in close regional proximity to each other and whose activities supplement each other along one or several value-added chains—is considered to be an important economic policy tool that is currently widely used by economic policymakers.

In Germany, cluster initiatives were conducted to improve networking among ICT businesses and with universities, research institutions, chambers and associations, capital investors, sponsoring institutions, consultants, and other actors. The aim of the networking is to enable and stimulate knowledge spillover. The economic policy instrument of actively supporting networking activities between businesses on a mesolevel became "fashionable" in the 1990s and has been used ever since to an increasing extent by political decision-makers. This leads to the question if this active support, as currently practiced, makes any sense at all because it poses the risk of creating artificial structures providing support for noninnovative businesses while important market players, namely, innovation-driven businesses, may have little or no interest in actively cooperating in such a cluster network or may prefer other means of cooperation to make the best possible use of innovation potentials. The survey and analysis focused on a number of different knowledge spillover channels to obtain more certainty about the channels that are used to transmit relevant know-how and that have a direct impact on revenue growth. Since the location of a business in a cluster region may lead, as discussed, to such transmission of knowledge, corporate management was asked in the survey, among other things, to assess if the business was part of a regional cluster and if it actively participated in it. By way of distinction, businesses were also asked about specific research cooperation projects with other businesses and research institutions. Any possible knowledge spillovers caused by, for example, the availability of qualified staff of a local university were also taken into consideration.

Other factors having an impact on corporate growth discussed in academic literatures, such as business size and equity ratio, which might determine the investment potential of young ICT companies, venture capital, and degree of internationalization, were also taken into account. The innovation capacity of a business is rated as one of the most important sources. Here, a distinction was made between research and development expenditure and the actual research output. An assessment of regional policies was also included in the econometric analysis.

The analysis under consideration led to some unexpected findings. While the relevance of expenditure for R&D or the launch of a new product, a high degree of internationalization and high equity ratio, venture capital or access to capital, inverse corporate age (young businesses grow faster than older ones), and corporate size go hand-in-hand with more opportunities for strong corporate growth, the involvement in a regional cluster does not indicate any growth effect. That is not all: Every business that was described by its management as being part of a cluster and as being actively involved in it even showed a significant negative effect on average growth during the past 5 years compared to companies not belonging to an ICT cluster. In summary, businesses that are not part of a cluster grow faster than businesses belonging to a cluster. This result contradicts the positive effect propagated in academic literature. It appears that in the ICT sector, especially fast-growing companies have no interest in joining clusters. Innovators seem to consider the monopoly rewards of their products/services as being at risk and fear imitation by competitors. It even seems that politically motivated cluster initiatives are particularly attractive for low-growth businesses.

Furthermore, the analysis shows that specific research cooperation projects concluded with one or more enterprises have a positive impact on corporate growth compared to companies that do not conclude cooperation projects. No immediate positive growth impact from cooperation projects between the interviewed companies and universities or research institutions was discernible.

The study will briefly present some figures on the ICT sector reflecting the position of Germany as an ICT location by international comparison and explain the networking initiative of the German Federal Ministry of Economics and Technology (BMWi). Some theoretical aspects and available empirical findings that have an impact on corporate growth will be presented in Sect. 5.3. This will be followed by the empirical section in Chap. 5.4. The analysis will end with conclusions and policy implications as well as some restrictive comments on the scope of the analysis under consideration.

## 5.2 Information and Communication Sector in Germany

Since 2000, the monitoring report of the federal government provides comprehensive information on Germany as an information and communication technology location. The 2009 report compares Germany to leading countries in the information and communication technology and provides an assessment of Germany's position. Twenty-one core indicators were taken into account for the benchmarking of the 14 leading ICT nations. Germany and Norway share a mediocre seventh rank, which means an improvement by two ranks compared to the preceding year. The USA leads the ranking with a clear margin.

Low public R&D spending in the ICT sector and lacking tax deductibility of private R&D expenditure, poor location marketing, lacking efficiency of innovations in market mature products, a shortage of skilled workers, funding problems of start-up companies, and ICT crime are considered to be essential drawbacks and location disadvantages. The clear decline of ICT expenditure in comparison to the gross domestic product (GDP) also gives rise to serious concerns. Improved bandwidth availability, good regulation, corporate purchasing via the Internet, increased use of social services, and the increased spread of mobile telephony are factors that enhance Germany's position as an ICT location.

In 2009, the revenue of the German ICT sector amounted to nearly EUR 140 billion, which corresponds to a 6% world market share and the fourth position in worldwide comparison. In 2009, Germany was overtaken by China. Revenues in information technology declined by 2.6% to EUR 65.4 billion and in telecommunication services by 2.2% to EUR 64.3 billion. However, compared to other countries—except South Korea—this is a moderate decline and amounts to an effective improvement by international standards.

There is a tendency to transfer the production of ICT goods to non-OECD countries. According to OECD information (2008), approximately 50% of all ICT products are now manufactured in developing countries or emerging markets. These countries also show a clear increase on the demand side. In effect, ICT expenditure of these countries increased by a remarkable 20%. In the BRIC countries and Indonesia, these expenditures increased on average by 20% p.a. in the period from 2003 to 2007.

For a high-wage country like Germany, the future lies in the production of highly innovative ICT goods and services. The constant improvement of broadband coverage provides new markets for digital content. After the bursting of the so-called dot.com bubble in 2001 and up to the start of the financial and economic crisis in 2008, the advertising and entertainment industry benefited particularly well with growth rates of 30%. These branches of the economy and social networks are currently the strongest growth motors and are also likely to be the expansion motors of the ICT sector in the medium term due to considerable growth rates in the field of mobile services provision and user-created Internet content. In addition, potentials with regard to embedded systems, cloud computing, Internet of services, e-mobility and traffic telematics, climate protection (green IT, e-energy), e-health and IT-security (BMWi 2009, p. 14) can be discerned in particular for Germany.

Policymakers discovered the mechanism of promoting clusters to maintain and/or strengthen the innovation capacities of the German ICT sector. To analyze the direct benefits of this support mechanism for businesses, this study distinguishes between ICT businesses that are located in regions receiving such support and businesses outside such regions. This means that businesses, who stated that they were involved in a cluster and actively participated in it, were analyzed. To preempt criticism that this only constitutes a subjective assessment by the interviewed corporate management, only those companies that also located in a cluster region were taken into consideration. The following description of the networking initiative seeks to show that the supported regions actually comply with the criteria for a cluster, at least in the sense commonly understood.

### 5.2.1 ICT Cluster or Network Initiatives[1] in Germany

Sector-specific networking initiatives are supported in Germany by the Federal Ministry of Economics and Technology (BMWi) since 1999. The initiative covers altogether nine topics, among them information and communications technology. Federal government currently sponsors 15 networks in the field of information and communication technology:

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[1] In the present context, the terms are used synonymously. For a distinction from other concepts of territorial agglomeration and regional innovation activities, see, for example, Jonas (2006, p. 3 et seqq.).

- Baden-Württemberg: connected
- CyberForum e.V.
- GEOkomm networks
- GIQS e.V.
- HörTech
- Regina e.V.
- Intralogistik-Netzwerk in Baden-Württemberg e.V.
- IT Saar
- IST Niedersachsen e.V.
- medRegio Lübeck Kompetenzzentrum eHealth Gmbh
- Mobile and satellite broadcasting technology Niederrhein
- NEMO-VisQuaNet The United Vision Net
- SafeTRANS e.V.
- Virtual Dimension Center
- Center of Competence Virtual Work Environment—it4work

According to the Federal Ministry of Economics and Technology (BMWi 2010a), these I(C)T networks of competence across Germany aim to increase the interconnectedness between industry and research and to accord greater visibility to the advantages of Germany as an innovation-friendly location. While the initiative Networks of Competence offers specific assistance in cluster management to members, which are accepted according to determined criteria, its primary aim is to enhance the external visibility of these networks for potential investors. Among the requirements for obtaining support is therefore that "All institutions and persons involved in the network are aware of their responsibilities and roles in the network and will present this awareness in internal and external relations. In doing so, the creation of a uniform external presentation, by means of joint print materials and a network website, will contribute visibly to the creation of an independent identity" (BMWi 2010b, p. 10).

A minimum size of ten actors is required and a corporate share of at least 50%. In addition, the involvement of a research institution must be ensured. Among the parties involved, there should also be service providers, in particular financial services providers and basic and further training facilities. The BMWi also requires that the network focuses on a specific field of innovation and that it has specific unique features setting it apart. The organizational degree of the network is also of great significance. Next to "branding," this is the focus of the second pillar of sponsoring. The organization unit of the network or the cluster management will receive specific support, for example, for conducting workshops and industrial fairs. Further assistance is provided by the publication of trend reports, network-specific short studies, online newsletters, joint Internet presentations, exchange and development of cooperation projects, internationalization, that is, the development of strategies for corresponding activities and the organization of group study visits (BMWi 2010b). Apart from BMWi and the outsourced Initiative Networks of Competence Germany, cluster policy in Germany is organized and implemented by the Federal Ministry of Education and Research (BMBF) and its associated bodies such as the German Research Foundation (DFG), project promoter Jülich, the German Aerospace Center (DLR), or the German Council of Science and Humanities (Wissenschaftsrat). The Federal Ministry of Transport, Building and Urban Development (BMVBS) is mainly responsible for the new federal states (Bundesländer). The Initiative Networks of Competence promotes clusters that are as a rule older than 24 months, hence clusters that are advanced in terms of cluster life cycles. Clusters were previously created at the initiative of federal states or regions; the regions were accordingly the original creative force behind clusters in Germany.[2]

It can be assumed that corporate management, in areas where such networking activities were established, will be aware of the issues relating to clusters since they took a conscious decision to either join the cluster initiative or to abstain from it. Before undertaking an analysis with regard to the growth dynamics of the interviewed companies in these cluster regions, the following section will briefly deal with the impact of innovative businesses and/or ICT businesses[3] on economic growth. Possible corporate growth impact factors that are specific to companies or regions will be explained. Only a selection of factors can be covered. The author is aware that the success of a business venture is directly or indirectly influenced by numerous other (socio-) economic (interdependent) factors. However, the present analysis does not focus on corporate personalities but rather seeks to establish the key features of a fast-growing ICT business.

## 5.3 Theoretical Aspects

### *5.3.1 Economic Growth Through Innovative Firms*

Economic growth can be attributed essentially to four fundamental forces: increase of production factors, more efficient allocation of resources, knowledge base, and innovative capacity of an economy. In this regard, innovations are rather seen to be a vehicle for expanding the existing, economically exploitable knowledge base of an economy and to enable dispersion of know-how. In the presence of full employment and efficient allocation of resources, economic growth is generated by the accumulation of knowledge and innovation. The correlation between knowledge and innovation is often described as a linear process and the result of focused research and development activities (R&D). Proponents of the endogenous growth theory, for example, emphasize the role of R&D and of investments into a research

[2] A more in-depth overview of cluster policies and cluster initiatives is provided by the European Cluster Observatory (http://www.clusterobservatory.eu/index.php?id=42&nid=).

[3] 83% of the interviewed companies responded with YES to the question if the company had engaged in innovative activities during the past 3 years.

sector (Romer 1986). This leads to so-called knowledge spillovers, which means that a business, in spite of patent protection, cannot fully contain the newly acquired knowledge. Since new knowledge cannot be protected comprehensively, other companies that do not conduct R&D will also benefit. On a macroeconomic level, constant marginal yields are generated. Lucas (1988) advances similar arguments but emphasizes investments into human capital. The latter increase productivity by gaining new knowledge, which is then transferred involuntarily to other economic agents, who are also able to work more productively. The entrepreneur as such, on the other hand, does not play any significant role in the endogenous growth theory with some exceptions (see, for example, Aghion and Howitt 1992, 1997; Howitt and Aghion 1998; Peretto 1998, 1999a, b; Schmitz 1989).

On the other hand, already Schumpeter (1911) emphasized the entrepreneur's relevance for innovations. While large enterprises characterized the economic infrastructure in the previous century up to the 1970s, a structural change in favor of small- and medium-sized companies took place in the final 30 years of the twentieth century. The same change occurred at the same time in all economically highly developed countries. This development is owed to globalization and the resulting challenges facing businesses. Audretsch and Thurik (2000) emphasize the change toward a knowledge-based society; other authors explain the decentralization of the macroeconomic structure with the demand for differentiated goods and flexible specialization.

It is undisputed that a considerable part of new innovations results from a diffuse combination of, i.a., learning by doing, certain cognitive skills, and the development and use of networks. These are the abilities that a successful entrepreneur must have. His/her knowledge combined with a certain willingness to take risks and other typical characteristics such as perceiving and creating new opportunities, acting in uncertain conditions, the willingness to face competition, and the drive for autonomy are the typical hallmarks of an entrepreneur and explain why small businesses, compared to large enterprises, generate more innovations in spite of lower R&D ratios. In large enterprises, innovations are often hampered by management structures, a lack of vision and/or a monopoly position of the enterprise concerned.

In addition to personal qualities, environment-related factors also have an important impact on the decision to opt for self-employment and on the successful development of a business. Prominent factors that influence entrepreneurship in certain economic sectors are profit prospects, market entry barriers, the level of demand, but also the social culture and standards.

Aspects relating to knowledge spillover and entrepreneurship are of considerable interest for the regional economy. The focus is on the agglomerations of enterprises in a region. Spillover effects, as well as improved funding opportunities, greater regional factor markets, a developed infrastructure, and adequate basic and further training facilities, result from the spatial concentration of enterprises. In particular, innovative or knowledge-oriented industries, such as the ICT sector, may benefit to a greater extent from agglomeration. High-tech businesses also mean well-trained staff, that is, human capital with purchasing power, which in turn attracts other businesses. Accordingly, economically highly developed regions often coincide with a high population density, which may reinforce knowledge spillover effects. With regard to knowledge spillover, a distinction is made between Marshall–Arrow–Romer externalities and Jacobs externalities (Glaeser et al. 1992). The former appear within a specific economic sector, while the latter are caused by the agglomeration of diverse industries.

## 5.3.2 *Selected Potential Impact Factors on the Corporate Growth of (ICT) Firms*

### 5.3.2.1 Knowledge Spillover due to Spatial Proximity and/or Clusters

As already indicated above, proponents of the endogenous growth theory (Romer 1986; Lucas 1988) have identified the "skipping" of knowledge from one economic subject to another as a pivotal growth-driving factor. This so-called knowledge spillover takes place by means of various channels. For example, due to cooperation projects with other businesses or research institutions or due to job changes of highly qualified staff, "new specific know-how" may diffuse from one enterprise to another. Another possibility is to draw from the experience and networks of a venture capital investor specialized in a particular market segment. University graduates and research assistants who take up employment with an enterprise are also potential sources for companies to gain new knowledge. Innovative businesses in the ICT sector in particular depend on the generation of relevant knowledge, be it product-specific or organizational, to ensure dynamic growth or survival.

It seems intuitively plausible that geographic concentrations of innovative enterprises, or enterprises that are above average in their productivity, regardless of whether they were formed by accident or by external input, attract other innovative businesses and, thus, contribute to an environment that is conducive to knowledge spillover. Such concentrations, also known as clusters, can be defined from an economic point of view as a network of producers, suppliers, research facilities, and other related facilities that are in a certain regional proximity to each other. The relationship between the members of a cluster is defined by supply chains or competition or by common interests. In principle, the cluster structure may provide also other efficiency benefits for the local companies in addition to the transfer of knowledge. These benefits include, for example, a common infrastructure, reduced transport and transaction costs, nontradable production inputs, and a large pool of qualified employees. However, for innovative businesses, knowledge spillover is the most important economic effect (Armington and Acs 2002; Capello 2002).

Even before Romer and Lucas formalized this effect between economic agents and their models that became known as endogenous economic theory, academic literature already addressed the formation of clusters and the geographic economy underlying this phenomenon. Marshall (1920) was one of the pioneers in this field and already discussed geographic location as a competitive advantage for enterprises with certain features in the context of the growing importance of knowledge for developed economies. The physical proximity of cluster members increases the probability that knowledge will be disseminated via formal meetings, such as conferences, joint projects, and industrial fairs, but also by means of informal gatherings of cluster members. This transmitted knowledge plays a major role in diffusing knowledge. Empirical studies have shown that there is a robust connection between clusters, knowledge spillover, and the innovation output of enterprises (e.g., Audretsch and Feldman 1996; Deeds et al. 1997; Baptista 2000). Jaffe et al. (1993) discovered in respect of high-growth innovative sectors that patent citations of other patents are five to ten times more likely within one city, at least within the first year after the patent was granted. Almeida and Kogut (1997) present similar results with regard to patent citation and, thus, emphasize the interconnectedness of innovation and spatial proximity. Enterprises established in clusters not only have a higher business output but possibly also a higher growth of revenue (Canina et al. 2005) and survival prospects (Folta et al. 2006; Sorenson and Audia 2000; Stuart and Sorensons 2003) as well as a higher founding rate (see in this respect Van Oort et al. (2004) for the establishment of ICT enterprises in the Netherlands). Chung and Kanins (2001) concluded that especially small firms benefit from a local firm aggregation of already established businesses because these have already created demand externalities; thus, newly formed businesses can benefit from the large volume of customers of the older enterprises, which are also more profitable as a rule.

Especially the highly innovative products and services of the ICT sector often contain a large portion of knowledge that is not readily available and often only exists in the minds of the persons involved in the development of certain products or processes. The higher this share of implicit knowledge, the more important direct communication becomes. Innovative businesses are often established in the vicinity of universities to profit from spillover effects (Audretsch et al. 2005; Audretsch and Feldman 1996; Malmberg et al. 1996; Gilbert et al. 2008; Mansfield 1995). Link and Rees (1990) discovered that in particular, the innovative capacity of small businesses is strengthened by collaborating with universities, while large enterprises with more than 10,000 employees cooperate comparatively more often with universities but seem to be able to profit only to a lesser extent from the collaboration. Audretsch and Lehmann (2005), too, observed a positive correlation between growth rates (in relation to the level of employment) of German high-tech enterprises and their geographic proximity to a university. However, a prerequisite was that the university produced a sufficient quantity of scientific output in the form of reviewed scientific publications. Munroe et al. (2002) discovered that the proximity of leading research facilities was beneficial for enterprises due to the available number of skilled employees and access to current research activities and new technologies. Venture capital is mentioned as another important factor that contributes decisively to the prosperous development of a cluster and/or the rate of newly established enterprises.[4]

Due to the considerable leaps in the development of information and communication technologies, clusters can no longer be analyzed only within geographic boundaries. However, due to its informal character, the person-to-person exchange of information provides certain additional advantages that should not be underestimated. The academic literature dealing with the spillover effects of implicit knowledge in clusters or in regional development (e.g., Kogut and Zander 1992; Jaffe et al. 1993; Adams and Jaffe 1996) emphasizes that this knowledge can often be gained only by direct observation, participation, or joint experience. In these instances, the knowledge in question is not only important for the imitation of certain processes but can also be understood as a form of mutual competition. The direct comparison and discussion of different solutions serves not only to exchange existing knowledge but also to discover new approaches. It also provides an opportunity to critically review one's own daily working practice (Maskell 2001). Spatial proximity gives rise to close personal relationships, which are often strengthened by similar cultural values. This environment, based on a close relationship with supplier companies, contact with customers, and changing highly qualified staff, generates a diffuse atmosphere that is conducive to collective learning processes (Giuliani 2005). This may be completely unintentional and transfer information or knowledge that does not confer any immediately apparent benefit. In such an environment, initially private knowledge can be transformed into public property by spatial proximity (Lawson and Lorenz 1999).

Thus, there are numerous arguments in favor of the beneficial growth impact of clusters; Silicon Valley is considered to be an incontrovertible example of the success of clusters. It is however questionable if such a unique regional composition of high-tech businesses can be replicated in other locations with the same success. It often seems that economic policymakers try to copy a successful practical model without giving due consideration to the institutional and socioeconomic differences. The development of a cluster must be seen as an evolutionary process that is determined by certain conditions but also by mere coincidences. Thus, enterprises are now more sensitive to the phenomenon of knowledge spillover and more actively seek to prevent such "skipping" of knowledge than 20 years ago. It can be assumed that a cluster requires a certain structure. Thus, a certain ratio of large market-leading enterprises to small enterprises may be decisive for the actual beneficial growth impact of a cluster. Even if the studies referred to above show some effects in this regard, this is usually subject to certain reservations. Thus, it is conceivable that the quality of the research institutions was decisive or that only enterprises within a certain size range experienced beneficial effects. Countries and industry-specific differences should also be considered in an

[4] Financing aspects will be discussed in more detail in the following section.

analysis. In addition, by reason of the available data, many studies only focus on one cluster region. Nevertheless, the following hypothesis is formulated:

> First hypothesis: ICT firms that benefit from knowledge spillover have a faster growth in revenue than ICT enterprises that use little exogenous knowledge.

Several possible transmission channels for the absorption of specific knowledge shall be considered. There may indeed be cause to take a critical look at publicly sponsored cluster initiatives, whether they have a wider scope or specifically serve ICT enterprises since they are politically desirable, but may be of only minor economic usefulness. In this study, a reference to other potential transmission channels shall be understood to refer to local universities and research cooperation projects.

In addition to knowledge spillover, there are of course other factors that may have an impact on growth dynamics and should be included in the analysis. In the case of venture capital, knowledge spillover cannot be separated from funding problems encountered by young, innovation-driven enterprises. If a venture capital company makes funds available to an enterprise, the enterprise often gains new industry-specific know-how at the same time. In this instance, the transfer of knowledge is expressly intended.

#### 5.3.2.2 Funding Problems of Young, Innovative, High-Tech Enterprises

An ICT enterprise or the underlying business model is often not readily transparent for outsiders, unless technically well versed. This may cause funding problems, especially for young ICT enterprises, since a bank clerk, for example, will only have a limited ability to assess ex ante the survival chances of a high-tech start-up enterprise; this is all the more true if a completely new product is to be introduced for which there is no reference market. The entrepreneur may not reveal all risks resulting from the business model but will rather seek to emphasize its opportunities. This asymmetrical information problem (Stiglitz and Weiss 1981), in combination with the rapidly dwindling collateral value of hardware components over time, presents in particular for inexperienced entrepreneurs an obstacle to obtain investment capital.

For many ICT enterprises, the basic rule applies: High entry costs may be incurred, while the marginal costs, especially for software businesses, are often very low. It is typical for ICT enterprises that the network effect leads to economies of scale on the demand side. If the new network is in strong demand, this is initially a beneficial effect; however, in case of investment capital funding, there is a risk that not enough capital to ensure an optimal future growth will be provided (Hyytinen and Pajarinen 2004). If the network fails, the young enterprise is likely to disappear from the market.

The increased risk for young ICT enterprises cannot be readily compensated by a higher loan interest rate. From the perspective of the lending bank, the quality of its credit portfolio deteriorates with increasing interest rates because enterprises with a stable but less profitable business model will withdraw, while higher-risk enterprises will be added (Stiglitz and Weiss 1981; Winker 1999). The interest rate at which the banks maximize their profits may be below the market interest rate, which in turn has a detrimental impact on high-risk ICT investments.

As opposed to funding for tangible capital assets, the funding of innovation is subject to additional specific conditions, which may lead to higher or additional financing restrictions. Expenditure for innovation has a different structure and weight compared to investments into tangible assets. Expenditure for innovation projects essentially includes, for example, personnel costs for R&D, conception, design, training and market launch, among others, construction, design, training, and launch. This leads to a problem with regard to providing collaterals for funding from external sources, which is often required to finance such expenses. This problem is thus typical for innovation projects. In addition, the knowledge gained in research and development is often implicit and, thus, not readily accessible. It is closely connected to the human capital of a business and is at least partially lost, as mentioned before, if an employee relinquishes his or her employment.

As a result, innovations are often only funded by internal means or equity. Hall (1992) revealed a positive and significant correlation between the elasticity of investments in research and development and the cash flow of US enterprises in the processing trade. One disadvantage relating to the funding of innovation from current income is caused by the potentially higher amplitude of the invested amount between each individual year. In phases when the enterprise generates only little or negative cash flow, a reduction of innovation activities is to be expected. If no financial reserves were formed in the past, there is a risk that the innovation project will fail. At the very least, the average amounts invested by businesses in the field of R&D might be reduced to a less-than-optimal level to avoid high adjustment costs in case of cash flow fluctuations.

But using internal funds for financing innovation requires the existence of such funds. This is rarely the case, especially for young businesses, and young start-up businesses often generate a negative cash flow in initial years until their product has reached market maturity. Thus, in particular, young high-tech businesses are affected by funding problems. These problems are often compounded by the fact that future demand for the product, which at this stage often only exists as a prototype or as a notion conceived by its inventor, can only be assessed with great difficulty. Furthermore, young entrepreneurs often have very little know-how with regard to developing a business or are specialized in one aspect only.

In summary, it can be said that ICT enterprises should suffer from financial restrictions as a matter of course, as there is a high incidence of the following risks:

- In the ICT sector, networking effects often have a major significance. Accordingly, it is important to define the “standard” or at least to follow it. As a matter of course, the business model involves a high level of risk, and the bank clerk of a bank’s loan department will rarely have the necessary specialist knowledge to adequately assess these risks. Under these circumstances, the potential borrower is in a position to conceal any risks.

- A high portion of fixed costs for research and development activities while their successful implementation in market matures and successful products is uncertain.
- A high value depreciation of collaterals or a high portion of immaterial property, such as patents and licenses.
- ICT products (e.g., software) can often be replicated without large expense.
- High-tech start-ups often have negative cash flow.
- A high innovation effort is required to ensure sustainable market presence.
- A high share of noncodified knowledge, with the ensuing risk that essential know-how may be lost to the enterprise.

Especially, risk capital or venture capital (VC) has certain advantages vis-à-vis credit financing. Lacking collaterals to secure a loan can be compensated by participation between entrepreneur and the capital investor to a corresponding extent. Investors providing venture capital, "venture capitalists" (VCs), usually specialize in certain industries; their experience in these industries allows them as a rule to appropriately assess any existing risks. VCs often link their participation narrowly to the management of the business. This circumstance makes it easier to influence or at least to monitor the management of the business and, thus, reduces the moral hazard problem (Myers and Majluf 1984). Moreover, in addition to capital, VCs also provide management expertise and networks; the added value gained from such expertise and networks should not be underestimated. VCs invest on average for a period of 5 years and as a rule do not require interest on their invested capital. The business model consists of transferring the portfolio company with profit to the owner, competitor, or another VC company after a few years. With regard to US businesses, Kortum and Lerner (2000) showed that a US dollar invested by a VC is three times as effective as a dollar invested by a company in R&D—in relation to the innovation output (measured in patent registrations). Yet other studies come to different conclusions. A disadvantage of venture capital funding is that investors are mainly interested in a quick return on their investment. This may lead to short project run times and a hasty market launch of new products, which may lead to less-than-optimal results. With regard to German VC-financed start-ups, Engel and Keilbach (2007) observed an above-average patent portfolio at the time when the venture capitalist joined the business than in comparative enterprises; however, this difference rapidly disappeared after the VC joined. The growth of these businesses was above average, which indicates that while VCs are attracted by patent registrations,[5] the focus of their participation is on the marketing of the products. Similar results are also demonstrated by Caselli et al. (2008) and Hellman and Puri (2000). However, the following effect should also be observed in the analyses, which is at the same time the second hypothesis:

[5] 73% of the 33 interviewed enterprises that received VC had developed at least a prototype or registered a patent prior to obtaining the VC.

Second hypothesis: ICT enterprises with VC funding should grow faster than enterprises without VC due to the additional know-how and networks. Furthermore, ICT enterprises with a high equity ratio grow faster than ICT enterprises with a high ratio of invested capital.

#### 5.3.2.3 Relevance of the Size of an Enterprise

Gibrat's law may serve here as starting point for the discussion of any potential significance of the size of a business on the future growth of the business. In 1931, Robert Gibrat postulated that the distribution of opportunities for growth was largely independent of the actual size of the business. Gibrat departed from the assumption that growth was determined in particular by making use of opportunities that are available to every enterprise. According to Gibrat, these opportunities are normally distributed, that is, that they occur for each enterprise with the same frequency. Thus, growth opportunities behave proportionally to the actual size of the enterprise. Thus, every enterprise will double its turnover within a defined period of time with the same probability, irrespective of its current turnover level. Gibrat based his theory on own empirical studies. The following studies initially confirmed these findings. However, at the time, only statistical data of very large enterprises (with reference to their turnover) were available for the econometric examinations. Mansfield (1962) and Evans (1987), among others, showed by including younger enterprises that the analytical–logical deductions of Gibrat's model could not be confirmed without reservation. They illustrate that smaller and younger enterprises have a lower probability of survival. Furthermore, small, innovative enterprises grow disproportionally faster in comparison to larger innovative enterprises. This may be due to the higher degree of diversification opportunities with regard to the products and/or business fields available to larger enterprises. Their more widespread positioning may prevent larger growth rates but offer on the other hand higher chance of survival in the event of an external shock. Empirical findings show that SMEs generate nearly twice as many innovations in relation to the innovation output per employer, and this in spite of cumulated lower R&D expenditure (Davidsson et al. 2007). Since innovations should correlate with growth, the assumption expressed above, that smaller enterprises should grow faster than large enterprises, is supported by this finding, at least with regard to small, innovative enterprises.

Jovanovic (1982) provides an additional explanation for this phenomenon by means of a theoretical model. Jovanovic models the negative correlation by varying production costs on the basis of varying learning effects over time. Enterprises that learn to produce more efficiently over time will survive and grow disproportionately, while inefficient ones will be driven out of the market.

Audretsch et al. (2004) in turn established that Gibrat's law applies to service enterprises in the gastronomy sector.[6] The reason why Gibrat's law does not apply to

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[6] In addition, a comprehensive and systematic compilation of all empirical studies on the topic of growth of enterprises is presented; for more recent studies as of 2001, see Cassia and Colombelli (2009).

the entire processing industry, but only to some sectors and to large portions of the services sector, is due, according to Audretsch et al., to the discrepancy between the two assumptions, on which the law is based. The first assumption is that the next "favorable opportunity" for higher growth behaves proportionally to the current size of a business or will develop evenly along the time axis; however, this assumption does not necessarily lead to the second assumption that corporate growth is dependent on the size of the enterprise. An important restriction is that such an assumption is only permissible if there is no correlation between the size of an enterprise and its probability of survival. Audretsch et al. argue that as soon as the survival probability correlates positively with the size of the enterprise, the assumption of a normal distribution of the growth opportunities across the board for all enterprises no longer applies. It is likely that negative growth will less often cause larger enterprises to disappear from the market than small enterprises. This bias leads to the result described above, namely that Gibrat's law applies to large enterprises, since they are more likely to survive negative growth over a certain period of time than smaller enterprises. Because the survival probability of enterprises differs in the various industry sectors, this effect has at the same time a more or less significant impact on the correlation between business size and growth. Numerous studies show that economic sectors in which capital intensity, economies of scale, and "sunk costs" are low, a distortion of survival probabilities to the disadvantage of smaller enterprises is hardly apparent; accordingly, in these sectors, there is no correlation between growth and business size (Audretsch et al. 2004).[7] However, since these factors often occur in the ICT sector, the third hypothesis is posited:

> Third hypothesis: Smaller and younger ICT enterprises grow faster over time than large ICT enterprises.

It must be assumed that an ICT enterprise or its founder bases its commercial independence on a single or only a few product innovations, which will either result in high monopoly rewards or in a failure of the business venture. Since the analysis only takes surviving companies into account, distortion of the survival probability or growth rates for younger ICT enterprises should be rather high.

## 5.4 Empirical Analysis of Selected (Potential) Growth Determinants of ICT Enterprises in Germany

An electronic questionnaire (see Annex) was distributed to ICT enterprises with a corresponding request to the management to complete the questionnaire. The classification of the interviewed businesses was done on the basis of the classification of economic activities compiled and published by the German Federal Office of

[7] See Santarelli et al. (2006) for a comprehensive overview of the empirical literature on Gibrat´s law.

Statistics in 2008 (WZ 2008). Enterprises falling into the divisions telecommunication; computer programming, consultancy, and related services; and information service activities, which correspond to WZ Classification Codes 61, 62, and 63, were approached.[8] Two-hundred and thirteen enterprises returned a completed questionnaire.[9] The survey was conducted at the end of 2009/beginning of 2010, thus still under the impression of global economic crisis caused by the subprime crisis in the USA.

To obtain a higher return rate, the answer options were divided into categories so that management only had to check the corresponding category. Therefore, an ordered probit model was used for the econometric analysis.

Model:

$$y_{it} = \mathrm{X}_{it} + \varepsilon_{it}$$

$$Y_{\text{sales growth}} = \begin{cases} 0 \text{ if } y = \text{ no sales growth or negative growth} \\ 1 \text{ if } y > 0 \leq 5\% \text{ sales growth} \\ 2 \text{ if } y > 5 \leq 10\% \text{ sales growth} \\ 3 \text{ if } y > 10 \leq 20\% \text{ sales growth} \\ 4 \text{ if } y > 20\% \text{ sales growth} \end{cases}$$

$y$ is the variable to be explained and classifies the average annual corporate growth of the interviewed enterprise during the past five years.

$X_{it'}$ is a vector of $i$ exogenous variables for point in time $t$, and $\varepsilon_{it}$ is an error term. As already explained, categories were also formed for a large portion of the exogenous variables. Since the returned questionnaires did not provide sufficient statistical data for all answer categories, these were consolidated as far as this was meaningful. The used variables or rather the actually used divisions are described below with an indication of the actually provided number of answers.

### 5.4.1 Descriptive Statistics

Numerous variants of the above model were assessed. For the sake of clarity, 11 variants or estimates were listed (see Annex). In each model, the revenue increase was expressed by reference to the number of employees and the age of the

[8] Details on the WZ (2008) are provided by the Federal Office of Statistics at: http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Content/Klassifikationen/GueterWirtschaftklassifikationen/Content75/KlassifikationWZ08,templateId=renderPrint.psml.

[9] Not all enterprises replied to all questions. Accordingly, the number of actual observations is below this number and is provided for all estimates. The detailed results and statistics available for each answer can be found in Table 5.1 and in the Annex. In total, approximately 4,000 businesses were approached.

enterprise as well as by reference to the control variables of the trade tax (municipal multiplier) rate and export ratio or export intensity. According to Wagner (2002), businesses that export show a significantly higher growth also with regard to employment. Wagner compares German-exporting businesses in the processing sector to nonexporting “twin businesses” over a certain observation period. A positive correlation between export intensity and corporate growth is to be expected for ICT businesses since economies of scale play an important role in this sector. A lower trade tax rate means a comparatively higher cash flow. Since cash flow, as described above, plays an important role in providing funding for innovative enterprises, it is conducive to growth; accordingly, a negative correlation between the trade tax rate and corporate growth may possibly exist.

To examine the hypotheses stated above, various proxies were used for the degree of innovation, spillover effects, and the capital structure and origin. This means specifically that the interviewed enterprises took R&D expenditure or intensity in relation to corporate turnover and the type of generated innovations into account. The following innovation types were distinguished: entirely new product; improvement of an existing product, and introduction of a new technology, which changed the production of an existing product substantially and organizational improvement. If the enterprise engaged in innovative activities, it had the option to indicate by means of multiple responses the types of innovations generated during the previous 3 years. These data were included as a rule in the analysis; however, for the sake of clarity, data that did not provide statistically significant results were omitted. To come to the point, it can be said, as was to be expected, that the introduction of a new product has a positive and significant impact on corporate growth. The other referenced innovation types do not have a direct, measurable impact on growth dynamics and, therefore, were omitted from the overview of results.

Various potential spillover channels for knowledge transfer were included in the analysis. This was a focal point in the analysis of clusters. To this end, the management of the interviewed enterprises was asked to respond to the following question:

> Is your enterprise an actor in a regional economic cluster? The term cluster is used to denote networks of closely cooperating businesses that are located in spatial proximity to each other and whose activities complement each other along one or more value chains or that are related to each other. Are there other enterprises from your industry and in your vicinity with which your enterprise maintains a close economic cooperation?
>
> (a) Yes
> (b) No

> Is the enterprise, according to your perception, an active participant in this cluster? Please provide your assessment on a scale of 1–5.
>
> 1. Very active
> 2. Active
> 3. Neutral
> 4. Not very active
> 5. Not active

Here too, the categories were consolidated to provide a higher and, thus, more balanced number of observations for each class. Responses 1 and 2 are assessed as active participants, while responses 4 and 5 are grouped as nonactive cluster members. Furthermore, on the basis of the data of the European Cluster Observatory and of the Initiative Networks of Competence of the BMWi, it was examined if these businesses were actually located in a cluster structure or if this was merely the subjective perception of the business' management without meeting objective criteria. In doing so, a very high degree of data coincidence was observed. The advantage of the data, which are made available to ICT networks by the BMWi, is that they relate to clusters that are not very young anymore. This means that the cluster has reached a certain minimum size and that the networking partners have already fulfilled essential admission criteria. Thus, the requirements for a "functioning" cluster are met. In addition to the existence of a critical number of ICT businesses in the region, there are also cooperation projects between enterprises and research institutions. Furthermore, cluster management ensures a better coordination of the cooperation and provides support in establishing contact among cluster members as well as in external marketing. As is also evident from the following table, only enterprises which indicated in their questionnaires that they were active members of a cluster were included in the probit assessment; subsequently, the numbers were adjusted to include only enterprises located in cities or towns that belong to the initiative "Networks for Competence Germany."

Furthermore, in the course of the survey, the question was asked if the enterprise had concluded a specific research cooperation project. If yes, a distinction was then made between cooperation projects among enterprises and with universities or research institutions. In each enterprise that had its registered office in a city or county that also harbored a university or university of applied science, a dummy variable was allocated with the value 1. Only universities or universities of applied science that offered a graduate course with high relevance for the ICT enterprise were taken into account. These included (applied) computer science, automation, electrical and electronic engineering, information technology, communications technology, embedded system engineering, and mechatronics. The enterprises were to benefit from an improved access to qualified human capital and research results. An assessment of how good or how bad the access to work force was asked under a separate heading and, thus, was also included in the econometric analysis.

The analysis also placed emphasis on regional policies. The basic assumption is that corporate decision-makers rate the performance of local policymakers in certain regions better than in other regions. Such a positive or negative assessment with regard to ICT location policy might also relate to growth dynamics.

In addition, the incidence of (ICT) enterprises, as well as the relative size of the ICT sector (in relation to the employment rate and number of ICT enterprises), in the region of the interviewed enterprise was included to check for possible Marshall–Arrow–Romer (MAR) and/or Jacobs spillover externalities (Gorter and Kok 2009; Carlino 2001), which might be caused by an increasing number of (ICT) businesses. Moreover, with the help of the Herfindahl index, it was established if the interviewed company was located in a homogeneous or a heterogeneous economic region. Coming to the point, it can also be stated that these variables had no significant impact so that for the sake of clarity these assessments were not included.

As stated already in the preceding section, moral hazard or rather the resulting adverse selection by potential lenders may make it hard or impossible for innovative enterprises to obtain funding from banks compared to less innovative companies with a more steady cash flow. In addition to the risk that the potential borrower may “conceal” risks, a lender also bears the burden of relatively high insolvency costs. It is highly likely that investment capital will rather be made available for fixed asset investments than for R&D investments. With regard to SMEs in Germany, Czarnitzki and Hottenrott (2009) show that internal financing shortfalls have a more significant impact on R&D investments than on fixed asset investments. Even in the case of successful R&D activities, meaning the generation of new knowledge, absorption of investment profits is far from being certain due to unintended positive external effects. European patent law is more liberal than US law, in particular with regard to ICT, meaning that it is more difficult to assert a patent on an ICT product at the European Patent Office than in the USA. While this may lead to more innovation, it hampers at the same time access to funding due to the reduced value of available securities for loans. Furthermore, patent registration costs are significantly higher in Germany or Europe than in the USA, even though the price differences between the European Patent Office and the US Patent and Trademark Office have begun to level out in recent years. Rassenfosse and Van Pottelsberghe (2011) have at any rate established the price elasticity of demand for patents at 0.4. As a consequence, patent registration costs may amount to an insurmountable obstacle especially for younger enterprises. Thus, there are a number of reasons why ICT enterprises only have access to equity capital or to accumulated profits in order to finance innovations or R&D expenditure. A high level of own cash resources makes a business more independent. Innovation projects that would have to be “approved” in case of investment capital funding can be carried out without further ado. This increased flexibility may present a temporal advantage in the innovation contest with competing market participants. It is also to be assumed that enterprises with a high equity capital ratio have higher growth perspectives than ICT companies with a high investment capital ratio. Equity capital in the form of venture capital increases this effect due to the additional know-how of the venture capital company. Though the enterprises included in this analysis have indicated that the participation of one (or more) venture capital company(/ies) provided an added value for their company, the argument that venture capital investors only invest in high-growth enterprises cannot be dismissed entirely and should be included in the results analysis with regard to the second hypothesis formulated above, that is, that the participation of a VC is conducive to growth (Table 5.1).

### 5.4.2 Results

Attached are the assessments conducted with the abovementioned variables in a probit model (Table 5.2).

**Table 5.1** Descriptive statistics

| Variable | Description | Number/share in % | Source |
|---|---|---|---|
| Sales growth | Average annual revenue growth over the last 5 years<br>$Y_{\text{sales growth}} = \begin{cases} 0 \text{ if } y = \text{no sales growth or negative growth} \\ 1 \text{ if } y > 0 \leq 5\% \text{ sales growth} \\ 2 \text{ if } y > 5 \leq 10\% \text{ sales growth} \\ 3 \text{ if } y > 10 \leq 20\% \text{ sales growth} \\ 4 \text{ if } y > 20\% \text{ sales growth} \end{cases}$ | 27/13.78<br>56/28.57<br>34/17.35<br>30/15.30<br>49/25.00 | Survey |
| Sales | Annual Sales in Mio Euro<br>$X_{\text{sales}} = \begin{cases} 1 \text{ if } x_{\text{sales}} \text{if} \leq 0.5\text{Mio.Euro} \\ 2 \text{ if } x_{\text{sales}} \text{ if } > 0.5 \leq 2.5\text{Mio.Euro} \\ 3 \text{ if } x_{\text{sales}} \text{ if } > 2.5 \leq 10\text{Mio.Euro} \\ 4 \text{ if } x_{\text{sales}} \text{ if } > 10\text{Mio.Euro} \end{cases}$ | 30/14.08<br>91/42.72<br>49/23.00<br>43/20.20 | Survey |
| Research and Development (R&D) | Does the company operates in research and development:<br>$X_{\text{R}} = \begin{cases} 0 \text{ if } x_{\text{R\&D}} = \text{No} \\ 1 \text{ if } x_{\text{R\&D}} = \text{Yes} \end{cases}$ | 134/65.69<br>70/34.31 | Survey |
| Export ratio | Export share of total sales in %<br>$X_{\text{Export}} = \begin{cases} 0 \text{ if } x_{\text{export}} = 0\% \\ 1 \text{ if } x_{\text{R\&D}} > 0\% \leq 20\% \\ 2 \text{ if } x_{\text{R\&D}} > 20\%. \end{cases}$ | 60/29.85<br>94/46.77<br>47/23.38 | Survey |
| Tax (municipal multiplier) rate | Business tax rate in 2008 at the company's headquarters | 213/100.00 | Federal Statistical Office |
| Venture capital (VC) | The surveyed companies received venture capital, and the question of added value for the company was given a positive response<br>$X_{\text{VC}} = \begin{cases} 0 \text{ if } x_{\text{VC}} = \text{No} \\ 1 \text{ if } x_{\text{VC}} = \text{Yes} \end{cases}$ | 167/86.97<br>25/13.03 | Survey |

(continued)

**Table 5.1** (continued)

| Variable | Description | Number/share in % | Source |
|---|---|---|---|
| Equity ratio | Equity ratio in % <br> $X_{Equity} = \begin{cases} 1 \text{ if } \mathrm{x}_{\text{equityratio}} \text{if} \leq 40\% \\ 2 \text{ if } \mathrm{x}_{\text{equityratio}} \text{if} > 40\% \leq 80\% \\ 3 \text{ if } \mathrm{x}_{\text{equityratio}} \text{if} > 80\% \end{cases}$ | 78/45.88<br>40/23.53<br>52/30.59 | Survey |
| University town | Universities or colleges that offer a degree in (applied) computer science, automation technology, electrical engineering, information technology, communication technology, embedded system engineering, mechatronics <br> $X_{\text{Uni}} = \begin{cases} 0 \text{ if } x_{\text{Uni}} = \text{No} \\ 1 \text{ if } x_{\text{Uni}} = \text{Yes} \end{cases}$ | 142/67.62<br>68/32.38 | Rectors' Conference<br>http://www.hs-kompass2.de |
| Cooperation | Do collaborations with other companies or research institutions (e.g., universities or research institutions) in terms of research and development of new products/services occur? <br> $X_{\text{Cooperation}} = \begin{cases} 0 \text{ if } x_{\text{Cooperation}} = \text{No} \\ 1 \text{ if } x_{\text{Cooperation}} = \text{Yes} \end{cases}$ | 30/61.90<br>80/38.10 | Survey |
| Cooperation with business | Do partnership with one or more other companies on research and development of new products/services occur? <br> $X_{\text{Cooperation Business}} = \begin{cases} 0 \text{ if } x_{\text{Cooperation Business}} = \text{No} \\ 1 \text{ if } x_{\text{Cooperation Business}} = \text{Yes} \end{cases}$ | 149/70.95<br>61/29.05 | Survey |
| Cooperation with universities | Do collaborations with one or more universities or other research institutions in terms of research and development of new products/services occur? <br> $X_{\text{Cooperation Uni}} = \begin{cases} 0 \text{ if } x_{\text{Cooperation Uni}} = \text{No} \\ 1 \text{ if } x_{\text{Cooperation Uni}} = \text{Yes} \end{cases}$ | 167/79.52<br>43/20.48 | Survey |

| | | | |
|---|---|---|---|
| ICT business (firm) density | Active member of the information and communications (WZ 2008) on the date 31.12.2007 in the respective district or country-city resident asked where the company is divided by the total local businesses (in the city/country of the surveyed company) | 210/100.00 | Federal Statistical Office |
| Actively involved in a cluster | For the variable is that the following three conditions had to be satisfied, that is, questions with yes or active had to be answered, and the company's headquarters is a city that belongs to the ICT Network "Competence Network Germany"<br>Question (1) Is your enterprise an actor in a regional economic cluster? The term cluster is used to denote networks of closely cooperating businesses that are located in spatial proximity to each other and whose activities complement each other along one or more value chains or that are related to each other. Are there other enterprises from your industry and in your vicinity with which your enterprise maintains a close economic cooperation?<br>$X_{\text{Cluster participant}} = \begin{cases} 0 \text{ if } x_{\text{Clusterparticipant}} = \text{No} \\ 1 \text{ if } x_{\text{Clusterparticipant}} = \text{Yes.} \end{cases}$<br>Question (2) Is the company's own perception of active participants in this cluster? Please make an assessment based on the scale<br>$X_{\text{active}} = \begin{cases} 1 \text{ if } x_{\text{active}} \text{if active} \\ 2 \text{ if } x_{\text{active}} \text{if neutral} \\ 3 \text{ if } x_{\text{active}} \text{if not active} \end{cases}$<br>In the case of xClusterparticipant = Yes and xactive = active and measurement company based in a city of 15 ICT network regions is that the variable xactiveclusterparticipant takes the value 1 and otherwise zero<br>$X_{\text{active cluster participant}} = \begin{cases} 0 \text{ if } x_{\text{active cluster participant}} = \text{No} \\ 1 \text{ if } x_{\text{active cluster participant}} = \text{Yes.} \end{cases}$ | 115/57.21<br>86/42.79<br>64/74.42<br>16/18.60<br>6/6.98<br>168/83.58<br>33/16.42 | Survey<br>and<br>Homepage "Competence Networks Germany":<br>http://www.kompetenznetze. de/netzwerke/netzwerklisting_ view?b_start:int=10&innovation_region=&innovation_range= 4e86e0b55209450e39135a4fd7499a35<br>European Cluster Observatory<br>http://www.clusterobservatory.eu/ |

(continued)

**Table 5.1** (continued)

| Variable | Description | Number/share in % | Source |
|---|---|---|---|
| Regional policy | Please evaluate the supporting effect of regional policy in a positive business development<br>$X_{\text{regional policy}} = \begin{cases} 0 \text{ if } x_{\text{regional policy}} & \text{if low} \\ 1 \text{ if } x_{\text{regional policy}} & \text{if neutral} \\ 2 \text{ if } x_{\text{regional policy}} & \text{if high} \end{cases}$ | 98/50.00<br>49/25.00<br>49/25.00 | Survey |
| Access to human capital | Assessment of the companies surveyed by the availability of qualified personnel in the labor market for the company's specific needs?<br>$X_{\text{access to human capital}} \begin{cases} 0 \text{ if } x_{\text{access to human capital}} & \text{if low} \\ 1 \text{ if } x_{\text{access to human capital}} & \text{if moderate} \\ 2 \text{ if } x_{\text{access to human capital}} & \text{if high} \end{cases}$ | 82/44.81<br>80/43.72<br>21/11.47 | Survey |
| Number of employees | $X_{\text{employee}} = \begin{cases} 0 \text{ if } x \leq 10 \text{ employees} \\ 1 \text{ if } y > 10 \leq 50 \text{ employees} \\ 2 \text{ if } y > 50 \leq 250 \text{ employees} \\ 3 \text{ if } y > 250 \text{ employees} \end{cases}$ | 45/21.12<br>117/54.93<br>36/16.90<br>15/7.05 | Survey |
| New product | The dummy variable takes the corresponding value of 1 if the interviewed companies have introduced in the last 3 years a completely new product or the value zero if not<br>$X_{\text{new product}} = \begin{cases} 0 \text{ if } x_{\text{new product}} = \text{No} \\ 1 \text{ if } x_{\text{new product}} = \text{Yes} \end{cases}$ | 114/54.29<br>96/45.71 | Survey |
| Business age | In years | 210/100.00 | Survey |
| Regional ICT business (firm) density | Active member of the Information and Communications (WZ 2008) on the date 31.12.2007 in the respective district or county-city resident asked where the company is divided by the square kilometers of the respective district or county-city | 210/100.00 | Federal Statistical Office |

| | | | |
|---|---|---|---|
| Regional business (firm) density | All active companies at the date 31.12.2007 in the respective district or county-city resident asked where the company is divided by the square kilometers of the respective district or county-city | 210/100.00 | Federal Statistical Office |
| Relative share of ICT business (firms) in the region | Active member of the information and communications (WZ 2008) on the date 31.12.2007 in the respective district or county-city resident asked where the company is divided by all active companies in the respective district or county-city | 210/100.00 | Federal Statistical Office |
| Relative share of ICT business (firms) in the region compared to the relative share of total German | Share of active companies in information and communication (WZ 2008) on all companies in the date 31.12.2007 in the respective district or county-city resident asked where the company is divided by the share of all ICT companies of all enterprises in Germany | 210/100.00 | Federal Statistical Office |
| Herfindahl index (employees) | The respective share of workers in the sector:<br>• Agriculture and forestry<br>• Producer. Industry excluding construction<br>• Construction<br>• Retail/hospitality/transportation<br>• Provision of financial and insurance services<br>• Real estate activities<br>• Professional/scientific. Technical services/otherwise. Services<br>• Public administration/defense/social insurance/education<br>• Art, entertainment, recreation, private households of all employees in each district or county-city resident questioned where the company is to be squared. All squared shares are added. It is generally assumed at a value $H < 0.10$, a uniform concentration. Values on $H > 0.18$ show the concentration of a sector | 210/100.00 | Federal Statistical Office |
| Regional ICT business (employment) density | Employees of the information and communications (WZ 2008) on the date 30.06.2008 in the respective district or county-city resident asked where the company is divided by the square kilometers of the respective district or county-city | 210/100.00 | Federal Statistical Office |
| Regional business (employment) density | Employees at the date 30.06.2008 in the respective district or county-city resident questioned where the company is divided by the square kilometers of the respective district or county-city | 210/100.00 | Federal Statistical Office |

(continued)

**Table 5.1** (continued)

| Variable | Description | Number/share in % | Source |
|---|---|---|---|
| Relative share of ICT business (employees) in the region | Employees of the information and communications (WZ 2008) on the date 30.06.2008 in the respective district or county-city resident asked where the company is divided by the share of all ICT employees in Germany | 210/100.00 | Federal Statistical Office |
| Herfindahl (firms) | The respective shares in companies in the sectors:<br>• Mining and quarrying and earth<br>• Manufacturing<br>• Energy supply<br>• Water supply<br>• Construction<br>• Trade, maintenance, and repair of automobile<br>• Transportation and storage<br>• Hotels and restaurants<br>• Provision of financial and insurance service<br>• Real estate activities<br>• Freelance scientific and technical services<br>• Other economic services<br>• Education<br>• Health and social work<br>• Art, entertainment, and recreation<br>• Other service of all enterprises in each district or county-city resident questioned where the company is to be squared. All squared shares are added. It is generally assumed at a value $H < 0.10$, a uniform concentration. Values of $H > 0.18$ show the concentration of a sector | 210/100.00 | Federal Statistical Office |
| Relative share of ICT business (employees) in the region compared to the relative share of total German | Share of employees of the information and communications (WZ 2008) to all companies on the date 31.12.2007 in the respective district or county-city resident asked where the company is divided by the share of all ICT companies of all enterprises in Germany | 210/10,000 | Federal Statistical Office |

Correlation matrix

| | Business age | Number of employee | Export ratio | Equity ration | Access to human capital | Cooperation business | Cooperation university | Regional policy | University town | Tax | Regional ICT firm density | Actively involved in a cluster | New product | VC | R&D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Business age | 1 | | | | | | | | | | | | | | |
| Number of employee | 0.1335 | 1 | | | | | | | | | | | | | |
| Export ratio | −0.1636 | −0.0103 | 1 | | | | | | | | | | | | |
| Equity ratio | −0.0625 | −0.1104 | 0.1113 | 1 | | | | | | | | | | | |
| Access to human capital | −0.0188 | −0.07 | 0.0406 | 0.0063 | 1 | | | | | | | | | | |
| Cooperation business | −0.0849 | 0.0523 | 0.1017 | −0.0403 | 0.1191 | 1 | | | | | | | | | |
| Cooperation university | −0.1136 | 0.0348 | 0.0679 | −0.102 | 0.1419 | 0.3406 | 1 | | | | | | | | |
| Regional policy | −0.1892 | −0.0723 | −0.1703 | −0.025 | 0.0699 | 0.0686 | 0.0662 | 1 | | | | | | | |
| University town | −0.1704 | 0.0844 | 0.0168 | 0.0833 | 0.0513 | 0.1185 | 0.076 | 0.0453 | 1 | | | | | | |
| Tax | −0.0845 | −0.0315 | −0.0043 | 0.0699 | 0.0185 | 0.1353 | 0.1069 | 0.0828 | 0.638 | 1 | | | | | |
| | −0.0011 | −0.0865 | −0.0018 | 0.0173 | 0.0413 | −0.0985 | −0.0601 | −0.1432 | 0.026 | 0.1115 | 1 | | | | |
| Regional ICT firm density | | | | | | | | | | | | | | | |
| Actively involved in a cluster | −0.036 | 0.1111 | −0.0234 | −0.0296 | 0.0189 | 0.1294 | 0.0841 | 0.0167 | 0.3351 | 0.2035 | 0.0067 | 1 | | | |
| New product | −0.14 | −0.0673 | 0.1216 | 0.0532 | 0.0624 | 0.2018 | 0.1247 | 0.0208 | 0.0318 | −0.0072 | 0.0658 | 0.0948 | 1 | | |
| VC | −0.2568 | 0.0711 | 0.1833 | −0.0869 | 0.0334 | 0.2038 | 0.1101 | 0.0295 | 0.1934 | 0.1072 | 0.0802 | 0.0091 | 0.0999 | 1 | |
| R&D | −0.1875 | −0.0503 | 0.2264 | 0.0731 | 0.1851 | 0.4919 | 0.4122 | 0 | 0.0645 | 0.0557 | 0.0407 | 0 | 0.3077 | 0.182 | 1 |

**Table 5.2** Estimation results

| Ordered probit regression model 1 | | Number of observations: 186 | | | Pseudo $R^2$ = 0.1195 | |
|---|---|---|---|---|---|---|
| LR $\chi^2(5)$ = 69.97 | | Prob > $\chi^2$ = 0.0000 | | | Log likelihood = −257.7724 | |
| Sales growth | Coefficient | Standard error | Z-value | $P > z$ | 95% confidence interval | |
| Business age | −0.0609897 | 0.0091906 | −6.64 | 0.000 | −0.0790029 | −0.0429764 |
| Number of employees | 0.3165917 | 0.0989123 | 43,891 | 0.001 | 0.1227272 | 0.5104562 |
| Tax | −0.000909 | 0.0014754 | −0.62 | 0.538 | −0.0038007 | 0.0019828 |
| R&D | 0.5425875 | 0.1725875 | 41,699 | 0.002 | 0.2043223 | 0.8808528 |
| Export ratio | 0.2361641 | 0.1152351 | 40,665 | 0.040 | 0.0103075 | 0.4620206 |
| /cut1 | −1,706,588 | 0.6725346 | | | −3,024,732 | −0.3884444 |
| /cut2 | −0.5963969 | 0.6642638 | | | −189,833 | 0.7055363 |
| /cut3 | −0.0451874 | 0.6607479 | | | −1,340,229 | 1,249,855 |
| /cut4 | 0.5102087 | 0.6605765 | | | −0.7844974 | 1,804,915 |
| Ordered probit regression model 2 | | Number of observations: 186 | | | Pseudo $R^2$ = 0.1085 | |
| LR $\chi^2(5)$ = 63.54 | | Prob > $\chi^2$ = 0.0000 | | | Log likelihood =−260.9885 | |
| Sales growth | Coefficient | Standard error | Z-value | $P > z$ | 95% confidence interval | |
| Business age | −0.0603334 | 0.0091516 | −6.59 | 0.000 | −0.0782701 | −0.0423967 |
| Number of employees | 0.3020688 | 0.0983381 | 40,727 | 0.002 | 0.1093296 | 0.494808 |
| Tax | −0.0007723 | 0.0014746 | −0.52 | 0.600 | −0.0036624 | 0.0021178 |
| New product | 0.3026719 | 0.1621071 | 31,778 | 0.062 | −0.0150521 | 0.6203959 |
| Export ratio | 0.2859347 | 0.1132449 | 19,025 | 0.012 | 0.0639788 | 0.5078905 |
| /cut1 | −1,794,353 | 0.6729164 | | | −3,113,245 | −0.4754615 |
| /cut2 | −0.7207349 | 0.6633193 | | | −2,020,817 | 0.5793471 |
| /cut3 | −0.1731732 | 0.6601975 | | | −1,467,137 | 112,079 |
| /cut4 | 0.3804453 | 0.6601895 | | | −0.9135022 | 1,674,393 |
| Ordered probit regression model 3 | | Number of observations: 186 | | | Pseudo $R2$ = 0.1106 | |
| LR $\chi^2(5)$ = 64.75 | | Prob > $\chi^2$ = 0.0000 | | | Log likelihood =−260.381 | |
| Sales growth | Coefficient | Standard error | Z-value | $P > z$ | 95% confidence interval | |
| Business age | −0.0618713 | 0.0091317 | −6.78 | 0.000 | −0.079769 | −0.0439735 |
| Number of employees | 0.3107915 | 0.0984948 | 42,430 | 0.002 | 0.1177453 | 0.5038377 |

(continued)

**Table 5.2** (continued)

| | | | | | | |
|---|---|---|---|---|---|---|
| Ordered probit regression model 3 | | Number of observations: 186 | | | Pseudo $R2$ = 0.1106 | |
| LR $\chi^2(5)$ = 64.75 | | Prob > $\chi^2$ = 0.0000 | | | Log likelihood =−260.381 | |
| Sales growth | Coefficient | Standard error | $Z$-value | $P > z$ | 95% confidence interval | |
| Tax | −0.0001995 | 0.0015092 | −0.13 | 0.895 | −0.0031575 | 0.0027585 |
| Actively involved in a cluster | −0.4769163 | 0.2202052 | −2.17 | 0.030 | −0.9085105 | −0.0453221 |
| Export ratio | 0.290385 | 0.1129803 | 20,852 | 0.010 | 0.0689478 | 0.5118223 |
| /cut1 | −1,784,668 | 0.6707472 | | | −3,099,308 | −0.4700272 |
| /cut2 | −0.7163219 | 0.6601817 | | | −2,010,254 | 0.5776104 |
| /cut3 | −0.166628 | 0.6569734 | | | −1,454,272 | 1,121,016 |
| /cut4 | 0.3946267 | 0.6574733 | | | −0.8939972 | 1,683,251 |
| Ordered probit regression model 4 | | Number of observations: 186 | | | Pseudo $R^2$ = 0.1091 | |
| LR $\chi^2(5)$ = 63.87 | | Prob > $\chi^2$ = 0.0000 | | | Log likelihood =−260.82192 | |
| Sales growth | Coefficient | Standard error | $Z$-value | $P > z$ | 95% confidence interval | |
| Business age | −0.0613678 | 0.0091384 | −6.72 | 0.000 | −0.0792788 | −0.0434567 |
| Number of employees | 0.2841439 | 0.0977754 | 33,270 | 0.004 | 0.0925077 | 0.4757802 |
| Tax | −0.0011152 | 0.0014738 | −0.76 | 0.449 | −0.0040038 | 0.0017734 |
| Cooperation with business | 0.3424893 | 0.1754199 | 34,700 | 0.051 | −0.0013273 | 0.6863059 |
| Export ratio | 0.2745165 | 0.1137165 | 15,008 | 0.016 | 0.0516362 | 0.4973968 |
| /cut1 | −201,343 | 0.6635541 | | | −3,313,972 | −0.7128883 |
| /cut2 | −0.9459341 | 0.6525138 | | | −2,224,838 | 0.3329695 |
| /cut3 | −0.398982 | 0.6484976 | | | −1,670,014 | 0.8720499 |
| /cut4 | 0.1582757 | 0.6482533 | | | −1,112,278 | 1,428,829 |
| Ordered probit regression model 5 | | Number of observations: 186 | | | Pseudo $R^2$ = 0.1040 | |
| LR $\chi^2(5)$ = 60.92 | | Prob > $\chi^2$ = 0.0000 | | | Log likelihood =−262.29573 | |
| Sales growth | Coefficient | Standard error | $Z$-value | $P > z$ | 95% confidence interval | |
| Business age | −0.0605744 | 0.0091465 | −6.62 | 0.000 | −0.0785012 | −0.0426476 |
| Number of employees | 0.2832274 | 0.0977192 | 32,905 | 0.004 | 0.0917014 | 0.4747535 |
| Tax | −0.0010062 | 0.0014711 | −0.68 | 0.494 | −0.0038895 | 0.0018772 |
| Cooperation with university | 0.1779234 | 0.19031 | 0.93 | 0.350 | −0.1950774 | 0.5509242 |

(continued)

**Table 5.2** (continued)

| Ordered probit regression model 5 | | Number of observations: 186 | | | Pseudo $R^2$ = 0.1040 | |
|---|---|---|---|---|---|---|
| LR $\chi^2(5)$ = 60.92 | | Prob > $\chi^2$ = 0.0000 | | | Log likelihood =−262.29573 | |
| Sales growth | Coefficient | Standard error | $Z$-value | $P > z$ | 95% confidence interval | |
| Export ratio | 0.2939287 | 0.1130518 | 21,947 | 0.009 | 0.0723513 | 0.5155061 |
| /cut1 | −1,995,781 | 0.6627146 | | | −3,294,678 | −0.6968843 |
| /cut2 | −0.9274522 | 0.651526 | | | −220,442 | 0.3495153 |
| /cut3 | −0.3870822 | 0.6476245 | | | −1,656,403 | 0.8822386 |
| /cut4 | 0.1608492 | 0.6472055 | | | −110,765 | 1,429,349 |
| Ordered probit regression model 6 | | Number of observations: 186 | | | Pseudo $R^2$ = 0.1026 | |
| LR $\chi^2(5)$ = 60.05 | | Prob > $\chi^2$ = 0.0000 | | | Log likelihood =−262.73291 | |
| Sales growth | Coefficient | Standard error | $Z$-value | $P > z$ | 95% confidence interval | |
| Business age | −0.0612239 | 0.0092025 | −6.65 | 0.000 | −0.0792605 | −0.0431872 |
| Number of employees | 0.2849188 | 0.0984276 | 32,540 | 0.004 | 0.0920042 | 0.4778334 |
| Tax | −0.0008947 | 0.0019381 | −0.46 | 0.644 | −0.0046932 | 0.0029039 |
| University town | −0.0069739 | 0.2224589 | −0.03 | 0.975 | −0.4429853 | 0.4290375 |
| Export ratio | 0.3006077 | 0.1128041 | 24,139 | 0.008 | 0.0795157 | 0.5216997 |
| /cut1 | −198,943 | 0.7558411 | | | −3,470,851 | −0.5080086 |
| /cut2 | −0.9309366 | 0.7488312 | | | −2,398,619 | 0.5367455 |
| /cut3 | −0.3923474 | 0.7450972 | | | −1,852,711 | 1,068,016 |
| /cut4 | 0.1575518 | 0.7431499 | | | −1,298,995 | 1,614,099 |
| Ordered probit regression model 7 | | Number of observations: 181 | | | Pseudo $R^2$ = 0.1103 | |
| LR $\chi^2(5)$ = 62.98 | | Prob > $\chi^2$ = 0.0000 | | | Log likelihood = −253.92001 | |
| Sales growth | Coefficient | Standard error | $Z$-value | $P > z$ | 95% confidence interval | |
| Business age | −0.0632476 | 0.0092139 | −6.86 | 0.000 | −0.0813064 | −0.0451887 |
| Number of employees | 0.3225352 | 0.0999876 | 44,986 | 0.001 | 0.1265631 | 0.5185074 |
| Tax | −0.0009424 | 0.0015135 | −0.62 | 0.534 | −0.0039087 | 0.002024 |
| Access to human capital | 0.1207442 | 0.1079238 | 40,878 | 0.263 | −0.0907826 | 0.3322709 |
| Export ratio | 0.2843736 | 0.1140255 | 17,930 | 0.013 | 0.0608876 | 0.5078595 |
| /cut1 | −1,951,903 | 0.6874061 | | | −3,299,194 | −0.6046118 |

(continued)

**Table 5.2** (continued)

| Ordered probit regression model 7<br>LR $\chi^2(5) = 62.98$<br>Sales growth | <br><br>Coefficient | Number of observations: 181<br>Prob > $\chi^2 = 0.0000$<br>Standard error | <br><br>$Z$-value | <br><br>$P > z$ | Pseudo $R^2 = 0.1103$<br>Log likelihood = −253.92001<br>95% confidence interval | |
|---|---|---|---|---|---|---|
| /cut2 | −0.8728224 | 0.6773946 | | | −2,200,491 | 0.4548467 |
| /cut3 | −0.3158601 | 0.6727003 | | | −1,634,328 | 1,002,608 |
| /cut4 | 0.2528832 | 0.6720639 | | | −1,064,338 | 1,570,104 |
| Ordered probit regression model 8<br>LR $\chi^2(5) = 60.07$<br>Sales growth | <br><br>Coefficient | Number of observations: 186<br>Prob > $\chi^2 = 0.0000$<br>Standard error | <br><br>$Z$-value | <br><br>$P > z$ | Pseudo $R^2 = 0.1026$<br>Log likelihood = −262.72076<br>95% confidence interval | |
| Business age | −0.0612727 | 0.0091332 | −6.71 | 0.000 | −0.0791736 | −0.0433719 |
| Number of employees | 0.2853248 | 0.0978236 | 33,635 | 0.004 | 0.0935941 | 0.4770555 |
| Tax | −0.0009772 | 0.0014942 | −0.65 | 0.513 | −0.0039057 | 0.0019513 |
| ICT firm density | 474,725 | 2,986,435 | 0.16 | 0.874 | −537,858 | 632,803 |
| Export ratio | 0.299856 | 0.1128885 | 24,139 | 0.008 | 0.0785987 | 0.5211134 |
| /cut1 | −1,990,504 | 0.665925 | | | −3,295,693 | −0.685315 |
| /cut2 | −0.9320508 | 0.6548006 | | | −2,215,436 | 0.3513348 |
| /cut3 | −0.3936059 | 0.6507779 | | | −1,669,107 | 0.8818954 |
| /cut4 | 0.156512 | 0.6505227 | | | −1,118,489 | 1,431,513 |
| Ordered probit regression model 9<br>LR $\chi^2(5) = 56.66$<br>Sales growth | <br><br>Coefficient | Number of observations: 175<br>Prob > $\chi^2 = 0.0000$<br>Standard error | <br><br>$Z$-value | <br><br>$P > z$ | Pseudo $R^2 = 0.1030$<br>Log likelihood = −246.68022<br>95% confidence interval | |
| Business age | −0.0622626 | 0.0094996 | −6.55 | 0.000 | −0.0808814 | −0.0451887 |
| Number of employees | 0.2909025 | 0.1016746 | 31,444 | 0.004 | 0.0916239 | 0.5185074 |
| Tax | −0.0003757 | 0.00152 | −0.25 | 0.805 | −0.0033549 | 0.002024 |
| Regional policy | −0.0793588 | 0.1030412 | −0.77 | 0.441 | −0.2813159 | 0.3322709 |
| Export ratio | 0.2742637 | 0.1155354 | 13,547 | 0.018 | 0.0478186 | 0.5078595 |
| /cut1 | −1,839,102 | 0.6901531 | | | −3,191,777 | −0.4864263 |
| /cut2 | −0.7752586 | 0.6812694 | | | −2,110,522 | 0.5600049 |
| /cut3 | −0.241249 | 0.6778219 | | | −1,569,756 | 1,087,258 |
| /cut4 | 0.2922003 | 0.6770623 | | | −1,034,817 | 1,619,218 |

(continued)

**Table 5.2** (continued)

| Ordered probit regression model 9 | | Number of observations: 175 | | | Pseudo $R^2$ = 0.1030 | |
|---|---|---|---|---|---|---|
| LR $\chi^2(5)$ = 56.66 | | Prob > $\chi^2$ = 0.0000 | | | Log likelihood = −246.68022 | |
| Sales growth | Coefficient | Standard error | *Z*-value | $P > z$ | 95% confidence interval | |
| Ordered probit regression model 10 | | Number of observations: 160 | | | Pseudo $R^2$ = 0.1408 | |
| LR $\chi^2(5)$ = 71.41 | | Prob > $\chi^2$ = 0.0000 | | | Log likelihood = −217.88332 | |
| Sales growth | Coefficient | Standard error | *Z*-value | $P > z$ | 95% confidence interval | |
| Business age | −0.0739443 | 0.0107636 | −6.87 | 0.000 | −0.0950405 | −0.0528481 |
| Number of employees | 0.4255806 | 0.1111843 | 30,376 | 0.000 | 0.2076634 | 0.6434978 |
| Tax | −0.0019861 | 0.0016291 | −1.22 | 0.223 | −0.0051792 | 0.0012069 |
| Equity ratio | 0.2604528 | 0.1027162 | 19,756 | 0.011 | 0.0591328 | 0.4617728 |
| Export ratio | 0.3042691 | 0.1204765 | 19,391 | 0.012 | 0.0681395 | 0.5403986 |
| /cut1 | −2,341,395 | 0.7328978 | | | −3,777,848 | −0.9049413 |
| /cut2 | −1,270,609 | 0.7198295 | | | −2,681,448 | 0.1402312 |
| /cut3 | −0.6607789 | 0.7153015 | | | −2,062,744 | 0.7411862 |
| /cut4 | −0.0072122 | 0.7137889 | | | −1,406,213 | 1,391,788 |
| Ordered probit regression model 11 | | Number of observations: 186 | | | Pseudo $R^2$ = 0.1136 | |
| LR $\chi^2(5)$ = 66.50 | | Prob > $\chi^2$ = 0.0000 | | | Log likelihood = −259.50883 | |
| Sales growth | Coefficient | Standard error | *Z*-value | $P > z$ | 95% confidence interval | |
| Business age | −0.0563961 | 0.0093217 | −6.05 | 0.000 | −0.0746664 | −0.0381258 |
| Number of employees | 0.2568207 | 0.0985279 | 22,313 | 0.009 | 0.0637096 | 0.4499317 |
| Tax | −0.0011859 | 0.0014761 | −0.80 | 0.422 | −0.004079 | 0.0017071 |
| VC | 0.6267491 | 0.2492107 | 18,660 | 0.012 | 0.1383052 | 1,115,193 |
| Export ratio | 0.2554976 | 0.1144972 | 44,958 | 0.026 | 0.0310873 | 0.479908 |
| /cut1 | −203,101 | 0.6648558 | | | −3,334,103 | −0.7279165 |
| /cut2 | −0.9740744 | 0.6539016 | | | −2,255,698 | 0.3075491 |
| /cut3 | −0.4264336 | 0.6497981 | | | −1,700,014 | 0.8471472 |
| /cut4 | 0.1442275 | 0.649489 | | | −1,128,747 | 1,417,202 |

This or rather the following summary reveals some interesting observations. According to the third hypothesis, the age of a business seems to have a negative and strongly significant impact on the prospects for high growth dynamics of each enterprise concerned. The number of employees, in other words a proxy for the size of the concerned enterprise, seems to have a high, significantly positive effect on the prospects for a high revenue growth. This is not a matter of course since the correlation between business age and business size will be usually positive and high. This leads to the assumption that ICT enterprises can be broadly grouped into two categories. On the one hand, there are young, dynamic businesses with a relatively high number of employees and, on the other hand, older businesses with rather low growth dynamics. R&D activities usually correlate with a higher prospect of growth, in particular if they result in a marketable product. If a marketable product is placed on the market, the prospects for increased sales will be enhanced, which is hardly surprising. Other surveyed innovations, such as organizational improvements, do not reveal any direct impact on growth. This is a hardly surprising fact since organizational improvements, for example, take place on a continuous basis and rather relate to cost reductions instead of having a direct impact on growth. The degree of internationalization of the enterprises, on the other hand, has a measurable positive significant impact. Increased export activity, measured as a ratio of domestic turnover to foreign turnover, increases the chance that an enterprise will find itself in a higher growth rate category (Fig. 5.1).

More surprising is the result for enterprises that are part of a cluster structure. The assessment relates to enterprises that stated that they were part of a cluster and, moreover, that they actively participated in the cluster. An initial analysis provided the surprising result that there is a significant negative correlation between enterprises that consider themselves to be an active member of a cluster and their growth dynamics. Therefore, in a second step, only enterprises that have their registered office in a region belonging to an ICT cluster, according to the data provided by BMWi and the European Cluster Observatory, were included in the assessment to add an objective component to the subjective assessment of the interviewed business. Since the networking initiative established by the Ministry of Economics, via the local cluster management, actively engages in internal and external marketing activities in the regions, it can be assumed that local businesses will be aware of this issue, meaning that businesses should have an awareness and knowledge of the existence of the network.

To measure the potential impact of intrasectoral spillover effects, so-called Marshall–Arrow–Romer (MRA) externalities, ICT enterprise density in the county or city of the interviewed enterprise was taken into consideration in a further assessment. However, a higher ICT business density per se did not result in an increased growth dynamics rate.[10] Interestingly enough, this changes as soon as a

[10] No significant effect resulted, as already mentioned, from the inclusion of the spread of enterprises and employment across all sectors in the analysis, to identify any Jacobs externalities, which arise from a conglomeration of various industries.

| Corporate growth impact factors | Number of observations | Impact/Significance* |
|---|---|---|
| Business age | 186 | -*** |
| Number of employees | 186 | +*** |
| Tax (municipal multiplier) rate | 186 | 0 |
| Export ratio | 186 | +** |
| R&D | 186 | +*** |
| New product | 186 | +* |
| Actively involved in a cluster | 186 | -** |
| Cooperation with businesses | 186 | +** |
| Cooperation with universities | 186 | 0 |
| University town | 186 | 0 |
| Access to human capital | 181 | 0 |
| Regional policy | 175 | 0 |
| Equity ratio | 160 | +*** |
| Venture capital | 186 | +*** |
| (ICT) Business or employment density | 86 | - |

* Significance level of 5-10% of the Z-value in the corresponding statistical test

** Significance level of 1-5% of the Z-value in the corresponding statistical test

*** Significance level of up to 1% of the Z-value in the corresponding statistical test

**Fig. 5.1** Summary of the results of the ordered probit estimations

specific cooperation was entered into with another enterprise. Cooperation with other businesses significantly increases the prospects for higher growth dynamics. This same effect could not be measured for cooperation projects with universities and/or research institutions. Also whether the enterprise is located in a university town, with a university or university of applied sciences, offering courses of study that are of relevance to ICT enterprises, does not seem to constitute a criterion for increased corporate growth prospects, compared to ICT enterprises situated in locations without a university or a university of applied sciences. Though nearly 40% of the interviewees responded that the availability of qualified employees was deemed to be a critical or even very critical aspect in relation to the needs of their own enterprise, no significant immediate correlation with corporate growth was discernible. The assessment of regional economic policies also did not provide any direct, measurable effect.

Of the interviewed enterprises that returned the questionnaire, 33 had obtained VC financing. 25 of these enterprises stated that the participation of the VC provided an additional added value to the business. These businesses are very likely to show a faster growth in revenue than businesses that did not receive VC financing. Data show in addition that numerous businesses had benefitted from VC participation a considerable time ago and that the growth dynamics remained high also after the end of the participation. The obtained data also show that the prospects for a high growth dynamics rate increase with an increasing equity capital ratio. The survey also indicated that enterprises stating that they had good or very good access to capital also showed a faster rate of growth. A relatively high correlation between these data and a high equity capital ratio was observed, which is hardly remarkable. Even if the result is not listed separately, a significant positive correlation between high growth dynamics and access to capital was established. The question of causality, in other words, if higher corporate growth leads to a higher equity capital ratio or vice versa, could not be definitely answered on the basis of the surveyed cross-sectional data or on the basis of the obtained data. However, the general issues revolving around obtaining financing for innovative enterprises were discussed in the previous section. In addition, the data under consideration indicate that lacking financing opportunities presents a growth obstacle for ICT enterprises. Nearly 28% of the interviewed businesses stated that they failed to obtain sufficient capital for necessary investments.

## 5.5 Conclusions

Dynamically growing ICT businesses are of vital importance for the entire German economy. The analysis under consideration examined potential growth determinants on the basis of approx. 300 enterprises to obtain more information about the dynamic growth of German ICT businesses. The data collected with great care and effort by means of an electronic questionnaire produced in part interesting results. The survey focused in particular on establishing company-specific and regional factors that had a positive impact on the growth of German ICT businesses. The findings show that research and development activities, the generation of new products, a high equity capital ratio, a high level of export activities, and specific cooperation projects with other businesses are characteristic for comparatively fast-growing enterprises in the ICT sector. The same applies to companies with venture capital financing. Growth dynamics behave conversely to the age of a business, meaning that young businesses grow faster than older ones. Since only businesses that "survived" were interviewed, these results may be distorted by a higher market exit rate of younger businesses and must accordingly be put into perspective with regard to their significance. Initially surprising were however the empirical results for businesses in a cluster. Even though they do not coincide at first glance with the commonly alleged positive effects of clusters, the results are not particularly astounding at second glance. The finding that businesses, which consider themselves to be part of a cluster and which have their registered seat in a region that was designated by the BMWi networking initiative, have significantly lower growth expectations permits the assumption that high-growth businesses are hardly interested in becoming actively involved in a cluster since it puts their monopoly profits or competitive advantages at risk. These businesses focus on specific research and development cooperation projects. They seek to avoid a drain of implicit technical knowledge by an opening or active involvement in the cluster since there is no evident necessity for it. On the other hand, low-growth businesses have an interest to become involved in a cluster to increase their survival prospects. The result illustrates that the structure of artificially induced networks unintentionally tends to attract low-growth enterprises, while the integration of successful business, on the other hand, is difficult even though the attraction of successful companies is the objective of public networking policies in order to achieve growth-inducing effects. The findings confirm that (initiated) ICT clusters in Germany only serve to a limited extent as locations for enhanced diffusion of knowledge since highly innovative and high-growth enterprises will rarely be induced to become actively involved in a cluster. The Dutch region of Eindhoven may serve as an example of positive exception. Philips, as an important I(C)T enterprise, voluntarily disclosed know-how and, thus, contributed significantly to the positive development of the local ICT cluster.

It must also be kept in mind that according to Porter, the term cluster must not be used synonymously with specific networks established between economic agents but rather describes a diffuse and creative atmosphere that has an innovative impact on the businesses established in a particular region. Indirect impacts, for example, on other businesses in a cluster could not be included in the scope of this study. As a consequence of a concentration of businesses, the mere geographic proximity will improve the chances for “coming across” potential future cooperation partners. One of the findings of this study is that specific cooperation agreements concluded between ICT enterprises with regard to R&D lead to improved prospects for corporate growth.

Of course, the analysis under consideration did not take all factors that may have a potential impact on growth into account. For example, the individual qualities of an entrepreneur of corporate managers were not taken into consideration. Their skills and personalities, corporate philosophy, the ability to promptly respond to customer needs or to changed circumstances in the competitive situation, and marketing activities and anticipating new technological trends are factors determining the success of a business venture. And finally, the coordination and activation of potentials are important determinants for success, which remained outside the scope of this analysis.

On the other hand, it was possible to identify some characteristic features of successful German ICT enterprises by means of very carefully collected data. The results of this study may motivate further sector-specific analyses, in particular with regard to the phenomenon of business agglomerations. Different behavioral patterns apply in the various industrial sectors and economic policymakers should anticipate them in order to respond successfully.

## Annex: Statistical information on the responses of surveyed companies (selection)

| The companies surveyed are | | |
|---|---|---|
| Answer | Amount | Percentage |
| An single-site company without branch | 115 | 54.25% |
| The headquarters of a company with branch(es) | 75 | 35.38% |
| Branch, subsidiary company | 20 | 15.95% |
| Other | 2 | 0.94% |
| No answer | 0 | 0.00% |
| The companies surveyed were | | |
| Answer | Amount | Percentage |
| A complete start-up company | 167 | 79.15% |
| A takeover of an existing company | 15 | 7.11% |
| A spin-off of an existing company | 24 | 11.37% |
| A spin-off from a university | 2 | 0.95% |
| A research institute | 0 | 0.00% |
| Other | 3 | 1.42% |
| No answer | 0 | 0.00% |
| How many permanent employees are currently working in the company? (Please convert part-time workers to full-time employees (with ½, ¼, etc.))? | | |
| Answer | Amount | Percentage |
| 0–10 | 45 | 21.13% |
| More than 10–25 | 80 | 37.56% |
| More than 25–50 | 37 | 17.37% |
| More than 50–100 | 17 | 7.98% |
| More than 100–250 | 19 | 8.92% |
| More than 250–500 | 7 | 3.29% |
| More than 500 | 8 | 3.76% |
| No answer | 0 | 0.00% |
| Compared with the number of employees from three years ago, the company now employs | | |
| Answer | Amount | Percentage |
| More employees | 129 | 60.56% |
| Fewer employees | 22 | 10.33% |
| About the same number of employees | 56 | 26.29% |
| No answer | 6 | 2.82% |
| What is the annual turnover of the company? | | |
| Answer | Amount | Percentage |
| Less than 0.1 Mio. € | 6 | 2.82% |
| More than 0.1 Mio. € to 0.5 Mio. € | 24 | 11.27% |
| More than 0.5 Mio. € to 1 Mio. € | 28 | 13.15% |
| More 1 Mio. € to 2.5 Mio. € | 63 | 29.58% |
| More than 2.5 Mio. € to 5 Mio. € | 33 | 15.49% |
| More than 5 Mio. € to 10 Mio. € | 16 | 7.51% |
| More than 10 Mio. € to 50 Mio. € | 29 | 13.62% |
| More than 50 Mio. € to 100 Mio. € | 8 | 3.76% |

(continued)

| | | |
|---|---|---|
| More than 100 Mio. € to 500 Mio. € | 4 | 1.88% |
| More than 500 Mio. € | 1 | 0.47% |
| No answer | 1 | 0.47% |

What is the percentage of foreign sales to total sales (export earnings)?

| Answer | Amount | Percentage |
|---|---|---|
| 0 | 60 | 28.17% |
| More than 0–20% | 94 | 44.13% |
| More than 20–40% | 28 | 13.15% |
| More than 40–60% | 12 | 5.63% |
| More than 60–80% | 4 | 1.88% |
| More than 80% | 3 | 1.41% |
| No answer | 12 | 5.63% |

What is the annual average growth rate of the company's turnover in the last five years? If the company does not yet exist for 5 years, please indicate the average annual growth rate since the start of business

| Answer | Amount | Percentage |
|---|---|---|
| No growth or negative growth | 27 | 12.68% |
| 0–2.5% | 27 | 12.68% |
| More than 2.5–5% | 29 | 13.62% |
| More than 5–10% | 34 | 15.96% |
| More than 10–20% | 30 | 14.08% |
| More than 20–30% | 27 | 12.68% |
| More than 30–50% | 8 | 3.76% |
| More than 50% (8) | 14 | 6.57% |
| No answer | 17 | 7.98% |

Has the company been innovative in the past 3 years? That is, has completely new product been developed within the last 3 years and/or was there an improvement of an existing product instead and/or was a new technology introduced, which has substantially changed the production of an existing product and or was there an organizational improvement in the company? (It is important to assess from the perspective of your business. It does not matter if another company has already introduced this innovation)

| Answer | Amount | Percentage |
|---|---|---|
| Yes (Y) | 178 | 83.57% |
| No (N) | 26 | 12.21% |
| No answer | 9 | 4.23% |

What kind of innovation(s) were there in the last 3 years?

| Answer | Amount | Percentage |
|---|---|---|
| Completely new product (1) | 96 | 45.07% |
| Improvement of an existing product (2) | 103 | 48.36% |
| Introduction of a new technology which has substantially changed the production of an existing product (3) | 74 | 34.74% |
| Organizational improvement (4) | 70 | 32.86% |

Does the company run research and development?

| Answer | Amount | Percentage |
|---|---|---|
| Yes (Y) | 134 | 62.91% |
| No (N) | 70 | 32.86% |
| No answer | 9 | 4.23% |

(continued)

Does the company run such research and development activities continuously or only occasionally?

| Answer | Amount | Percentage |
|---|---|---|
| Continuously (1) | 97 | 51.60% |
| Occasionally (2) | 36 | 19.15% |
| No answer | 55 | 29.26% |

What was the expenditure on research and development as a percentage of total sales in 2008?

| Answer | Amount | Percentage |
|---|---|---|
| 0% (1) | 2 | 1.06% |
| More than 0–2.5% (2) | 8 | 4.26% |
| More than 2.5–5% (3) | 24 | 12.77% |
| More than 5–7.5% (4) | 21 | 11.17% |
| More than 7.5–10% (5) | 19 | 10.11% |
| More than 10% | 49 | 26.06% |
| No answer | 65 | 34.57% |

In the last 3 years, has there been at least one application for a patent by the company, or is one currently in the application stage?

| Answer | Amount | Percentage |
|---|---|---|
| Yes (Y) | 20 | 9.39% |
| No (N) | 180 | 84.51% |
| No answer | 13 | 6.10% |

Is it possible for the company without further ado to raise the necessary capital for new investments?

| Answer | Amount | Percentage |
|---|---|---|
| Totally applies (1) | 35 | 16.43% |
| Applies most of the time (2) | 55 | 25.82% |
| Applies partially (3) | 47 | 22.07% |
| Does not apply most of the time (4) | 41 | 19.25% |
| Does not apply at all (5) | 18 | 8.45% |
| No answer (6) | 17 | 7.98% |

How high is the equity ratio of the company?

| Answer | Amount | Percentage |
|---|---|---|
| 0% (1) | 0 | 0.00% |
| More than 0–20% (2) | 42 | 19.72% |
| More than 20–40% (3) | 36 | 16.90% |
| More than 40–60% (4) | 24 | 11.27% |
| More than 60–80% (5) | 16 | 7.51% |
| More than 80% | 52 | 24.41% |
| No answer | 43 | 20.19% |

Does the company currently receives venture capital, or has it ever received any?

| Answer | Amount | Percentage |
|---|---|---|
| Yes (Y) | 33 | 15.49% |
| No (N) | 167 | 78.40% |
| No answer | 13 | 6.10% |

(continued)

Has the company filed one or several patents or developed a prototype at the time it received venture capital?

| Answer | Amount | Percentage |
|---|---|---|
| Yes, one or more patents (1) | 8 | 3.76% |
| Yes, one or more prototypes (2) | 15 | 7.04% |
| Neither (3) | 13 | 6.10% |

Has the influence of the venture capital company basically brought an added value to the company in terms of additional know-how and/or additional networks? Please rate on a scale from 1 to 5.

| Answer | Amount | Percentage |
|---|---|---|
| Very high (1) | 0 | 0.00% |
| High (2) | 10 | 6.45% |
| Moderate (3) | 10 | 6.45% |
| Low (4) | 5 | 3.23% |
| No added value (5) | 6 | 3.87% |
| No answer | 124 | 80.00% |

What was or is the added value to the company by the venture capitalist (or venture capital company)?

| Answer | Amount | Percentage |
|---|---|---|
| Additional patent application (s) (1) | 0 | 0.00% |
| A higher revenue growth than previously (2) | 7 | 3.29% |
| Additional know-how and/or networks with other companies (3) | 16 | 7.51% |
| Other | 2 | 0.94% |

How is the availability of qualified personnel in the labor market for the company-specific needs assessed? Please rate on a scale from 1 to 5

| Answer | Amount | Percentage |
|---|---|---|
| Very high (1) | 13 | 6.10% |
| High (2) | 28 | 13.15% |
| Moderate (3) | 82 | 38.50% |
| Low (4) | 63 | 29.58% |
| Very low (5) | 20 | 9.39% |
| No answer | 7 | 3.29% |

Is the company a player in regional economic cluster? The term cluster means networks of closely cooperating companies, which are located in close proximity to each other and which are related or complement their activities, along one or more value chains. Are there other companies in your industry and your area with which the company maintains close economic cooperation?

| Answer | Amount | Percentage |
|---|---|---|
| Yes (Y) | 87 | 40.85% |
| No (N) | 116 | 54.46% |
| No answer | 10 | 4.69% |

Is the company, in their own perception, an active participant in this cluster? Please rate on a scale from 1 to 5

| Answer | Amount | Percentage |
|---|---|---|
| Very active (1) | 19 | 10.86% |
| Active (2) | 47 | 26.86% |
| Neutral (3) | 16 | 9.14% |

(continued)

| | | |
|---|---|---|
| Little active (4) | 5 | 2.86% |
| Not active (5) | 0 | 0.00% |
| No answer | 88 | 50.29% |

Do collaborations with other companies or research institutions (e.g., universities or research institution) happen in terms of research and development of new products/services?

| Answer | Amount | Percentage |
|---|---|---|
| Yes, there is cooperation in terms of research and development with other companies (1) | 62 | 29.11% |
| Yes, there is cooperation in terms of research and development with research institutions (2) | 45 | 21.13% |
| No, there is no cooperation in terms of research and development (3) | 53 | 24.88% |

Did one or more patents develop from there collaborations, which otherwise would have probably not been developed?

| Answer | Amount | Percentage |
|---|---|---|
| Yes (1) | 5 | 2.87% |
| No (2) | 66 | 37.93% |
| No idea (3) | 4 | 2.30% |
| No answer | 99 | 56.90% |

How high would you estimate the value of cooperation in terms of new innovations for products/services? Please rate on a scale from 1 to 5.

| Answer | Amount | Percentage |
|---|---|---|
| Very high (1) | 10 | 5.75% |
| High (2) | 40 | 22.99% |
| Moderate (3) | 25 | 14.37% |
| Low (4) | 4 | 2.30% |
| Very low (5) | 1 | 0.57% |
| No answer | 94 | 54.02% |

Are the partners located in close proximity (less than 30 km) in terms of research and development of new products/services?

| Answer | Amount | Percentage |
|---|---|---|
| All partners are located in close proximity (1) | 21 | 9.86% |
| Most of the partners are located in close proximity (2) | 33 | 15.49% |
| About half of the partners are located in close proximity (3) | 22 | 10.33% |
| Few partners are located in close proximity (4) | 32 | 15.02% |
| No partners are located in close proximity (5) | 26 | 12.21% |
| No answer | 79 | 37.09% |

Please evaluate the supporting effect of politics on a positive business development (policies at regional level).

| Answer | Amount | Percentage |
|---|---|---|
| Very high (1) | 15 | 7.04% |
| High (2) | 36 | 16.90% |
| Moderate (3) | 49 | 23.00% |
| Little (4) | 44 | 20.66% |
| Very little (5) | 54 | 25.35% |
| No answer | 15 | 7.04% |

(continued)

What is the annual turnover of the company?

| Answer | Amount | Percentage |
|---|---|---|
| Less than 0.1 Mio. € | 6 | 2.82% |
| More than 0.1 Mio. € to 0.5 Mio. € | 24 | 11.27% |
| More than 0.5 Mio. € to 1 Mio. € | 28 | 13.15% |
| More 1 Mio. € to 2.5 Mio. € | 63 | 29.58% |
| More than 2.5 Mio. € to 5 Mio. € | 33 | 15.49% |
| More than 5 Mio. € to 10 Mio. € | 16 | 7.51% |
| More than 10 Mio. € to 50 Mio. € | 29 | 13.62% |
| More than 50 Mio. € to 100 Mio. € | 8 | 3.76% |
| More than 100 Mio. € to 500 Mio. € | 4 | 1.88% |
| More than 500 Mio. € | 1 | 0.47% |
| No answer | 1 | 0.47% |

What is the percentage of foreign sales to total sales (export earnings)?

| Answer | Amount | Percentage |
|---|---|---|
| 0 | 60 | 28.17% |
| More than 0–20% | 94 | 44.13% |
| More than 20–40% | 28 | 13.15% |
| More than 40–60% | 12 | 5.63% |
| More than 60–80% | 4 | 1.88% |
| More than 80% | 3 | 1.41% |
| No answer | 12 | 5.63% |

What is the annual average growth rate of the company's turnover in the last five years? If the company does not yet exist for 5 years, please indicate the average annual growth rate since the start of business

| Answer | Amount | Percentage |
|---|---|---|
| No growth or negative growth | 27 | 12.68% |
| 0–2.5% | 27 | 12.68% |
| More than 2.5–5% | 29 | 13.62% |
| More than 5–10% | 34 | 15.96% |
| More than 10–20% | 30 | 14.08% |
| More than 20–30% | 27 | 12.68% |
| More than 30–50% | 8 | 3.76% |
| More than 50% (8) | 14 | 6.57% |
| No answer | 17 | 7.98% |

Has the company been innovative in the past 3 years? That is, has completely new product been developed within the last 3 years, and/or was there an improvement of an existing product instead, and/or was a new technology introduced, which has substantially changed the production of an existing product, and/or was there an organizational improvement in the company? (It is important to assess from the perspective of your business. It does not matter that another company has already introduced this innovation)

| Answer | Amount | Percentage |
|---|---|---|
| Yes (Y) | 178 | 83.57% |
| No (N) | 26 | 12.21% |
| No answer | 9 | 4.23% |

(continued)

| What kind of innovation(s) were there in the last 3 years? | | |
|---|---|---|
| Answer | Amount | Percentage |
| Completely new product (1) | 96 | 45.07% |
| Improvement of an existing product (2) | 103 | 48.36% |
| Introduction of a new technology which has substantially changed the production of an existing product (3) | 74 | 34.74% |
| Organizational improvement (4) | 70 | 32.86% |
| **Does the company run research and development?** | | |
| Answer | Amount | Percentage |
| Yes (Y) | 134 | 62.91% |
| No (N) | 70 | 32.86% |
| No answer | 9 | 4.23% |
| **Does the company run such research and development activities continuously or only occasionally?** | | |
| Answer | Amount | Percentage |
| Continuously (1) | 97 | 51.60% |
| Occasionally (2) | 36 | 19.15% |
| No answer | 55 | 29.26% |
| **What was the expenditure on research and development as a percentage of total sales in 2008?** | | |
| Answer | Amount | Percentage |
| 0% (1) | 2 | 1.06% |
| More than 0–2.5% (2) | 8 | 4.26% |
| More than 2.5–5% (3) | 24 | 12.77% |
| More than 5–7.5% (4) | 21 | 11.17% |
| More than 7.5–10% (5) | 19 | 10.11% |
| More than 10% | 49 | 26.06% |
| No answer | 65 | 34.57% |
| **In the last 3 years, has there been at least one application for a patent by the company, or is one currently in the application stage?** | | |
| Answer | Amount | Percentage |
| Yes (Y) | 20 | 9.39% |
| No (N) | 180 | 84.51% |
| No answer | 13 | 6.10% |
| **Is it possible for the company without further ado to raise the necessary capital for new investments?** | | |
| Answer | Amount | Percentage |
| Totally applies (1) | 35 | 16.43% |
| Applies most of the time (2) | 55 | 25.82% |
| Applies partially (3) | 47 | 22.07% |
| Does not apply most of the time (4) | 41 | 19.25% |
| Does not apply at all (5) | 18 | 8.45% |
| No answer (6) | 17 | 7.98% |
| **How high is the equity ratio of the company?** | | |
| Answer | Amount | Percentage |
| 0% (1) | 0 | 0.00% |
| More than 0–20% (2) | 42 | 19.72% |
| More than 20–40% (3) | 36 | 16.90% |

(continued)

| | | |
|---|---|---|
| More than 40–60% (4) | 24 | 11.27% |
| More than 60–80% (5) | 16 | 7.51% |
| More than 80% | 52 | 24.41% |
| No answer | 43 | 20.19% |
| Does the company currently receives venture capital, or has it ever received any? | | |
| Answer | Amount | Percentage |
| Yes (Y) | 33 | 15.49% |
| No (N) | 167 | 78.40% |
| No answer | 13 | 6.10% |
| Has the company filed one or several patents or developed a prototype at the time it received venture capital? | | |
| Answer | Amount | Percentage |
| Yes, one or more patents (1) | 8 | 3.76% |
| Yes, one or more prototypes (2) | 15 | 7.04% |
| Neither (3) | 13 | 6.10% |
| Has the influence of the venture capital company basically brought an added value to the company in terms of additional know-how and/or additional networks? Please rate on a scale from 1 to 5 | | |
| Answer | Amount | Percentage |
| Very high (1) | 0 | 0.00% |
| High (2) | 10 | 6.45% |
| Moderate (3) | 10 | 6.45% |
| Low (4) | 5 | 3.23% |
| No added value (5) | 6 | 3.87% |
| No answer | 124 | 80.00% |
| What was or is the added value to the company by the venture capitalist (or venture capital company)? | | |
| Answer | Amount | Percentage |
| Additional patent application (s) (1) | 0 | 0.00% |
| A higher revenue growth than previously (2) | 7 | 3.29% |
| Additional know-how and/or networks with other companies (3) | 16 | 7.51% |
| Other | 2 | 0.94% |
| How is the availability of qualified personnel in the labor market for the company-specific needs assessed? Please rate on a scale from 1 to 5 | | |
| Answer | Amount | Percentage |
| Very high (1) | 13 | 6.10% |
| High (2) | 28 | 13.15% |
| Moderate (3) | 82 | 38.50% |
| Low (4) | 63 | 29.58% |
| Very low (5) | 20 | 9.39% |
| No answer | 7 | 3.29% |
| Is the company a player in regional economic cluster? The term cluster means networks of closely cooperating companies, which are located in close proximity to each other and which are related or complement their activities, along one or more value chains. Are there other companies in your industry and your area with which the company maintains close economic cooperation? | | |

(continued)

| Answer | Amount | Percentage |
|---|---|---|
| Yes (Y) | 87 | 40.85% |
| No (N) | 116 | 54.46% |
| No answer | 10 | 4.69% |

Is the company, in their own perception, an active participant in this cluster? Please rate on a scale from 1 to 5

| Answer | Amount | Percentage |
|---|---|---|
| Very active (1) | 19 | 10.86% |
| Active (2) | 47 | 26.86% |
| Neutral (3) | 16 | 9.14% |
| Little active (4) | 5 | 2.86% |
| Not active (5) | 0 | 0.00% |
| No answer | 88 | 50.29% |

Do collaborations with other companies or research institutions (e.g., universities or research institution) happen in terms of research and development of new products/services?

| Answer | Amount | Percentage |
|---|---|---|
| Yes, there is cooperation in terms of research and development with other companies (1) | 62 | 29.11% |
| Yes, there is cooperation in terms of research and development with research institutions (2) | 45 | 21.13% |
| No, there is no cooperation in terms of research and development (3) | 53 | 24.88% |

Did one or more patents develop from there collaborations, which otherwise would have probably not been developed?

| Answer | Amount | Percentage |
|---|---|---|
| Yes (1) | 5 | 2.87% |
| No (2) | 66 | 37.93% |
| No idea (3) | 4 | 2.30% |
| No answer | 99 | 56.90% |

How high would you estimate the value of cooperation in terms of new innovations for products/services? Please rate on a scale from 1 to 5

| Answer | Amount | Percentage |
|---|---|---|
| Very high (1) | 10 | 5.75% |
| High (2) | 40 | 22.99% |
| Moderate (3) | 25 | 14.37% |
| Low (4) | 4 | 2.30% |
| Very low (5) | 1 | 0.57% |
| No answer | 94 | 54.02% |

Are the partners located in close proximity (less than 30 km) in terms of research and development of new products/services?

| Answer | Amount | Percentage |
|---|---|---|
| All partners are located in close proximity (1) | 21 | 9.86% |
| Most of the partners are located in close proximity (2) | 33 | 15.49% |
| About half of the partners are located in close proximity (3) | 22 | 10.33% |
| Few partners are located in close proximity (4) | 32 | 15.02% |
| No partners are located in close proximity (5) | 26 | 12.21% |
| No answer | 79 | 37.09% |

(continued)

Please evaluate the supporting effect of politics on a positive business development (policies at regional level)

| Answer | Amount | Percentage |
|---|---|---|
| Very high (1) | 15 | 7.04% |
| High (2) | 36 | 16.90% |
| Moderate (3) | 49 | 23.00% |
| Little (4) | 44 | 20.66% |
| Very little (5) | 54 | 25.35% |
| No answer | 15 | 7.04% |

To what extent do barriers of large companies prevent or hinder an involvement in networks? Please rate on a scale from 1 to 5

| Answer | Amount | Percentage |
|---|---|---|
| Very high (1) | 24 | 11.27% |
| High (2) | 39 | 18.31% |
| Moderate (3) | 44 | 20.66% |
| Low (4) | 41 | 19.25% |
| Very low (5) | 20 | 9.39% |
| No answer | 45 | 21.13% |

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# Chapter 6
# Innovation and Specialization Dynamics in the European Automotive Sector: Comparative Analysis of Cooperation and Application Network

**Oliver Emons**

## 6.1 Introduction

The strong global competition in the automotive industry—standing for medium and even high technology—reinforces the role of both product innovation and process innovation; therefore, expenditures on research and development (R&D) are important elements in the strategy of leading firms. At the same time, governments in countries and regions with automotive producers are interested in promoting regional innovation systems that reinforce the international competitiveness of automotive firms.

Improving regional innovation dynamics is a natural element of policies that focus on growth and innovativeness. Reinforcing regional R&D activities tends to stimulate regional economic development (Hafner and Kurt 2008, S. 40). In order to ensure future competitive advantages, it is important to keep up with the broad international technological development (BMBF 2007c).

In this context, the German Federal Ministry of Education and Research (BMBF) points out that it is important to invest in R&D, education, and skills in the future. Moreover, in the Report on Germany's Technology Performance 2007, it is well documented that education and research are therefore a top priority for the federal government. In this context, clusters become increasingly important because modern clusters are an instrument in promoting innovation, long-term industrial development, industrial competitiveness, and growth (Baptista and Swann 1998, p. 538). The existence of dynamic clusters with networked companies is crucial in various ways; certainly, a cluster facilitates the exchange of knowledge in networks. Clustering offers advantages to all actors; from a policy perspective, clusters are supposed to be promoted in structurally weak areas in order to become competitive and to prepare these regions for a more active role in globalization. International macroeconomic shocks—such as the banking crisis—and the surge of new Asian competitors have created considerable pressure in the EU automotive industry. The automotive industry is thus facing a broader restructuring phase, and this will affect the relevant regions with considerable value added of the automotive

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**Table 6.1** Mobility of inventors

| Mobility of inventors | | |
|---|---|---|
| | I1 | I2 |
| A1 | $t_0$ | $t_1$ |
| A2 | $t_1$ | $t_2$ |

**Table 6.2** Cooperation of applicants at *t*

| Cooperation of applicants at *t* | | |
|---|---|---|
| | E1 | E2 |
| A1 | Coop | – |
| A2 | – | Coop |

sector. The relevance of the automotive sector is emphasized in the high-tech strategy of the German government. Besides 16 other branches, the automotive and transport sector will be promoted (BMBF 2007b, pp. 18–19) in order to retain Germany's top position. Innovation processes are no longer dominated by OEMs (original equipment manufacturers) rather innovations are generated by automotive suppliers (Tier 1, Tier 2, and Tier 3). In the following sections of this chapter, it is shown that the exchange of knowledge—cooperation and mobility of scientists—can be understood as one of the most important determinants of innovation formations.

Both cooperation between firms and mobility of employees/researchers are crucial for innovation dynamics. The following tables illustrate what is meant by cooperation and mobility (two different forms of knowledge spillovers). Mobility means that an inventor I1 has worked for two different applicants A1 and A2 on two different patents at a given time period. Cooperation of applicants implies that at time *t*, two applicants are listed on one patent. In that case, we assume research cooperation. A definition of clusters and innovation networks is necessary to understand the connection between innovation and economic growth (Sect. 6.2). Section 6.3 describes the social network analysis method and shows that the method is quite useful in understanding the innovation dynamics in European cluster regions in that way. Our analysis looks at cooperation and application networks of different automotive clusters in Germany, Austria, and the Netherlands (Tables 6.1 and 6.2).

## 6.2 Innovation Systems and Networks

One of the main questions in the last years is what the basics for a successful innovation activity are. One concept that tries to answer this question is the systems approach, which emphasizes the systematic character of the innovation activity and the role of innovation ability (Cantner et al. 2009). It is undisputed that industrial innovations are generated systematically (Jungmittag 2000, pp. 7–12). The generation of new knowledge is a process where many actors and institutions are involved. These actors are linked with each other and are interconnected. There also are several feedback mechanisms between these actors (Welfens et al. 2006, p. 37). Consequently, these actors are integrated into a more or less wide-ranging system of other actors. The exchange of knowledge and know-how between actors implies that knowledge can diffuse easier. This tends to result in the creation of new skills. One result of the respective process is innovation resulting from the interplay of several specific ingredients such as innovative firms, universities, and independent R&D labs.

### *6.2.1 Regional Innovation Systems*

In addition to specific layers of innovation systems, the focus of this chapter lies on the overall regional innovation system. In our analysis, we explore one sector in two selected EU regions. A useful definition of a regional innovation system is given by Cantner et al. (2009). They define regional innovation systems as geographically confined *networks* of actors. These actors collaborate under certain basic institutional conditions in production, diffusion, and utilization of new, economically usable knowledge. Following the idea of Cantner et al., one may also look at the interaction of enterprises and research institutions. They also point out that the application of the systems approach to regional innovation networks relies on two basic findings:

1. The existence of regional effects of knowledge transfer (geographically closed spillovers)
2. The process of innovation must be seen as interactive, social network activities

The second finding assumes that the creation of new knowledge is a learning process that is based on the actors' experiences and learning from the experiences of other actors. This is defined as an interaction between different actors. There are various reasons for an interaction between actors, for example, the division of costs for R&D activities or the advantages in a joint exploration of new markets.

Thus, the general conditions in the environment of the inventor play an important role in innovations. This should be considered when innovation processes are analyzed.

Cantner et al. call this the "collective invention" and emphasize that networks are a basic form of coordination for the exchange of knowledge. Thus, a network is characterized by an informal exchange of knowledge (know-how). The network stands for reciprocal and largely nonpaid exchange of information. In this context, networks are relevant, for example, for the exchange of information at fairs, conferences, or forums. One special form of information exchange is represented by research cooperation.

In line with our analysis, we take a look at cooperation and application networks in the automotive industry. We use patents as an indicator for measuring the relevant links and dynamics. There are, however, some disadvantages in the approach chosen. For example, not every element of new knowledge can be patented, and therefore, part of innovation dynamics is overlooked or not fully taken into account. On the other hand, there are clear advantages: Patents and patent

**Table 6.3** Advantages and disadvantages of patents

| Advantages | Disadvantages |
|---|---|
| Existence of strong links between patents and inventions | Not everything is patentable |
| Patents covering a wide range of technologies (partly no data) | The patent addiction is different (within the technology fields) |
| Every patent document offers a lot of useful information about the generation process | Some patents have a high industrial value; other patents have no value |
| The access to patent data over national and regional patent offices is easier by now (digital access) | There are differences in the patent laws—this is why the comparability between patent statistics is limited |
| Adequate geographical and chronological distance | Changes in the patent laws lead to difficult comparative analysis between countries |
| | Patent data is complex—it is a result of a complex and economic process. |

Based partly on OECD (2008)

applications are indicators that are available over a long period of time. A comparison between the advantages and disadvantages is shown in the following table (Table 6.3).

A patent offers a wide range of information. You can find the name and address of the applicant who has the ownership. You can also find useful information like the name(s) and address(es) of the inventor(s) and the technology classification (that must not be the same as the applicant).

## *6.2.2 Regional Innovation Systems*

In conjunction with clusters, networks play an important role because knowledge and the exchange of knowledge are survival factors for cluster growth and for the cluster life cycle. One condition in cohesion with the systematic character is the existence of geographically closed spillovers. Marshall (1920) could show that there are three positive effects that are essential for the building of clusters. These are immobile local inputs, the local supply of qualified labor, and the existence of knowledge spillovers. Our analysis is partly in line with the idea that the leapfrog of knowledge is one of the main conditions for the functioning of a cluster.[1]

One useful definition of clusters is by Porter (1998). According to him, clusters are "[. . .] geographically close groups of interconnected companies and associated institutions in a particular field, linked by common technologies and skills. They normally exist within a geographic area where ease of communication, logistics and personal interaction is possible. Clusters are normally concentrated in regions and sometimes in a single town" (Table 6.4).

[1] See also Audretsch (1998, 2000); Jaffe et al. (1993); Feldman (2002).

**Table 6.4** Advantages and disadvantages of clusters

| Concept | Benefits |
|---|---|
| Marshallian externalities | |
| Labor market pooling | Labor cost savings due to access to specialized skills, especially in an environment where quick turnaround is important |
| Greater variety of specialized intermediate goods and services | Access to a local supplier base that has more product variety and a high degree of specialization |
| (Tacit) knowledge spillovers | Access to tacit knowledge in geographic proximity by means of both formal processes as well as through such informal channels as knowledge leakages, made possible by casual interfirm interactions |
| Porter's market conditions | |
| Demanding customers | Motivational effects due to demands of highly competitive local customers that improve quality, cost, etc. |
| Rivalry | Motivational effects related to social/peer pressure |
| Complementarities | Better sales opportunities of firms due to search cost savings for the buyers of complementary products offered in proximity and privileged opportunities for cooperation (sales, marketing, etc.) between nearby suppliers of complementary products |
| Cost advantages | |
| Transportation | Transportation cost savings due to geographic proximity, especially in the case of just in time delivery contracts |
| Trust | Transaction cost savings due to an environment that encourages trust |

Source: Lublinski (2003), pp. 453–467

Beside that definition, there are also other concepts describing similar processes and structures. All of these concepts exhibit one crucial similarity. Positive external effects are one main component of the analysis. These ideas are generated outside of the enterprise and cannot be characterized as the absorbent enterprises' own investment (OECD 2007, pp. 26–28). Overall, the mobility of knowledge workers between enterprises must be emphasized.

In that case, an important part of knowledge has a personal bonded character. This knowledge is called "tacit knowledge." Spillovers that appear to have tacit knowledge are named knowledge spillovers (Audretsch 1998). Knowledge spillovers moved into the focus of the economic geography and the knowledge management particularly in the context of the new growth theory (Krugman 1991).

Jaffe et al. (1993) have found evidence that these spillovers have a regional effect. The development in dynamic high-tech clusters has shown that the number of moving personnel between enterprises is higher than in nonclustered areas. The effect tends to stimulate ideas and knowledge and must be seen as an important reason for the success of the Silicon Valley (Saxenian 1994).

The connection between actors is defined as social closeness (Cantner et al. 2009). Our study analyzes that construct. We assume that geographical closeness of the different actors is important but that it is not a unique feature of the generation of clusters and innovations. Breschhi and Lissoni (2003) have mentioned that huge social closeness is one important condition for knowledge flow. Other authors have defined different closeness forms (Jürgens et al. 2009) and emphasized the construct of an "open innovation." In open innovation, not only the organization's own innovation competence must be seen, the organization also has to integrate the information and competences of customers and suppliers. The interaction between different closeness forms is important.

A concrete description of closeness forms is analyzed in the paper of Langendijk and Lorentzen (2006). The authors distinguish between geographical and organizational closeness. Thus, the interaction of both closeness forms is the basis for the building of local innovation systems for the fact that regional clusters will emerge in certain regions.

## 6.3 The Social Network Analysis

Social closeness is one important condition for theoretical constructs like clusters, networks, and regional innovation networks. Our study analyzes the construction and interpretation of inventor networks. One method to measure the social closeness and to make it viewable is the social network analysis. The method offers the possibility to identify the inventors who have worked for more than one applicant. The study of Cantner and Graf (2004a, p. 11) has found evidence that a strong exchange of inventors tends to result in a stronger connection between applicants. In order to measure the connection between the mobility of inventors and the cooperation of applicants, it is important to operationalize and measure the theoretical construct in order to describe it with an indicator variable. Firstly, the social network method will be described.

### *6.3.1 Basics of Social Network Analysis*

The social network analysis has emerged as an important technique in, for example, sociology, economics, and *social sciences* (Cantner and Graf 2004a, pp. 2–3; Schnegg and Lang 2002).

Mainly social network analyses measure social structures (social networks). These structures can be seen as networks that basically consist of graphs. Graphs, in turn, consist of nodes and edges. These nodes are equated with actors, and the ties can be seen as the relations between these actors. Nodes, for example, represent humans, organizations, companies, or even countries. Relations might be the exchange of information, goods, or knowledge or the R&D cooperation between companies (Klocke 2007, p. 138). In our analysis, it is not the attributes of the actors that are relevant but the relationship between these actors. Both the network as a whole and the individual actor must be analyzed. Mobility networks are defined as a network, where the connection between these nodes indicates that an inventor has worked for both applicants (on different patents). Cooperation networks are defined as research cooperation, namely, in the form that both applicants are found on one patent.

### 6.3.2 Method

Our analysis offers a visual and a mathematical analysis of these relationships (Hannemann and Riddle 2005). In the study, we use patents as an indicator to measure the exchange of knowledge (knowledge spillover). If someone wants to create a network of applicants, the raw data have to be sorted and the database has to be refined. After some calculation steps, a symmetric matrix has to be generated, which shows the mobility of inventors, considering that we have to find a method to find the data that we need. For the construction of mobility networks, we only use patents where at least one inventor lives in one of the examined regions of our analysis.

One step in our analysis includes the creation of a raw patent data table. We use the PATSTAT database of the European Patent Office that gives us access to 62 million patents (Oct. 2008) published at the office.

The procedure for the creation of mobility and for cooperation networks follows the same structure. As a first step, we create a table that includes the following information:

- Application date
- The inventors of the patent
- The applicant(s) of the patent
- The IPC classification

After some calculation steps, a symmetric matrix is generated. This table shows us the mobility of inventors.

A matrix ($M$) consists of $n$ rows and $m$ columns ($n$ and $m$ are equal to the number of rows and columns).

The entries in the rows ($M_{ij}$) of the matrix give us evidence of the kind of relationship, therefore the existence of the relationship, and the intensity between row element $i$ and column element $j$. Secondly, we have to build a matrix where the applicants and the inventors are compared. If there is a connection between an applicant and an inventor, the corresponding cell of the matrix is unity. If there is no connection, the value is zero. Cantner and Graf denote this matrix as a “2-mode-Sociomatrix X.” This matrix gives basic information about the dimension of the network. But for our analysis, it is necessary to implement another analysis step. The target is to exhibit a “square matrix.” The matrix mirrors the connections between applicants. In order to build such a matrix, matrix X has to be multiplied by the transpose of matrix X. The result is a so-called adjacency matrix A. The matrix is symmetric. As a last step, the matrix has to be imported into a network visualization program (UCINET). The result is a visual presentation of the mobility network. Now it is possible to run a mathematical analysis.

### 6.3.3 Network Analytical Indexes

Our networks are general networks that can be analyzed in various ways. An example is found in Schnegg and Lang (2002). They talk of theoretical graphical concepts with which it is possible to make important and valid statements about a network. Both authors show this by means of the already mentioned example of groups from the eastern central highlands of New Guinea described by different concepts. Furthermore, here, the potential of social network analysis becomes clear, which is not exclusively suitable for the visualization of relationships but also for the supporting calculation of statistical parameters. In the literature on social network analysis, there are also other authors who prefer these concepts—or network analytical metrics—and underline the importance of the network analysis. For our purposes, the concepts of density and centrality are used in particular.

The *density* of a network indicates the proportion of effective relationships based on the possible relationships in a network. It is common to measure how closely a group is intertwined (Wassermann and Faust 1994; Jansen 2006, p. 94).

If $g$ is the number of players, then the number of possible relationships is defined as

$$g \times (g - 1) \tag{6.1}$$

In this way, the entries are not observed in the diagonal of the matrix. The number of actual relationships is the number of ones in a matrix. This number of actual relationships is given by the abbreviation $a$. The density is defined as

$$\frac{a}{g} \times (g - 1) \tag{6.2}$$

Density is a simple concept. It must, however, be respected that the density depends on the size of a respective network. In this respect, it cannot be used for a comparison of our networks. It now says something about the individual network. If there were to be a comparison, *the networks would have to be equal*.

*Centrality* offers us the opportunity to make further statements about the internal structure of a network. Firstly, we are interested in the so-called centrality degree. The centrality degree gives us the possibility to make statements about the position of each actor in a network. Thereby, the concept shows the number of relationships that every player in a network keeps with other actors in an examined network (Kilduff and Wenpin 2003, p. 32):

$$C_{\mathrm{D}}(n_i) = \frac{d(n_i)}{g - 1} \tag{6.3}$$

$d(n_i)$ is the number of all neighboring points of the applicant $i$. In contrast to the density, it does not describe the network as a whole, rather properties of the individual actors. It indicates the number of incoming and outgoing links to an actor. In the case of symmetric networks, incoming and outgoing links are identical (Schnegg and Lang 2002). In contrast to the density, the centrality degree of networks of different sizes could be used. For a comparison, we calculate the *average centrality degree*. The average centrality degree provides information about the average connections each actor has to other actors in the network. The concept of components also gives us an opportunity to make important statements about the network. Components are interconnected segments of a network (Wassermann and Faust 1994, 109 ff.) As demonstrated in our networks, several subgroups are formed. There is no direct connection between these subgroups. Before we devote ourselves to evaluating the results in the following chapter, first we will show how the automotive sector can be identified among the large number of patents.

## 6.4 Dataset

In every analysis, it is important to collect adequate data for the respective regions. In connection with the database, there are several issues that need to be clarified in advance of our analysis:

1. What regions are to be considered or selected?
2. How is the sector identified in the patent database?
3. What period should be used to ensure a possible rational basis for comparison?

The following discussion will briefly focus on these issues.

### *6.4.1 Selected Countries*

On the basis of various indicators, this chapter examines the choice of the different regions. This chapter offers an analysis of the SM for three European countries (four regions). The initial region consists of the cities of Solingen, Remscheid, and Wuppertal. This region is known as the Bergisch City Triangle. The second region is Munich. Furthermore, we dedicate ourselves to a comparison region in Austria and one region in the Netherlands. The innovation system of each country is discussed in detail. Secondly, we will give an overview of the NUTS3-regions within these countries. These regions have a reverence to the automotive sector (Table 6.5). [2]

[2] Nomenclature des Unités Territoriales Statistiques is a hierarchical classification, which divides the Member States for the purpose of statistical surveys conducted in three levels (NUTS 1, NUTS 2, NUTS-3).

**Table 6.5** Investigated regions

| Country | Investigated regions/NUTS3 | |
|---|---|---|
| Germany | "DEA18" Remscheid<br>"DEA19" Solingen<br>"DEA1A" Wuppertal | Bergisch City Triangle |
| | "DE212" Capital Munich<br>"DE21H" Munich | |
| Netherlands | "NL413" Northeast-North-Brabant<br>"NL414"Southeast-North-Brabant | |
| Austria | "AT130" Vienna<br>"AT126" Vienna/north<br>"AT127" Vienna/south | |

**Table 6.6** General economic development of Germany

| Indicator | National performance | | EU27 average | |
|---|---|---|---|---|
| | 2004 | 2008 | 2004 | 2008 |
| GDP per capita in PPS | 116.3 | 115.6 | 100 | 100 |
| Real GDP growth rate (annual growth rate) | 1.2 | 1.3 | 2.5 | 0.9 |
| Labor productivity (per person employed) (EU27 = 100) | 0.4 | 1.4 | 0.7 | 0.9 |
| Employment growth (annual % change) | 0.4 | 1.4 | 0.7 | 0.9 |
| Inflation rate (average annual) | 1.8 | 2.8 | 2.0 | 3.7 |
| Real unit labor costs (growth rate) | 9.8 | 7.3 | 9.0 | 7.0 |

Source: Inno Germany (2009a, b)

## 6.4.2 Germany

A look at the following table illustrates the economic development of Germany in a direct comparison to the EU27 average values between 2004 and 2008 (Table 6.6).

The real GDP in Germany grew by 1.3% in 2008, slightly higher than in the EU27. Another development is reflected in the unemployment rate. The rate decreased between the years 2004 and 2008, but in 2008, the unemployment rate was above the EU average. In 2009, however, the GDP per capita in PPS was above the EU average; however, between 2004 and 2008, a slight loss of 0.7 PPS is shown (EUROSTAT 2010).

Germany is a country that heavily depends on exports. This is reflected by the high export rate of 40% of GDP (2008). This dependence on global markets has led to the boom in these markets 2005–2008 and has also led to economic growth in Germany. Due to the worldwide recession, however, a drawback of this export dependence can be seen. The industry has had to struggle with a severe drop in demand.

In May 2009, in a direct comparison with the previous month, a 17.9% decline in industrial production was observed (Inno Germany 2009a; Inno UK 2009). Sectors with high research and development intensity, particularly the automotive and supply industry, were affected by this first.

A look at the development of individual sectors in the German economy shows significant differences. Our analysis is mainly related to the automotive sector. The automobile industry has played an important role for Germany. Although automobiles are built by the major automobile manufacturers, there are a large number of international suppliers behind the OEMs providing complete system components as well as taking over a large part of the research and development process. The following table shows that German vehicle production has increased significantly since 1960. In 2007, Germany was the leader in vehicle production (OICA 2010).

In the EU27, Germany boasts the most workers in the automotive industry. According to the ACEA 2007, 834,000 people were employed in this field. If the component industry is excluded, still 322,000 people were employed in that industry (VDI 2008). In addition to a continuous growth in employment, continued revenue growth can also be seen. The turnover in 1995 was approximately €30 billion and twice as high in 2007 (VDA Annual Report 2009).

Germany’s leading position in the car production is also proven by the fact that there is a high concentration of automobile manufacturers. A detailed list of all automotive and motors manufactures is listed in the appendix. The largest manufacturers are Volkswagen in Ingolstadt and Wolfsburg, BMW in Munich, Opel in Russelsheim and Bochum, Ford in Cologne, and Daimler in Düsseldorf.

#### 6.4.2.1 Germany’s Innovation System

The main comparative advantage of Germany, in contrast to other European countries, is that Germany has specialized in upscale consumer goods (machinery, automobiles, etc.). The strong demand from the catch-up countries, like China, has boosted the export-driven boom of recent years. The economic situation in Germany can be characterized by a high proportion of research- and knowledge-intensive industries. The 2007 Technology Performance Report says that 39% of the total economic output is attributable to these industries. In particular, the research-intensive industry has a clear emphasis.

In 2005, Germany was the largest exporter of technology goods and achieved a surplus of €164 billion. This means that Germany ranked in second place as the net exporter of technology. This export success of the research-intensive industries in the recent years has been spurred in particular by the automotive, mechanical engineering, and chemical industries. Between 2002 and 2004, two-thirds of German industrial companies have been successful with product and process innovations. In this case, Germany took the top position in the EU. Thus, Germany’s economy has efficient production structures.

The strength of the German innovation system can be explained by the fact that there is an excellent research environment with a large number of renowned

**Table 6.7** R&D indicators for Germany

| | EPO patent applications[a] (intensity of patents) | | | R&D expenditure as a share of GDP[b] | |
|---|---|---|---|---|---|
| | Per 1 million inhabitants, by priority year | | | In % of GDP | |
| Time | UK | Hungary | Germany | Germany | EU27 |
| 2000 | 101,677 | 11,803 | 268,869 | 2.45 | 1.74 |
| 2006 | 49,707 | 8,754 | 203,855 | 2.54 | 1.76 |

Source: [a]EUROSTAT (2010); [b]Taken from BMWF/BMVIT/BMWFJ (2009), as a share of gross domestic product—International Comparison

universities and research institutes. Furthermore, German researchers and companies are characterized by a high patenting propensity (Inno Germany 2009a, b).

The financial crisis and the global recession have led to the fact that the innovation system in Germany has changed considerably. There is serious business to generate innovation because access to capital is severely limited (Table 6.7).

Looking at our analysis period, it is clear that there is a continuous increase in R&D expenditures in Germany. In the period of 2000–2006, R&D expenditures increased by 0.09%. On the other hand, there was a decrease in patent applications to the European Patent Office. Between 1995 and 2006, an increase in R&D expenditures from 2.2% to about 2.5% can be observed. It must, however, be noted that the target to spend 3% of the R&D expenditure to GDP ratio in recent years could not be realized (BMBF 2007c).

The next years will show what an impact the financial crisis will have on the patenting propensity of companies. In this context, many companies have postponed innovation projects because the access to new capital is difficult. The automotive industry is in a turbulent restructuring phase due to the ongoing economic crisis. Because of the high importance of employment in this industry and the high concentration of this industry on individual sites, these restructurings can give us evidence about the rise or decline of regions. The relevance of the automotive sector is also emphasized in the high-tech strategy of the German government. Besides the other 16 branches, the automotive and transport technology shall be promoted (BMBF 2007b, S. 18–19) in order to retain the top position of Germany in the automotive industry in the future. In that case, the top international position of Germany in the vehicle, traffic, and transportation technologies will be permanently guaranteed. Innovation processes are no longer dominated by the automobile manufacturers. Rather, more and more innovations are generated by the parts suppliers (Tier 1, Tier 2, and Tier 3). The BMBF has indicated, in a direct link with the development of clusters, that the assets will mainly produce innovations due to the fact that knowledge can be exchanged quickly and efficiently. Furthermore, it must be possible to apply this knowledge (BMBF 2007b, pp. 30–31). The BMBF also emphasizes that clusters should be promoted. The automotive sector is often undervalued in its importance for the German economy. Statistics must always be regarded with a certain degree of distrust because not every company is included (Kinkel and Zanker 2007, p. 10). It may happen that a company, for example, produces springs for pens and other suspension forks for vehicles. Despite this problem, the statistic gives us a first impression of the automotive sector. Accordingly, the total R&D expenses in the vehicle and especially in the manufacturing of motor vehicles have steadily increased (Wissenschaftsstatistik 2008).

#### 6.4.2.2 Automotive Industry in North Rhine-Westphalia

The automotive industry has high economic relevance for NRW. There are a lot of automobile headquarters—Ford in Cologne, Opel in Bochum, and Daimler in Düsseldorf. Furthermore, large global automotive suppliers are located in North Rhine-Westphalia. It extends the range of specialized electronics and component manufacturers such as Johnson Controls in Burscheid; Delphi in Wuppertal; TRW in Gelsenkirchen, Dusseldorf, and Krefeld; specialists in body and chassis as Thyssen Krupp in Essen, Brose in Wuppertal, or Edscha in Remscheid; or specialists in the field of driving and motor, such as VDO, in Dortmund and Cologne or Pierburg Neuss. The fact that approximately 30% of all German suppliers come from NRW plays an important role for the selection of regions in this state, as well as the fact that this year, about 7 million cars were produced in NRW. Furthermore, the automotive industry must be seen as the main source of exports for NRW. There is a high concentration of employment in Bochum (Opel), Cologne (Ford), East Westphalia, South Westphalia, the metropolis region of Düsseldorf, and of course, in the Bergisch City Triangle (Zenit 2007, p. 18). Universities with a technical background can be found in Dortmund and Münster; universities in Aachen, Cologne, Duisburg-Essen, Gelsenkirchen, Bochum, Bielefeld, and Wuppertal have a general background in the automotive industry (Zenit 2007).

An important aim of North Rhine-Westphalia's state government is to make NRW Germany's leading innovation state. The government has realized that clusters play a central role as drivers of innovation. The state government has identified a total of 16 regional clusters in which automotive cluster initiatives can also be found.

The NRW-Clustersekretariat has the main function to identify clusters in NRW and to assist regional and industrial clusters (e.g., the Kompetenzhoch3 initiative in the Bergisch City Triangle). In that case, there are nine regional and industrial automotive clusters in NRW. One can also find cluster initiatives in Bochum and Aachen.

#### 6.4.2.3 Automotive Industry in the Bergisch City Triangle

The initial region of our analysis consists of the cities of Solingen, Remscheid, and Wuppertal. This region is known as the Bergisch City Triangle and has a particularly high density of automotive companies.

In the automotive competence field, 16,000 people are employed. These make up 7.5% of the total employees of the economic region. The “Bergische Entwicklungsagentur” (the development agency in Solingen/Remscheid and Wuppertal) exhibits that by the share of total employment, the importance of the competence field is 50% higher than for the entire state of North Rhine-Westphalia (Kompetenzhoch3 2008).

In the region of the “Bergisch City Triangle,” there is a traditionally rooted and grown structure for automotive suppliers. These suppliers are OEMs (original equipment manufacturers) and are positioned internationally with highly specialized products. Here, you can find large anchor companies like Brose, Delphi, and Johnson Controls (Zenit 2007).

#### 6.4.2.4 Automotive Industry in Munich

Besides the regions in North Rhine-Westphalia, we also concentrate on the region around the Bavarian state capital and the third largest city in Germany: Munich. In a direct comparison between the federal states of Germany, Bavaria shows a rise in economic output (GDP) in real terms by 26.1% between 1998 and 2008. North Rhine-Westphalia, however, only has a real growth of 10.7%. So you can say that Bavaria has clear top position (also if you take a look at the start-ups) if you focus on a ranking of the federal states (STMWIVT 2009, p. 4). Like the GDP per capita (nominal), the disposable income of citizens increased as well. If you look at the expenditure for research and development (absolute, as well as relatively), you can see that Bavaria also has the highest courts. In 2008, a total of 13,528 patents were filed. Here, three of ten patents can be dedicated to the southern province of Germany (STMWIVT 2009, p. 10). Baden Wurttemberg is the only federal state of Germany that has a higher share of total registrations (30.6% in 2006).

At the state level, cluster initiatives have also been formed that focus on the industry. The “Allianz Bayern Innovativ” is the overriding cluster initiative and is a driving force for cluster development. Certain areas of expertise are encouraged. Here, you can find competences like automotive and information and communication technology. The automotive cluster is a production-driven cluster; however, the area of information and communication technologies must be accounted to the high-tech clusters. In Bavaria, 180,000 people are working in the automotive manufacturing industry. The automotive cluster of Bavaria is characterized by a high productivity and innovation activity. Remarkably, almost all colleges and universities in the country also have some focus in the automotive industry (Hallmann 2007, p. 98).

Another important state cluster initiative is “BAIKA” (Bavarian innovation and cooperation initiative of the automotive industry). The main task of this initiative is to combine the forces of automotive manufacturers and suppliers. Currently, 2,200 companies and institutions with an academic background are involved. Here, you can find institutions from almost 50 countries, inter alia alone 1,150 institutions and companies from Bavaria. “BAIKA” is involved in “Bayern Innovativ” and even has connections across national borders (BAIKA 2009) to automotive clusters, partner


**Fig. 6.1** BAIKA OEMs and suppliers. Source: BAIKA 2009

associations, and trade chambers. The following figure presents a list of the participating OEMs (Audi, BMW, Daimler, Ford) and suppliers (e.g., Delphi, Johnson Controls, Continental, Goodyear) (Fig. 6.1).

Upper Bavaria must also be seen as the most innovative region within Bavaria. The mapping of the “European Cluster Observatory” gives Upper Bavaria three stars and identifies the cluster as a highly innovative cluster. One focus of economic policy also lies on the automotive industry and on ICT.

TNS (2008) indicated that the metropolitan region of Munich (Munich area) has the largest gross value added in a direct comparison to other metropolitan regions in Germany. The innovative strength of this region is also confirmed by a recently published study (Eikelpasch 2008, p. 578). Munich can match relating to the economic strength and the economic competitive position of the city with other European regions. The metropolitan region consists of Upper Bavaria in Munich, as well as the administrative district of Swabia, the city of Landshut, and the districts of Landshut and Dingolfing-Landau (TNS et al. 2008, pp. 1–3). The automotive industry in this metropolitan region includes about 586 companies. The clear economic center is the city of Munich.

GDP for Munich has increased steadily by millions (€) in recent years. Munich’s share of Bavarian GDP in 2008 was 16.9%, 29.4% if you include the surrounding area (Referat für Arbeit und Wirtschaft 2010, p. 4). Twenty-one percent of the population of Bavaria lives in the region of Munich. The service sector dominates and provides about 76% of the region’s GDP. The share of the manufacturing sector in Munich is approximately 24% of total GDP (München.De 2009). The research environment of Munich is marked by a close cooperation between cities, local universities, companies, and research institutes. Beside large universities such as the Ludwig-Maximilians University and the Technical University of Munich, the city also has specialized colleges. Here, you can find Fraunhofer and Max Plank Institutes. The strength of the research landscape is highlighted by the fact that about 50,000 people work directly and indirectly in research and development. Besides the country and the city, a lot of big companies (BMW) are also investing in start-ups. The city has, in this respect, a significant expertise in the automotive sector. In addition to passenger cars, trucks, buses, and motorcycles are also manufactured in the city. In addition, a large number of suppliers and components manufacturers and a variety of technical services have settled in Munich (Wirtschaftsraum München 2010).

## 6.4.3 Austria

### 6.4.3.1 The Austrian Economy

Since the 1960s, the Austrian economy has experienced a fundamental transformation in a significant increase in the importance of the service sector (tertiary sector). This is primarily due to the gross value added of various economic sectors (two thirds of gross value added is generated by this sector). Second is the secondary sector with about 31% of the gross value added. The decline of the secondary sector, however, can be detected in almost all EU27 countries.

Taking a glance at current economic indicators for Austria itself, the GDP per capita, the real GDP growth, and labor productivity have fallen per head (Inno Austria 2009). The recent financial crisis began in 2008, but in spite of the decline of the indicators, the growth of real GDP is well above the average of the EU27. The inflation rate, unit labor costs, and unemployment rate show an opposite effect, which were found to be well below the average in 2008.

Austria is a country that is very much affected by globalization. This can primarily be measured by the level of exports. This rate has risen from 34.9% in 1995 to 59.4% in 2008. The EU average was at 41.3% in 2008, but an increase in exports tends to result in an increased import quota. A look at foreign trade shows that Austrian export and import levels have doubled since 1995. The most important trading partner is Germany because more than 40% of the imported goods come from and about 30% of all exported goods go to Germany (Statistik Austria 2009).

Other important trading partners are Italy, Switzerland, and also Eastern European countries like the Czech Republic and Hungary. The export of goods is dominated by Austrian automotive and engine manufacturers (Table 6.8).

Austrian companies have recognized the opening of the East (Eastern enlargement of the EU) ("Eastern Europe" effect) as one of the first "early movers." Meanwhile, nearly 23% of merchandise exports went to Central and Eastern Europe. Furthermore, 20% of GDP have been invested in Central and Eastern European countries. Calculations of industrialists (IV) show that the opening up

**Table 6.8** General economic development of Austria

| Indicator | National performance | | EU27 average | |
|---|---|---|---|---|
| | 2004 | 2008 | 2004 | 2008 |
| GDP per capita in PPS | 126.9 | 124.7 | 100* | 100* |
| Real GDP growth rate (% change previous year) | 2.5 | 1.8 | 2.5 | 0.9 |
| Labor productivity per person employed (EU27 = 100) | 117.5 | 114.8 | 100* | 100* |
| Employment growth (annual % change) | 0.4 | 1.6 | 0.7 | 0.9 |
| Inflation rate (average annual) | 2.0 | 3.2 | 2.0 | 3.7 |
| Real unit labor costs (growth rate) | −1.8 | 0.6 | −1.4 | 0.5 |
| Unemployment rate as % of the labor force) | 4.9 | 3.8 | 9.0 | 7.0 |

Source: Inno Austria (2009)

**Table 6.9** R&D indicators for Austria

| | EPO patent applications[a] (intensity of patents) | | | R&D expenditure as a share of GDP[b] | |
|---|---|---|---|---|---|
| | Per 1 million inhabitants, by priority year | | | In % of GDP | |
| Time | UK | Germany | Austria | Austria | EU27 |
| 2000 | 101,677 | 268,869 | 147,361 | 1.92 | 1.74 |
| 2006 | 49,707 | 203,855 | 145,075 | 2.45 | 1.76 |

Source: [a]EUROSTAT (2010); [b]Taken from BMWF/BMVIT/BMWFJ (2009), as a share of gross domestic product—International Comparison

of Eastern Europe and Austria becoming a member of the EU have resulted in a yearly economic growth of about 1% (IV 2009).

Eight million people live in Austria. The country has 22 public and 11 private universities and 20 colleges and 16 teacher-training colleges. A look at the R&D indicators in Austria show that, in contrast to Germany and the United Kingdom, a slight decrease in patent applications at the EPO was recorded. Furthermore, a significant increase in R&D expenditure up to 2.45% in 2006 was recorded. It is noteworthy that since 1997, Austria's R&D rate is above the average R&D spending within the EU and, since 2004, even higher than the average rate of OECD countries. Since 2006, it is roughly on par with the rate of Germany (ÖTB 2008). As in other OECD countries, the majority of the R&D expenditure in Austria is invested by companies (Table 6.9).

Meanwhile, 2,000 companies—mainly small- and medium-sized business enterprises—do research in Austria. International companies also provide a significant contribution to the research landscape in Austria.

Other important nonuniversity institutions are the Austrian Institute of Technology (research) (AIT) and the Austrian Academy of Sciences (basic research). The individual states' investment in research and development has also increased. A total of 49,377 people have worked in this area (2006), of which the majority has worked (more than 60%) in the company sector. A quarter of the researchers worked in the higher education sector. More than 70% of R&D expenditures are attributable to the corporate sector, which accounts for the largest part of the experimental development.

In a direct comparison between the federal regions, the largest share of expenditure on R&D can be found in the Vienna region (38.5%) and Styria (17.8%) (BMWF 2009). In Austria, in contrast to other countries, a very high (above average) share of research funding is made by international companies with headquarters in Austria.

Through the development of Austria in 2008, it seemed able to reach the Lisbon target of 3% of GDP.

#### 6.4.3.2 Cluster Initiatives

In the 1990s, Austria began to systematically investigate and develop clusters. The first emergence regions of clusters were Styria (ACstyria Car Cluster) and Upper

Table 6.10 Vienna region—cluster initiatives

| Vienna |
| --- |
| Life Science cluster Vienna region |
| Automotive cluster Vienna region |
| Creative industries cluster |
| ICT cluster |

Source: Clement and Welbich-Macek (2007), pp. 226/227

Styria. Now, cluster initiatives can be found in almost all provinces. An indicative list of cluster initiatives for the Vienna region can be found in the following table (also includes cluster-like relationships) (Table 6.10).

In recent years, Austria developed a cluster culture. Each state prefers its own approach. An internationalized cluster, for example, is the Life Science Cluster and the Automotive Cluster Vienna Region. In Austria, clusters currently serve mainly to increase R&D activity. The aim is to stimulate economic growth and the competitiveness of the country. Furthermore, Austria is involved in European cluster programs.

The PRO INNO Europe Cluster Alliances consists (among others) of one network that is named the CEE Cluster Network, cluster policy networking and exchange via the themes of internationalization and incubation. This network was initiated under Austrian leadership (Clement and Welbich-Macek 2007, p. 34).

It is remarkable for the cluster policy in Austria that clusters are indeed intertwined with many aspects of Austrian economic policy, but this integration is not very organized. One reason for this diffuse involvement may be seen in the strong alignment of the Austrian economic policy at the federal level (4C Foresees 2009, p. 118). On the one hand, regional cluster initiatives are encouraged to build on strengths, but on the other hand, federal limits should not be an obstacle to business cooperation. An example of a federal cross-cluster initiative is the Automotive Cluster Vienna Region, which is part of the Lower Business Agency ecoplus and part of the Vienna Business Agency (4C Foresees 2009, pp. 151–152).

#### 6.4.3.3 Automotive Industry in Austria

Despite the fact that Austria does not have its own car brand, the automotive industry is economically relevant for Austria. In Austria, there is, in addition to a strong network of automotive suppliers, strong expertise in research and development in the automotive sector.

Some regions show strong automotive clustering. The best-known clusters are in Styria, Upper Austria, and Vienna. More than 175,000 people work in the automotive sector, with estimates distorted by an indirect employment (by the automotive industry) of 296,000 people in this sector. The supplier industry consists of 700 companies with an annual turnover of €20 billion. In 2006, 308,594 new cars were registered, while 242,211 cars were exported. This shows that the automotive industry can be considered to be one of the most important export industries in Austria. Almost €400 million will have been invested annually in research and development.

**Table 6.11** Cluster partners of the automotive cluster Vienna region

| Federal stat of the member | Number |
|---|---|
| Vienna | 59 |
| Lower Austria | 43 |
| Burgenland | 3 |
| Other partners | 23 |

Source: ACVR (2009), data from 2009

Furthermore, the industry directly employs approximately 2,200 people in automotive research and development. Apart from the Austrian Research Centers, among others, the Joanneum Research and the Technical University of Vienna play a leading role in automotive research (ACEA 2009).

#### 6.4.3.4 Automotive Cluster Vienna Region

One of the main cluster initiatives includes the Automotive Cluster Vienna Region (4C Foresees 2009, p. 118). After its founding in 2001, the number of members is 128 (including 63 manufacturing companies) (Table 6.11).

With a turnover of €4,932,841,289 (ACVR 2010) and a total of 36,040 employees, it is one of the largest clusters in Austria (Clement and Welbich-Macek 2007, pp. 226/227). The focus is on automotive suppliers. These clusters offer (Clement and Welbich-Macek 2007, p. 154) advantages in the form of information advantages, simplified access to information, the opening of new markets, and the initiation of collaborations.

Furthermore, the Automotive Cluster Vienna Region is involved in the Centrope Region (Central European region extended)(Automotive Cluster CENTROPE). This region is described as the Detroit of the East. This region covers Austria, Slovakia, Hungary, the Czech Republic, Romania, and Poland and is becoming increasingly important for the automotive industry. This form of cooperation is supported by three major cluster initiatives. In addition to this, the ACVR (Automotive Cluster Vienna Region), the Automotive Cluster Slovakia, and the PANAC (Pannon Automotive Cluster) are a part of the initial Automotive Cluster Centrope.

### *6.4.4 The Netherlands*

#### 6.4.4.1 General Economic Situation

If you look at the years before the financial crisis, it can be stated that the Dutch economy was in good shape.

All the indicators (listed in the table below) have developed positively between 2004 and 2006. The unemployment rate has fallen over time and was significantly lower than in the EU27. A glance at the values before the start of the financial crisis shows that all of these values developed positively (Inno The Netherlands 2009, p. 1).

The Netherlands is an open economy and the fifth largest exporter of the EU (WTO 2009, p. 9) (Table 6.12).

The following table gives us a very useful overview of the most important import and export goods (with a share of 34% and 31% of machinery and transport equipment). If we compare the main trading partners for the Netherlands, it becomes readily apparent that Germany is one of the main partners (Table 6.13).

Both countries have mutually close relations in the field of education and science. This is illustrated by the fact that there are 400 student exchange programs. There are also 650 cooperation agreements with institutes and departments of universities and nonuniversity research institutions, such as Max-Planck-Institutes and Fraunhofer Institutes. Due to the geographical proximity to the state of North Rhine-Westphalia, there is also a strong cooperation in the form of networks between universities, companies, and partners from the Netherlands (BMBF 2007a, p. 3) (Table 6.14).

**Table 6.12** Indicators: economic performance of the Netherlands

| | National performance | | EU27 average | |
|---|---|---|---|---|
| | 2004 | 2007 | 2004 | 2007 |
| GDP per capita in PPS | 126.2 | 130.9 | 100* | 100* |
| Real GDP growth rate (annual growth rate) | 2.2 | 3.5 | 2.5 | 2.8 |
| Labor productivity [per person employed] (EU27 = 100) | 112.2 | 112.4 | 100* | 100* |
| Employment growth (annual % change) | −0.9 | 2.5 | 0.7 | 1.8 |
| Inflation rate (average annual) | 1.4 | 1.6 | 2.0 | 2.3 |
| Real unit labor costs (growth rate) | −0.5 | 0.4 | −1.4 | −0.8 |
| Unemployment rate (% share of the population | 4.6 | 3.2 | 9.0 | 7.1 |

Source: Inno The Netherlands (2009)

**Table 6.13** Netherlands—import–export worldwide—2006

| Important import goods | Share of total imports (%) | Important export goods | Share of total exports (%) |
|---|---|---|---|
| Machinery and transport | 34 | Machinery and transport | 31 |
| Petroleum and products | 17 | Chemical products | 17 |
| Chemical products | 13 | Live animals, food, and beverage | 13 |
| Live animals, food, and beverage | 8 | Petroleum and products | 13 |

Source: BMBF (2007a), S. 11

**Table 6.14** F&E indicators for the Netherlands between 2000 and 2006

| | EPO patent applications[a] (intensity of patents) | | | R&D expenditure as a share of GDP[b] | |
|---|---|---|---|---|---|
| | Per 1 million inhabitants, by priority year | | | In % of GDP | |
| Time | UK | Germany | Netherlands | Netherlands | EU27 |
| 2000 | 101,677 | 268,869 | 216,511 | 1.83 | 1.74 |
| 2006 | 49,707 | 203,855 | 116,623 | 1.67 (−0.16) | 1.76 |

Source:[a]EUROSTAT (2010); [b]Taken from BMWF/BMVIT/BMWFJ (2009), as a share of gross domestic product—International Comparison

A look at the typical indicators of R&D for the Netherlands indicates that between 2000 and 2006, all values declined. The patent applications filed with the EPA even decreased by half. In the year 2000, 1.83% of total GDP was spent on R&D. The spending fell in 2006 to 0.16%. In 2007, however, the expenditure on R&D was 2% of the total GDP (International Cooperation 2010c). However, this is below the OECD average of 2.29%. Half of the research is financed by companies. The government of the Netherlands, however, is involved in the R&D expenditure with 36% investment. Foreign companies and EU funds account for 11% of total expenditure.

One of the most important actors of research funding is the Ministry of Education, Culture and Science (OCW). Research institutions are divided into universities (14), (semi-) public research institutes, and companies. The largest research companies in the Netherlands are Shell, DSM, Unilever, Nobel, Akzo, and Phillips. Thirty percent of the research is done by universities. Research institutes and 55% of companies (a direct comparison with Sweden shows that about 70% of companies (International Cooperation 2010c)) carry out about 15% of the research. In 2007, Dutch universities spent €148,931.5 million on R&D. In the same year, a total of 91,090 people were employed in research and development—with 44,116 researchers (the number of researchers in private companies is 59.2%) (International Cooperation 2010c).

In addition to the Royal Netherlands Academy of Sciences (KNAW), which is funded by OCW, the Netherlands Organization for Scientific Research (NWO) must also be taken into account, which acts as a research council in the country. Under the umbrella of the KNAW, there are a total of 18 research institutes. Research interests are in basic research and strategic research.

The NWO is an independent organization, which also plays a major role in basic research. The main tasks of the NWO are mainly supporting research for research institutions and universities.

The NWO, KNAW, TNO (Organization for Applied Scientific Research), academic libraries, research institutes in the social and arts sector, and research institutions with an international focus are subject to the Ministry of Education, Culture and Science. The Ministry is responsible for a total of 30 institutions. The main emphasis in technology and science policy is information and communication technologies, chemistry, and genomics (International Cooperation 2010c).

#### 6.4.4.2 Automotive Industry in the Netherlands

The Dutch automotive industry is, in a direct comparison with the European standards, relatively small. Here, you will find companies such as Scania and DAF (both truck manufacturers) and Donkervoort and Spyker (both sports car manufacturers) that mainly produce sports cars, highly innovative transportation systems, and components and systems for vehicles, which can also be regarded as highly innovative. In production and employment, the automotive industry in the Netherlands cannot compete with countries like Sweden or Germany. This is also reflected by patent applications for the automotive sector (innovation output indicator). Between 1992 and 1999, 476 patents applications were made, and between 2000 and 2007, a total of 630 patents were filed at the European Patent Office. Despite this low number of applications, a look at the automotive market shows that the Netherlands belongs to the sixth largest car market in Europe (7 million vehicles). Here, however, a clear trend can be found that prevails to small cars (Trade & Invest 2009, p. 2). In the entire automotive industry as a whole, 22,234 people are employed. A total of 132,434 vehicles are produced in the Netherlands (2006). Dutch companies produce components for major car manufacturers like BMW, Daimler Chrysler, GM, and Volkswagen and for sports car manufacturers such as Ferrari and Maserati. The only vehicle manufacturer in the Netherlands is Nedcar (100% Mitsubishi). Nedcar currently produces the Colt and Outlander models. The VDL Group mainly produces travel and public buses (Berkhof, Bova). The automotive supplier industry in the Netherlands consists of 140 firms. These companies play an important role in the European automotive industry. The total turnover of these mostly small- or medium-sized companies is around €6 billion (Trade & Invest 2009, p. 3).

#### 6.4.4.3 Eindhoven

Geographically, the focus of the automotive industry lies in the southeast of the Netherlands. Here, OEMs and parts suppliers play a major role in employment and in the generation of innovations. In the Eindhoven region, automotive companies like DAF Trucks (highest number of employees in the automotive industry in the Netherlands based in Eindhoven), the VDL Group, TomTom, Phillips, and Siemens VDO Automotive. The focuses of the automotive industry are in industrial design, electronics, manufacturing, development, and testing. Here, you can find research institutions such as the Technical University of Eindhoven, TMO Automotive, and PDE. Network organizations such as ATC, CCAR, and Federation Holland Automotive are active in the region around Eindhoven (Fig. 6.2). The main task of this network organization is to promote cooperation between companies and research institutes (REDE 2008, pp. 52–55). The total number of people employed in the Dutch automotive sector is about 39,298; 6,910 are employed in the Eindhoven region. The entire automotive industry in this region consists of 125 companies.

In the North Brabant region, the number of companies is higher (385 companies). In a direct comparison to the Netherlands, a total of 2,178 companies are attributable to the automotive industry (REDE 2008, pp. 52–55). If you are using our definition, you can call this a cluster because there is sufficient density in cooperative relationships between companies and public and private research institutes. This relationship is also reflected by the patent applications in the region. There is a growth from 110 to 151 patent applications.

Fifty percent of the national R&D expenditure is spent in the Eindhoven region. In the creation of patents, the Eindhoven region must be classified as the top region (550 patents per 100,000 inhabitants). The knowledge-based landscape is shaped by


**Fig. 6.2** Nord Brabant and the Eindhoven region. Source: REDE 2008, S. 4

Phillips. On the High Tech Campus Eindhoven, numerous educational and knowledge institutions can be found such as NatLab and the Technical University Eindhoven (Hölzl 2009, p. 147). It is remarkable that there is collaboration between researchers from Phillips with researchers from companies such as Siemens and Bosch and that this research cooperation is also desired. The focus of the campus is on bio- and medical technology, microsystems, nanotechnology, and automotive development. The research and development in these areas should be cross-industry (Hölzl 2009, p. 153). Eindhoven is the fifth largest city in the Netherlands and is the capital of the Eindhoven region.

## 6.5 Results

After the above steps, it is now possible to generate and compare the networks of the automotive sector. Before we present the results, we will show how the networks have to be read and interpreted. In our analysis, we consider two forms of connections between applicants on a patent. On the one hand, we dedicate ourselves to the so-called mobility of inventors, and on the other hand, we analyze the direct, joint cooperation of the applicant in the form of cooperation networks.

Cooperation networks are characterized by the fact that because of a joint patent application by at least two different applicants, research collaboration has taken place. These networks are then read as follows:

- Applicants in the network are characterized by nodes.
- A connection between nodes ("deep") is the result of a cooperation between two applicants. Both applicants can be found on one patent. At least one inventor comes from the suspected region. In this way, we assume research collaboration.

- The width of the connection ("tie strength") shows the strength of the connection between two applicants. It shows the frequency of cooperation. With greater tie strength, a stronger cooperation relationship is assumed.
- It is quite possible that several applicants appear together. The result is a cooperation network.

Mobility networks are networks with the following unique characteristics:

- Applicants are represented by nodes.
- If there is a connection between nodes, inventor mobility is indicated.
- Inventor mobility means that an inventor can be found on two separate patents by two different applicants. This means that an inventor has worked for two applicants.
- In this case, we assume that knowledge has spilled over.
- This form of knowledge transfer is called knowledge spillover.

*Relationship networks* are networks that combine both of the above network types. Thus, changes in *cooperative networks* and *mobility networks* have a different influence on the respective relationship network.

The most important distinction between the two types of networks can be explained by the fact that mobility networks reflect the unwanted transfer of knowledge (positive externalities) and cooperation networks reflect the direct wanted transmission of knowledge. Our study is based mainly on studies that make a geographical map on the basis of the residence of the inventor. The address of a patent applicant may be problematic because many companies are parent companies with different settlements. The registration of a patent usually takes place at the address of the main headquarters. In this way, however, the place of knowledge creation is distorted (Maurseth and Verspagen 2002).

### *6.5.1 Results for the Bergisch City Triangle*

We have decided to divide our study into two periods (1992–1999 and 2000–2007). This results in two relationship networks for each region. Isolated applicants (not linked to other actors) have been removed from these networks. The following table assists us in interpreting the respective networks. This table lists important information regarding the density of the network, the number of participating applicants (total + isolated applicant), the average centrality degree, and the integration of research and development institutes and the centrality of the network. This information is divided into the cooperative network (Coop), the mobility networks (Mobi), and the respective networks of relationships for both time periods (Table 6.15).

Before we devote ourselves to a comparative analysis for both periods, first, similarities in the two networks will be analyzed.

The following two figures show the relationship networks of the Bergisch City Triangle. A first look at the networks shows that a mobility of inventors and a

**Table 6.15** Network indicators for the Bergisch City Triangle (Coop = cooperation, Mobi = intercompany mobility of patent applicants, RN = relationship network = Coop + Mobi)

| | Coop 92–99 | Coop 00–07 | Mobi 92–99 | Mobi 00–07 | RN 92–99 | RN 00–07 |
|---|---|---|---|---|---|---|
| Total applicants (absolute figure) | 70 | 78 (+8) | 70 | 78 (+8) | 70 | 78 (+8) |
| Isolated applicant (absolute figure) | 51 | 59 (+8) | 50 | 62 (+12) | 31 | 47 (+16) |
| Centrality of network | 2.74% | 4.82% | 3.42% | 2.32% | 12.53% | 8.30% |
| Density of network | 0.0095 | 0.0050 | 0.0120 | 0.0033 | 0.0232 | 0.0100 |
| Joint applicants (absolute figures) | 19 | 19 (=) | 20 | 16 (−4) | 39 | 31 (−8) |
| Average degree centrality (strength of internal structure) | 0.657 | 0.385 | 0.829 | 0.256 | 1.600 | 0.769 |
| Research institutes/ universities as part of the network | No | No | No | No | No | No |
| Most central actor | Ford Motor Company Limited; Ford Werke AG; Ford France S.A. | Ford Werke AG; Getrag Ford Transmissions GmbH; Endert, Guido | Bergische Stahl-Industrie; SAB WABCO BSI Verkehrstechnik Products GmbH; Knorr-Bremse MRP Systeme für Schienenfahrzeuge GmbH & Co KG | Ford Global Technologies, LLC; Edscha AG; Getrag Ford Transmissions GmbH | Bergische Stahl-Industrie; SAB WABCO BSI Verkehrstechnik Products GmbH; Ford Motor Company Limited | Ford Global Technologies, LLC; Ford Werke AG; Getrag Ford Transmission GmbH |

Source: EIIW calculations

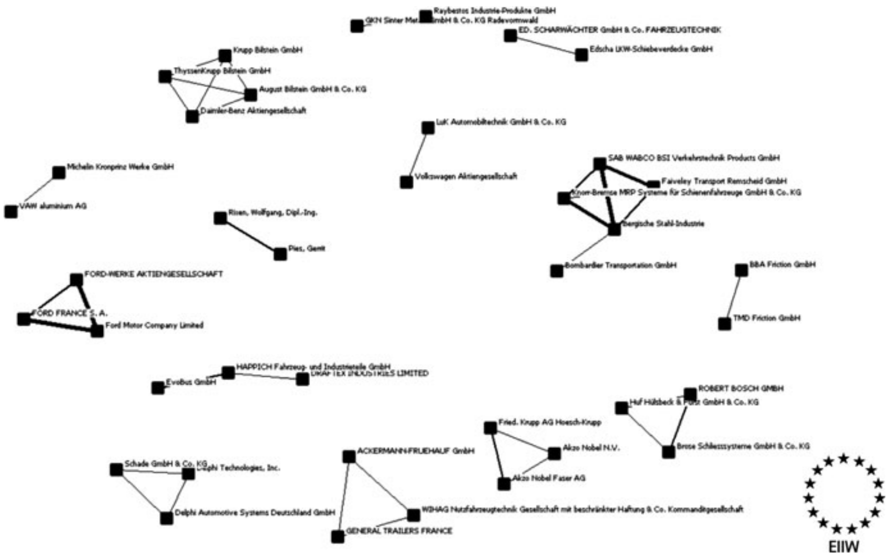


**Fig. 6.3** Bergisch City Triangle: relationship network 1992–1999. Source: EIIW calculations

cooperation of applicants still exist. Both patterns of relationships have different intensity degrees, which are not necessarily self-evident; perhaps there are regions that have no mobility. It is also clear that only companies but no research institutes are listed in both networks. A study in the health-care sector of the Bergisch City Triangle (Welfens et al. 2008) clearly showed that in the case of mobility networks, there are relations between research institutions and companies and that these connections are—against the background of a transfer of knowledge (knowledge source)—desirable (Fig. 6.3).

In this way, we can identify the first problem within our network (regardless of the respective time period). The lack of involvement by research institutions in the networks of the Bergisch triangle cities must be regarded as a distinct disadvantage. From an economic point of view, a university is both a service company in the field of higher education as well as an actor and research knowledge supplier. A part of knowledge is provided as a public good (e.g., via the Internet). In addition to the free codified knowledge, there are complex noncodified knowledge elements. Access to this knowledge, however, requires a proximity to the site of knowledge production. These conditions are given in the Bergisch City Triangle, as a region with a university (and with neighboring sites), which provides science and economics courses. Leaders from politics, science, and industry should contribute more strongly and must be involved more actively than before since the Bergisch University of Wuppertal is a knowledge producer and a carrier of networks. There should be closer collaborations between companies in the region and the University of Wuppertal, for example, with the faculties of engineering. A further analysis of the networks shows that there is no shift toward a contiguous network.

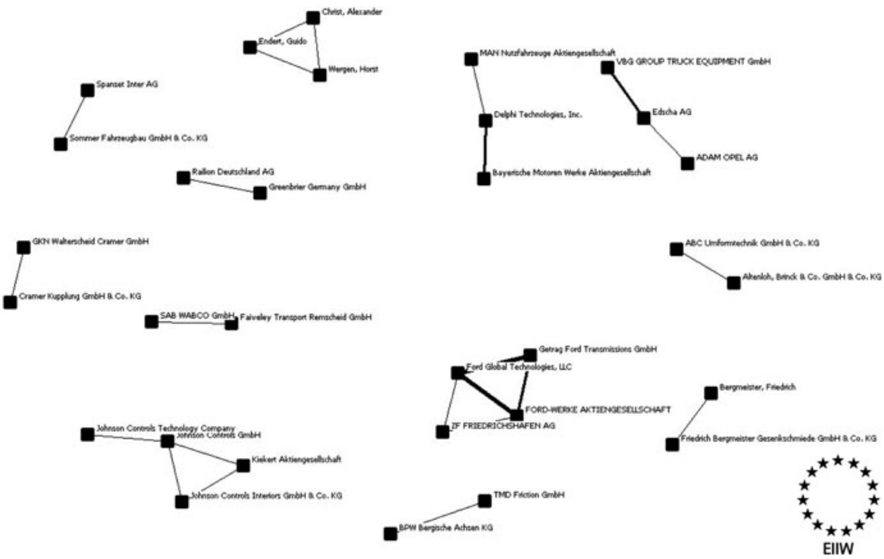


**Fig. 6.4** Bergisch City Triangle: relationship network 2000–2007. Source: EIIW calculations

It is rather a collection of several components. The analysis also shows that, despite an increase in applicants, there is a trend toward increasing fragmentation. There are still relations between two or three applicants, but there are also larger identified components (Fig. 6.4).

There are a lot of global players represented within the networks.

Among other things, in both relational networks, the applicant Ford has several ties to partial or subsidiary corporations. Ford is one of the central players in both networks and has become more important (see relationship network from 2000 to 2007). Ford can be described as a "star." A "star" is a player that has the most connections with other applicants. A closer look at connections of players shows that Ford has the most links to subsidiary companies. Similar compounds can be identified in an analysis of the bivariate relations with respect to this special form of relationship. We define this special form of scientist mobility as an intramobility of inventors.

Intramobility can be dangerous because if there is only one big central player in the network, a disappearance of this actor leads to—a strong expression of intra-mobility within the network—the possible breakup of the network. Large anchor companies in the network (applicant) Brose, Delphi, and Johnson Controls revert to research personnel from the region. This can be measured by the fact that all three companies are located in the mobility networks of the Bergisch City Triangle.

If we take a look at the following table, important statements can be made about the network. The density of the cooperation network decreases (from 0.0095 to 0.0050), as well as the density values for the mobility network (from 0.0120 to 0.0033). This loss of density leads to a decrease in the density value in the relationship network (0.0232 to 0.0100). The density is seen as a relative value but not independent of the size of the network.

To avoid distortions, the average centrality degrees for the individual networks are taken into account. This shows a decrease in values for both relationship networks (from 1.600 to 0.769). This declining trend can also be observed in the two other types of networks. The degree of centrality in the overall network (entire network centrality) also decreases (in all three network types). The relationship network centrality decreases from 3.18% to 2.34%. This decrease in network centrality is taken largely from the mobility network. Because of an increase in the actors involved in the networks, this decrease in values (absolute number of applicants) is rather surprising. The growth of isolated components, however, offers no adequate explanation here.

Summarizing these observations together now, it appears that the relationship network is moving in the direction of decreasing cohesion. This decrease in cohesion will be borne by the individual networks in very different ways. It is especially noteworthy that the mobility network is mainly responsible for the decline in the values of the relationship network. The cooperation network appears, however, not, in spite of a constant number of connected players, in a position to compensate this development. One can clearly speak of the loss of innovative capacity of actors in the relationship network. As a final point, it should also be mentioned that in the period of 1992–1999, a slightly higher willingness of companies' mobility can be realized, but over time, however, the cooperation of applicants has become more important.

### *6.5.2 Results for Munich*

There are no large networks in the Bergisch City Triangle, but by taking a look at the networks for the city of Munich, a coherent network structure can be found. For both cooperation networks and time periods, two large components can be found with BMW as a central actor. These networks offer a good example that clearly indicates how a large OEM plays a dominant role in a network and how this actor can influence the whole network structure. There are also several other major car manufacturers such as Audi, Porsche, and VW and large international suppliers such as Bosch, Delphi, or Continental, which surprisingly maintain direct cooperation links to BMW. In addition to these big components, the cooperation networks also consist of several bivariate connections and components with three or four players (Fig. 6.5).

The networking of the mobility networks is far less than the networking of the cooperative networks. Over time, the networking of the actors is increasing, which can be explained partly by the increase in the related applicants (against the backdrop of an increasing number of total actors). As well as the fact that major applicants can be found in the mobility networks (similar to the cooperation networks), the number of components in the first period is much higher than in

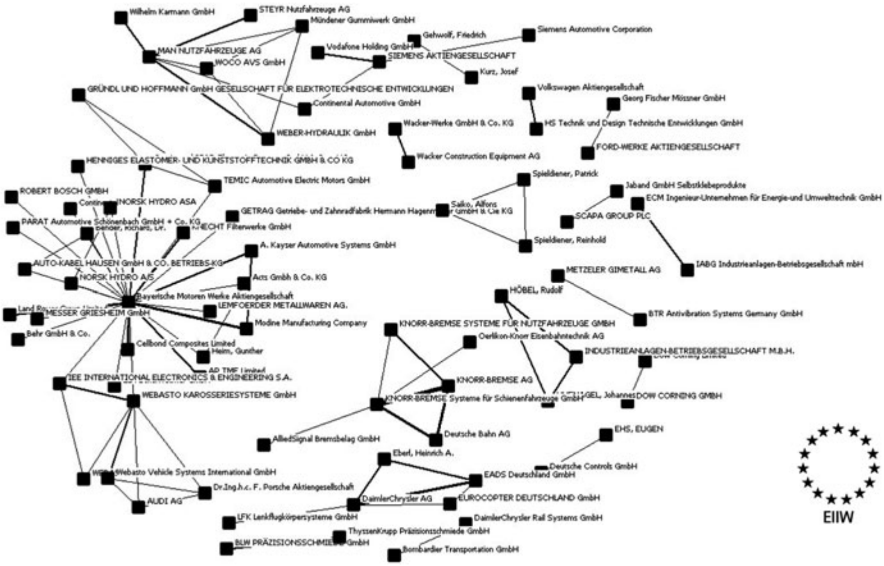


**Fig. 6.5** Munich: relationship network 1992–1999. Source: own figure

the second period. However, we must keep in mind that networking improves over time.

Like in the Bergisch City Triangle, large companies in the network can be defined as a "star." Within the cooperation and relationship networks, BMW plays a dominant role. In the first period, the EADS Germany GmbH, but in the second period the Webasto AG, must be seen as stars. Overall, BMW AG has a dominant role because the company is also found among the three most central actors. The presentation of network analytical metrics for Munich indicates that the total number of applicants and isolated applicants is increasing in the cooperation and mobility networks over time. Only the development of the relationship network shows an increase in applicants and a decrease in isolated applicants. In a comparison with the investigated German regions, the region of Munich has the largest number of connected network actors. The centrality of the cooperation network is decreasing between 1992 and 2007, but the density of the network is increasing. A similar picture gives us the development of mobility and relationship networks. The number of connected applicants is increasing in all networks. On the basis of increasing values for the average degree centrality, it can be suggested that there is stronger networking of actors (Fig. 6.6).

The existence of mobility networks indicates that patent applicants refer to research personnel from the region. This can be seen as an indicator of knowledge spillovers. This statement is supported by the fact that if someone takes the number of all applicants in relation to the number of connected and isolated applicants, it becomes clear that for the cooperation and mobility networks, there is an increase in isolated applicants of about 10, but the increase in the number of associated

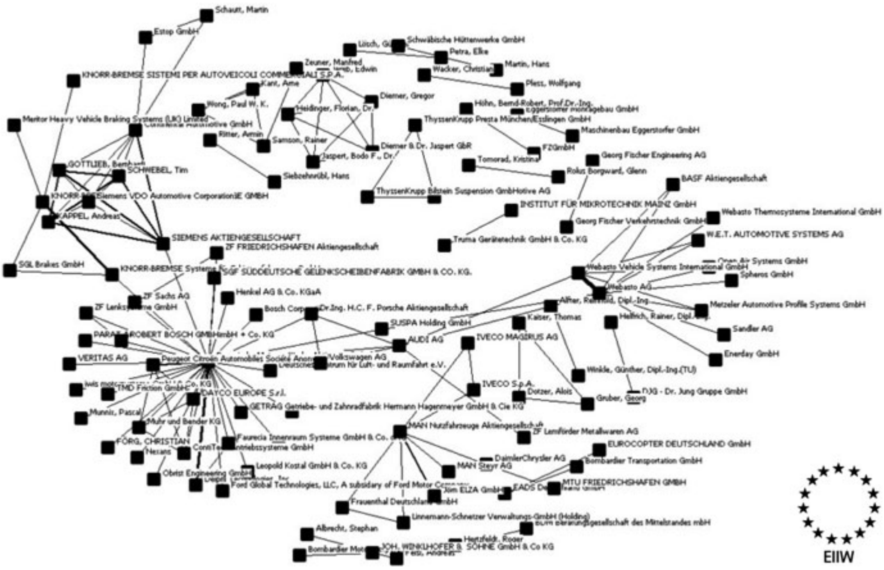


**Fig. 6.6** Munich: relationship network 2000–2007. Source: own figure

applicants is slightly higher (+13). This means that an increase in mobility or cooperation must be assumed. However, there is no involvement from institutions and universities in the networks (despite the fact that there is a high concentration of research institutions in this region). Only one active research institute can be found in the mobility network for the time period of 2000–2007 (Table 6.16).

### 6.5.3 *Results for the Vienna Region*

If one takes a look at the cluster initiatives of the Vienna region, it is emphasized that there is significant expertise in the automotive sector. A first look at the automotive patent applications shows that the value is doubled within the two observation periods (368 applications to the EPO 1992–1999 to 664 applications in the second period). In this analysis, however, the Vienna region is clearly not responsible for this development (only for a growth of four applications in the second period). This result is supported by an analysis of the network analytic metrics (Table 6.17).

It is also clear that despite the slight growth of patent applications (+4) all types of networks have a slight loss of the absolute value of applicants (−2 each network). On the one hand, the number of isolated actors is either constant or declining; on the other hand, there is an increase in the number of involved applicants in the cooperation and relationship network. The growth in the relationship network has different reasons. The cooperation network has a stronger internal structure despite

**Table 6.16** Network indicators for Munich (Coop = cooperation, Mobi = intercompany mobility of patent applicants, RN = relationship network = Coop + Mobi)

| | Coop 92–99 | Coop 00-07 | Mobi 92–99 | Mobi 00–07 | RN 92–99 | RN 00–07 |
|---|---|---|---|---|---|---|
| Total applicants (absolute figure) | 164 | 187 | 164 | 187 | 164 | 187 |
| Isolated applicant (absolute figure) | 105 | 115 (+10) | 132 | 142 (+10) | 84 | 76 (−8) |
| Centrality of network | 6.65% | 2.42% | 0.96% | 0.68% | 3.37% | 1.80% |
| Density of network | 0.0055 | 0.0081 | 0.0022 | 0.0045 | 0.0091 | 0.0140 |
| Joint applicants (absolute figures) | 59 | 72 (+13) | 32 | 45 (+13) | 80 | 111 (+31) |
| Average degree centrality (strength of internal structure) | 0.890 | 1.497 | 0.366 | 0.834 | 1.488 | 2.599 |
| Research institutes/ universities as part of the network | No | No | No | Yes | No | Yes |
| Most central actor | BMW AG; MAN Nutzfahrzeuge AG; Modine Manufacturing Company; A. Kayser Automotive Systems GmbH | BMW AG; Siemens AG, Keppel, Andreas, Schwebel, Tim | EADS Deutschland GmbH ; KNORR-BREMSE AG; DaimlerChrysler AG; Knorr Bremse; Systeme für Schienenfahrzeuge GmbH | Webasto AG; Webasto Vehicle Systems International GmbH; Bayerische Motoren Werke Aktiengesellschaft; MAN Nutzfahrzeuge Aktiengesellschaft | BMW AG; Knorr Bremse Systeme für Schienenfahrzeuge GmbH; Knorr Bremse AG; MAN Nutzfahrzeuge AG, Webasto Karosseriesysteme GmbH | BMW AG; Webasto AG; Webasto Vehicle Systems International GmbH; Siemens AG |

Source: EIIW calculations

**Table 6.17** Network indicators for the Vienna Region (Coop = cooperation, Mobi = intercompany mobility of patent applicants, RN = relationship network = Coop + Mobi)

| | Coop 92–99 | Coop 00–07 | Mobi 92–99 | Mobi 00–07 | RN 92–99 | RN 00–07 |
|---|---|---|---|---|---|---|
| Total applicants (absolute figure) | 49 | 47 (−2) | 49 | 47 (−2) | 49 | 47 (−2) |
| Isolated applicant (absolute figure) | 42 | 39 (−3) | 45 | 45 (=) | 40 | 37 (−3) |
| Centrality of network | 1.91% | 3.02% | 2.04% | 2.17% | 3.95% | 2.97% |
| Density of network | 0.0051 | 0.0074 | 0.0026 | 0.0009 | 0.0077 | 0.0083 |
| Joint applicants (absolute figures) | 7 (14.29%) | 8 (+1) (17.02%) | 4 (8.1%) | 2 (−2) (4.3%) | 9 (18.3%) | 10 (+1) (21.3%) |
| Average degree centrality (strength of internal structure) | 0.245 | 0.340 | 0.122 | 0.043 | 0.367 | 0.383 |
| Research institutes/ universities as part of the network | No | No | No | No | No | No |
| Most central actor | DWA Deutsche Waggonbau GmbH; Volkswagen AGt; Siemens AG; Steyr Daimler- Puch AG | Volkswagen AG; Continental Automotive GmbH; Greenbrier Germany GmbH; Bombardier Transportation GmbH | Steyr Daimler- Puch AG; Engineering Center Steyr GmbH & Co KG; Bombardier Transportation GmbH; DaimlerChrysler AG | MAN Nutzfahrzeuge Österreich AG; MAN Nutzfahrzeuge AG | Steyr Daimler- Puch AG; DaimlerChrysler AG; DWA Deutsche Waggonbau GmbH; Volkswagen AG | Volkswagen AG; Continental Automotive GmbH; Greenbrier Germany GmbH; Bombardier Transportation GmbH |

Source: EIIW calculations

a declining number of applicants. However, there is a decrease of one half of the number of involved applicants in the mobility network.

In the first period, there is little mobility and the existing structure is deteriorating significantly in the second period. The Automotive Cluster Vienna Region (ACVR) sees itself as a network that is, besides a promoter of innovation and an actor of pooling of competence, an actor in promoting and increasing knowledge transfer. Comparing our results for the cooperation and mobility network, a knowledge increase in the Vienna region is limited. This approach is restricted because we measure spillovers on the basis of patents, and unpatented knowledge (pure technical innovation) is not taken into account (Frietsch 2007, p. 1). Furthermore, the mobility network carries the risk of intramobility between related applicants in the second period. In that case, it can be assumed that a "genuine" mobility network no longer exists. Moreover, the relationship between all of the applicants, the average related-degree centrality and the very small size of the network shows that there is no internal structure. This is supported by the fact of low-density values for all networks. Research institutes are not actively involved in our network types. In literature, it is often assumed that agglomeration areas are very successful economically if they can be expected to be in classic technology locations with universities and research institutes. Belonging to these areas creates the opportunity to draw on a high and growing supply of people in technical jobs with university and college degrees (Döring 2004, p. 10). Central actors in the networks are DWA German Wagon GmbH, Volkswagen AG, Steyr Daimler-Puch AG, and MAN Nutzfahrzeuge AG Austria. Volkswagen AG became a star in the cooperation network and the relationship network in the second period.

The results for the network analytic metrics suggest that a network of cooperation and mobility network exists in both periods. There is a decrease in applicants in the cooperation network. Despite the decrease, a stronger internal networking can be observed. In the first period, the mobility network highlights a very weak structure. In the second period, the mobility network exhibits another loss of the internal structure. A look at the relationship networks of the Vienna region shows that neither of the actors can take a leading role. There is a central key player (FORD AG) in the network of the Bergisch City Triangle. Furthermore, in the second period, the building components are more oblivious. In the first period, there were three components. In the relationship network of the second period, a total of four components can be found (Figs. 6.7 and 6.8).

The city of Vienna and the Vienna region (NUTS3) accommodate a large number of automotive companies—e.g., Bombardier, MAN (Vienna, high-volume parts), Bosch, Magna Steyr, and Eybl International (automotive textiles). Companies such as Volkswagen and Bombardier are represented in our networks in both periods. Here, the appearance and disappearance of applicants in the various relationship networks must be seen under the light of developments in the individual companies. The applicant Steyr-Daimler-Puch AG disappears in the relationship network for 2000–2007. This can be explained by a spin-off of business parts since 1987.

The business part of the vehicle techniques was purchased by the Magna Automotive Group. In 1998, the majority of shares in Steyr-Daimler-Puch AG

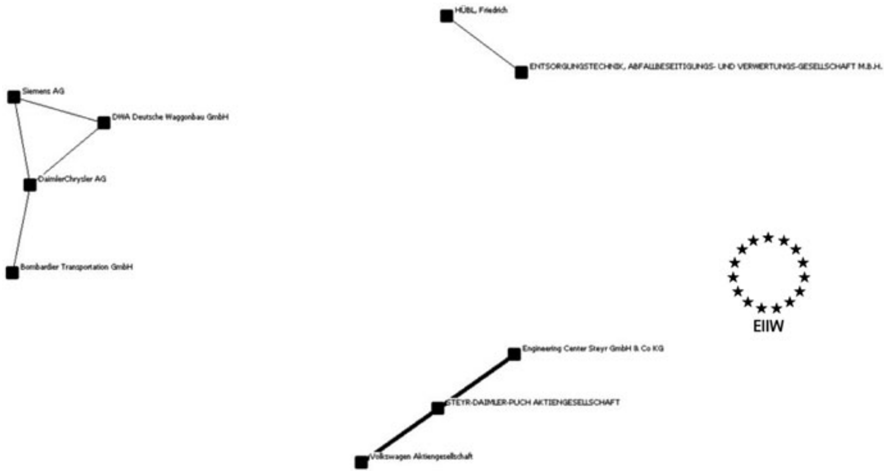


**Fig. 6.7** Vienna region: relationship network 2000–2007. Source: own figure

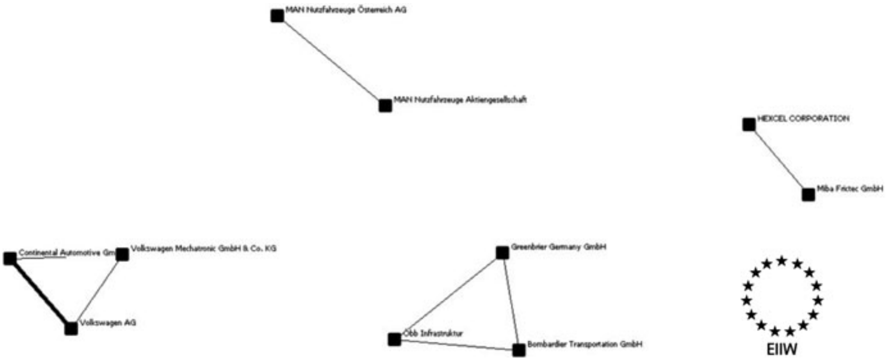


**Fig. 6.8** Vienna region: relationship network 2000–2007. Source: own figure

were adapted by the Magna International Inc. Magna Steyr AG & Co KG was founded in 2001. In June 2002, Steyr-Daimler-Puch AG & Co KG was renamed Automotive Magna Steyr AG & Co KG and STEYR Powertrain AG & Co KG was renamed Magna Steyr Powertrain AG & Co KG (Magna Steyr 2010). In the early 1990s, Steyr Nutzfahrzeuge AG (trucks) was acquired by Man AG (MAN 2010). The power transmission division was sold to ZF Friedrichshafen AG. Magna Steyr has not immersed as an actor in the relationship networks nor in the cooperation and mobility networks. The headquarters of Magna Steyr AG & Co KG is located in Oberwaltersdorf. This region is part of the studied region of NUTS3 AT127. The fact that the company does not appear in our networks as an active actor may be due to the fact that the company does not work with inventors from the region.

Bombardier, in contrast, appears in two networks. Furthermore, it is striking that DWA German Wagon GmbH no longer appears as an actor in the relationship network from 2000 to 2007. The reason must be—similar to the development of Magna Steyr AG & Co KG—the acquisition of a competitor. In 1998, DWA was taken over by the burly Canadian company, Bombardier.

### *6.5.4 Results for the Eindhoven Region*

The evaluation of the results for the region around Eindhoven shows that there are mobility, cooperation, and also networks of relationships. In a first visual inspection of the various networks, it is significant that there is a fragmentation of the individual components. A significant central component is not found for either period. The networks clearly show that there are so-called anchor companies located in the Eindhoven region, above all, Phillips. Phillips appears as a connected actor in both cooperation networks for both periods. In the mobility network, Philips only appears in the first period. This is surprising because Philips is very dominant. Perhaps it can be explained by the existence of the High Tech Campus. It is remarkable that there is collaboration between researchers from Phillips and researchers from companies such as Siemens and Bosch.

In this regard, Hölzl (2009, p. 154) stresses that formerly long-monitored "knowledge stocks" were released with the emergence of the high-tech campus of Phillips. This results perhaps in a decrease of the mobility of scientists. It must, however, be taken into account that there are many spin-offs of Philips. In this case, the CAT (Centre for Applied Technologies) plays a major role.

This research institute is also located at the High Tech Campus Eindhoven. The CAT is an organization that is affiliated with the NatLab. Hölzl (2009, p. 150) mentions that the CAT is an institute for fundamental research that was formed in the 1970s in order to guide engineers that will later be affiliates abroad (location manager), which in turn were completely independent. Some of these engineers are now working for spin-offs from Phillips. Other former employees are now employed in research institutions such as the TNO Science and Industry Organization (CRO). The TNO is an organization that has relocated its automotive research to Eindhoven (500 employees). Despite the fact that it is a clear competitor of Phillips, Hölzl explains that there is certain confidence. The CAT has thus helped to build trust structures and to prevent conflicts. Further, Hölzl (2009, p. 149) stresses that beneath the fact that the actors do not belong to the same group, there is sharing of a common language, common standards, values, and history, and this tends to stimulate the exchange of implicit personal knowledge (Fig. 6.9).

Despite a restructuring of the Phillips Group, the research and development department of the Group has remained in Eindhoven. Because of the emphasis on cooperation with other companies (High Tech Campus), much stronger networking would be expected of the cooperation network of the Eindhoven region. This assumption is unfortunately not confirmed because the cooperative network is only marked by a slight increase in the connected applicants (Fig. 6.10).

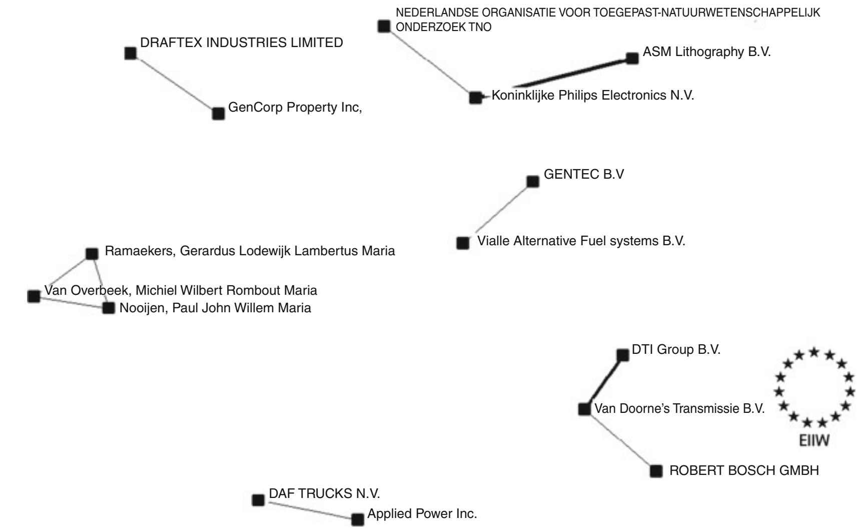


**Fig. 6.9** Eindhoven: relationship network 1992–1999. Source: own calculations

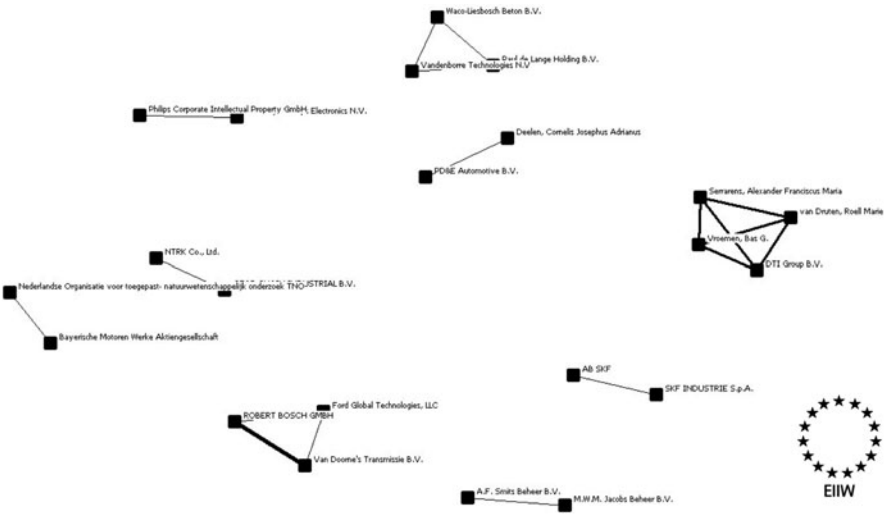


**Fig. 6.10** Eindhoven: relationship network 2000–2007. Source: own calculations

In the networks for Eindhoven, individual inventors or individuals can also be found. A final review of the network analytical metrics shows that there is no integration of research institutes and universities in the networks of cooperation, but there is integration in the mobility networks (Table 6.18).

The first positive impression of a growing number of applications, however, quickly mitigated because this increase is accompanied by an increase in the

**Table 6.18** Network indicators for the Eindhoven Region (Coop = cooperation, Mobi = intercompany mobility of patent applicants, RN = relationship network = Coop + Mobi)

| | Coop 92–99 | Coop 00–07 | Mobi 92–99 | Mobi 00–07 | RN 92–99 | RN 00–07 |
|---|---|---|---|---|---|---|
| Total applicants (absolute figure) | 49 | 60 | 49 | 60 | 49 | 60 |
| Isolated applicant (absolute figure) | 40 | 50 (+10) | 41 | 49 (+8) | 34 | 38 (+4) |
| Centrality of network | 1.99% | 3.23% | 2.02% | 1.98% | 2.30% | 2.76% |
| Density of network | 0.0085 | 0.0079 | 0.0060 | 0.0062 | 0.0145 | 0.0192 |
| Joint applicants (absolute figures) | 9 | 10 (+1) | 8 | 11 (+3) | 15 | 22 (+7) |
| Average degree centrality (strength of internal structure) | 0.408 | 0.467 | 0.286 | 0.367 | 0.694 | 1.133 |
| Research institutes/ universities as part of the network | No | No | Yes | Yes | Yes | Yes |
| Most central actor | Koninklijke Philips Electronics N.V.; ASM Lithography B.V.; Ramaekers, Gerardus Lodewijk Lambertus Maria; Van Overbeek, Michiel Wilbert Rombout Maria | van Druten, Roell Marie; Serrarens, Alexander Franciscus Maria; Vroemen, Bas G.; Paul de Lange Holding B.V. | DTI Group B.V.; Van Doorne's Transmissie B.V.; Draftex Industries Ltd.; GenCorp Property Inc. | Robert Bosch; Van Doorne's Transmissie B.V.; Ford Global Technologies, LLC; SKF INDUSTRIE S.p.A. | Koninklijke Philips Electronics N.V.; Van Doorne's Transmissie B.V.; ASM Lithography B.V.; DTI Group B.V. | van Druten, Roell Marie; DTI Group B.V.; Serrarens, Alexander Franciscus Maria; Vroemen, Bas G. |

Source: EIIW calculations

number of isolated applicants. The values for the density of the cooperation network also decline over time. Low growth in the average centrality degree does not affect the network structure. The development of the relationship network shows a barely noticeable change and a barely average growth of the degree centrality. The small number of connected actors (similar to the networks of Vienna) shows that there is insufficient reliance on research staff from the region around Eindhoven. A disadvantage is the fact that the Technical University of Eindhoven is not actively part of the network structure.

## 6.6 Patent Citation

It could be shown that patents provide a lot of information that can be used for research. In addition to the social network analysis, the so-called patent citation method is also used in our analysis. This method can be considered the most important evaluation and analysis capabilities in patent search. Meanwhile, there is only a tiny selection of scientific papers dealing with these issues. One of the pioneering studies on this subject is the paper by Jaffe et al. (1993). The "Case–control matching" by Jaffe et al. performs a comparison between the probability of geographical colocalization of citing and cited patents and the probability of geographical colocalization of randomly selected "control patents" to these cited patents. The randomly selected control patents must belong to the same technological class and continue along the same period as the cited patent. We also have to check whether these patents themselves have no citations (Scherngell 2007, p. 112).

If an applicant applies for a patent, a document is created and detailed information must be given. Next to the name of the inventor, or the entry of the applicant of the invention, the inventors also have to give the patent office detailed information about what is new about the invention and what information already existed at the time of registration. These references (citations) provide the basis for the method of patent citations. Jaffe and Tratjenberg (2002) further conclude that the reference to earlier patents suggests that the knowledge of these patents was useful and important for the development of new knowledge, which is described in the citing patent. They come to the conclusion that, contrary to the ideas of Krugman (1991), knowledge flows, and therefore, knowledge spillovers may also be captured by patent citations. Therefore, it can be concluded that it is possible to follow a "paper trail."

When someone is working with patent citations, one must also take into account that this indicator has certain methodological limitations:

- Patent citations in general have the same disadvantages as patents.
- A distinct disadvantage can still be the considered addition of citations by officers of the institution. This gives rise to the impression that often no real spillovers are recorded.
- Record adjustment because of self-citations (Scherngell 2007, p. 43).

The disadvantages with respect to adding citations must be mitigated since the EPO officials complement the application.

Other exemplary studies that dealt with patent citations that must be considered when analyzing the unit of analysis are the studies of Maurseth and Verspagen (2002), Thompson (2004), and Thompson and Fox-Kean (2005). The other part that is relevant for Austria is the important and pioneering study of Scherngell (2007). The aim of the study by Mausreth and Verspagen was to investigate whether geographical distance and national borders and different languages hinder the flow of knowledge in Europe.

### 6.6.1 Method

Our methodology is primarily based on the study of Scherngell (2007). Our geographic dimension is significantly larger. All preparatory work in the context of social network analysis is conducted to flow into the analysis of patent citations. Scherngell primarily investigated NUTS2 regions in his study. Our focus is relying on NUTS3 regions. Furthermore, the classification of automotive and ICT sectors is also used in the retrieval of patent data and patent citations. The same concordance tables that were used for the analysis of the social network are also used to analyze patent citations. The patent citation analysis also offers a wide range of interesting instruments. In our analysis, we mainly study the so-called patent citation index.

In this case, patents are retrieved from the database in which at least one inventor is from one of the considered regions and then we calculate how often these patents cite other patents from other regions. When we define the citing patents, we calculate how often patents from the considered region are cited by other patents (received citations). It can yield information about knowledge generation if we look at how often a region cites patents about the absorption of a knowledge region. After some necessary calculation steps (see Mahmutovic 2010, pp. 14–15), we get the data and use Microsoft Excel to clean up the raw data. This cleanup of raw data is necessary because it can happen that applicants' names are spelled differently. Siemens AG and Siemens AG would be considered as two different applicants. In addition to the cleanup step, the so-called self-citations have to be removed. Self-citations arise when some parties of the citing and cited patent are identical.

After we have run the query and after we have done the necessary cleanup steps, we can calculate the patent citation index for each region. The following formula illustrates the approach, where GZ indicates the number of citations made and EZ the number of citations received. Dividing both values results in a value above or below 1. A value below 1 says that more knowledge was absorbed in a region, and a value below 1 indicates greater knowledge creation:

$$PI = \frac{GZ}{EZ} \tag{6.4}$$

**Table 6.19** Patent citation index (automotive)

| Automotive | Citations made | Received citations | Ranking | Index[a] |
|---|---|---|---|---|
| Vienna | 374 | 326 | 4 | 1.15 |
| Munich | 5,680 | 5,318 | 1 | 1.07 |
| Eindhoven | 1,081 | 832 | 3 | 1.30 |
| Bergisch City Triangle | 1,267 | 1,104 | 2 | 1.15 |

[a]Citations made per-keeping citations
Source: EPO (2008), EPO worldwide Statistical Patent Database

The study by Scherngell shows that most countries absorb as much knowledge as they generate (Scherngell 2007, p. 90). The following remarks are intended to give us an idea of the values for the patent citation index of the analyzed regions (Table 6.19).

### 6.6.2 Patent Citation Index: Benchmarked Regions

The following table presents the results of the calculation of the values for the patent citation index in the automotive sector. This table also offers information about the number of citations made and received. Looking at the relation between these two values, we can rank our regions. We suppose that values close to zero are better because knowledge is created.

In an interpretation of the values for the automotive sector, the following procedure is appropriate. First, we consider citations received and made. These figures first show us patents in the region that are frequently cited and often quoted. Then we can include the relevant proportion of citations made and received in our analysis. Substituting the absorption of knowledge with the absorption of knowledge spillovers and the generation of citations to the generation of knowledge spillovers, the following conclusions can be made:

The finding of Scherngell that most regions generate about as much knowledge spillovers as they absorb is also reflected in our study. The only difference in contrast to Scherngell's analysis is the dimension of the regions. We consider NUTS3 regions. Accordingly, it can be stated as a first result, not only in NUTS2 regions (High Tech), that the ratio of citations made and received is the same. This ratio can also be seen in the automotive NUTS3 regions. Besides this trend, there are also some outliers. The regions of West Midlands and Hungary are more generating, and Arvika is a much less generating region. The values for automotive regions in Central Europe are around the value of 1. The values of the Eastern European or northern regions are significantly far from the value of 1.

## 6.7 Conclusions

Network analysis is quite useful for understanding knowledge dynamics in the automotive industry. It has turned out that there are application and cooperation networks in the automotive industry in both the German and the Austrian cluster regions that offer interesting inside views into the knowledge transfer (knowledge spillovers) of cluster actors; the role of regional innovation systems should, for example, be reinforced and adequate incentives for cluster formation could be useful.

It also has turned out that the relationship networks of the compared regions are unique, which results in the different developments of these networks. So it is important to look at not only network analytical metrics but also different economic developments (behavior of big OEMs that behave as anchor companies) in the regions that perhaps explain the different developments. In this context, it is not easy to find universal instruments for cluster building. A loss of a big OEM, for example, will perhaps lead to a collapse of the whole network. So it is important to describe the role of an OEM or a supplier. It is also important to identify reasons for the decrease in the network structure.

On the one hand, the analysis offers important results for cluster management and cluster policy actors and a useful exploration of EPO patent database, respectively. On the other hand, there are important new findings for cluster dynamics and for the “social network analysis,” as well as opportunity for further research (more countries, more sectors, and over more time periods).

As regards policy conclusions, one may suggest that future EU innovation policies, as well as national innovation policies, put more emphasis on efficient Schumpeterian networking; R&D support for cluster regions should be carefully evaluated, and interregional benchmarking should be quite useful.

The following remarks are intended to compare the results again. In a first visual analysis of the networks, we could give some important conclusions about the internal structure of the network. We analyzed selected regions in terms of their inventor mobility to examine cooperation between companies and research institutions and bring some transparency into the inner network structure of these relationships. New knowledge cannot be completely protected from other companies.

Patents are likewise unreliable—despite the long term—in that they exclude other companies completely. One of the most important channels of knowledge transfer (knowledge spillovers) is the mobility of inventors (Phäler and Wiese 2008) and cooperation in the form of jointly published patents. The exchange of knowledge in clusters is important to create new innovative products and to stimulate economic growth.

The evaluation scheme in the following table should help to summarize the results of the different regions. In this case, four major areas of social network analysis have been identified (these areas are regarded as equivalent/quarter of the results). The major areas for evaluation are the number of actors involved (absolute), the number (absolute) of connected actors, the integration of research institutes, and the change in

**Table 6.20** Evaluation scheme for social network analysis (automotive)

| |
|---|
| *Social network analysis* |
| (1) Number of actors involved |
| + + +: High number of actors involved (≤60) |
| + + −: Average number of actors involved (40–59) |
| + − −: Low number of actors involved (20–39) |
| − − −: Poor number of actors involved (0–19) |
| (2) Number of connected actors |
| + + +: High number of connected actors (≤60) |
| + + −: Average number of connected actors (40–59) |
| + − −: Low number of connected actors (20–39) |
| − − −: Poor number of connected actors (0–19) |
| (3) The integration of research institutions (relationship network 2000–2007) |
| + + +: Significant involvement of research institutions (<10) |
| + + −: Moderate involvement (more than 5) |
| + − −: Low involvement (less than 5) |
| − − −: No involvement |
| (4) Change of the average degree centrality |
| + + +: Increasing network over time |
| + + −: Slightly networking |
| + − −: Decrease in networking |
| − − −: Sharply decrease in networking |

Source: own weighting

the network with regard to the degree of cross-linking. We calculated all network analytical metrics, and in a next step, we ranked these regions (Table 6.20).

In addition to the social network analysis, the following evaluation table also shows the weighted relationship between citations that are made and received. Values that are located near zero scored significantly positively ("efficient" relationship between citations made and received) (Table 6.21).

This is demonstrated by the following ranking:

- Looking at the results for the social network analysis, *Munich* ranks first. Big OEMs are involved in different networks. One of the big players is BMW AG. This is not surprising, but you can also find major suppliers (including major suppliers such as Bosch Tier 1) in the relationship networks. Mobility networks are smaller than the cooperative networks. This development can be transferred to almost any other regions compared. The Munich region also shows a healthy growth of all relevant players. Due to the increasing connection of applicants in the mobility network, it seems likely that there is an increasing use of research personnel. It becomes clear that there is only integration of universities or research institutes in the mobility network of 2000–2007. For the Munich region, it would be beneficial to promote the active involvement of institutions and universities in the cooperative network. Through the analysis of the relationship of citations that are made and received, Munich ranks first.

**Table 6.21** Comparison of results for social network analysis and patent citations (automotive)

| Automotive | Social network analysis | Social network analysis Ranking | Citation index Ranking |
|---|---|---|---|
| Country | Individual expression | | |
| Germany (Bergisch City Triangle) | (1) + + +<br>(2) + - -<br>(3) - - -<br>(4) - - - | 4 | 4 |
| Germany (Munich) | (1) + + +<br>(2) + + +<br>(3) + - -<br>(4) + + + | 1 | 1 |
| The Netherlands (Eindhoven) | (1) + + +<br>(2) + - -<br>(3) + - -<br>(4) + + + | 2 | 3 |
| Austria (Vienna region) | (1) + - -<br>(2) - - -<br>(3) - - -<br>(4) + - - | 3 | 2 |

Source: Social network analysis: based on a proprietary evaluation scheme (see discussion in Sect. 6.5)

- In addition to the social network analysis, *Eindhoven* ranks second: The networks are characterized by significant fragmentation. This is particularly evident in the small number of actors involved. A key component is barely discernible. The networks in Eindhoven are, however, characterized by a high number of involved actors. This impression is rapidly mitigated, however, if someone looks at the number of isolated applicants as this number is rising. The largest "anchor" company in Eindhoven is Phillips. This big company is actively involved in all networks in the first comparison period. Individual inventors can also be found in cooperation networks. It must be noted that there is active integration of research institutes into the mobility networks. The small number of the actors involved leads to the assumption that there is rarely recourse of research personnel from the region. It is also noticeable that the Technical University of Eindhoven is not active in any of the networks. In the patent citations, Eindhoven is ranked in third place (last rank).
- *Vienna Region*: Intramobility is also visible in the networks for Vienna. Here, there is also some potential danger. Extrapolating the intramobility from the mobility network of the second investigation period has resulted in the nonexistence of a mobility network. Furthermore, you can find a barely existing network structure in almost every network. Most central actors in the networks are the PSA, VW, and Steyr Daimler-Puch AG. It can also be shown that there is further decline in the importance of mobility networks during the second period. The regional company MAGNA AG & Co KG (most recently known by the attempted takeover of OPEL AG) is not

immersing in our networks. This is a sign of a nonrecourse on locally based inventors.

- Bergisch *City Triangle*: This region ranks last (4). The relationship network of the Bergisch City Triangle shows a rather large fragmentation of the components and a decrease in cohesion over time. Almost all of the metrics are falling. The cooperation network does show an increase in connected applicants (and thus a decrease in the isolated parties), but this may not help the network of relationships to sufficiently stabilize. Research institutes are not embedded in the cooperation and mobility networks. This is a sign that companies, as well as the political operators in the region, appear to fail to use the local university (University of Wuppertal) as a knowledge producer and actively support collaborative research with the goal to develop an innovative product. The potential of the region, particularly for research cooperation, is therefore not fully exploited. Also, within the isolated components (not within the networks listed), no research institutes can be found. The mobility of researchers in the Bergisch City Triangle is higher than the cooperation of applicants, but this development is negative. This development cannot be compensated by a stagnant number of investors. Our analysis suggests that the use of research personnel from the region is decreasing. Further investigations will show whether there is a revival of the relationship network. The comparison between absorbed and generated knowledge shows that the Bergisch City Triangle can be found in second place. The ranking of the Vienna region also shows that the citation index offers potential for the second place.

As an important result of our analysis, it can be stated that the reasons for why companies can retire as actors of networks can be identified. First, one must remember that there are many individual reasons for the removal of players. But if you look at the development in our networks, causes could be:

- Eliminated by the fact that the inventor's residence was taken in the selection of our patent dataset for social networks (residence of inventors). This suggests that a company does not appear because there is no recourse on research personnel from the region (see above).
- R&D of many German companies (suppliers) is done at German locations (Kinkel and Zanker 2007, p. 199); according to this, actors do not appear because they do not exercise R&D activities abroad.
- Elimination of actors from a network through:

  (a) Outsourcing
  (b) Acquisition
  (c) Dissolution

of companies (in all types of networks) (Case of Vienna region).

- Another reason for an international company may be the relocation of parts of the production (even relocation and no active R&D activities in the region).
- Possible reason can be the elimination of a large supplier/OEM.

- Nonapplication of a patent (the risk that a “double invention” is patented) (Hentschel and Koller 2007, pp. 20–21).
- Profitability reasons (balancing of costs and benefits), especially in times of crisis. No application because there are economic reasons (economic and financial crisis).
- Knowledge inventories will be released by an actor; mobility is perhaps reduced and an actor may no longer appear as an active participant in a mobility network (e.g., Phillips in Eindhoven—Mobility network for 2000–2007).

Our analysis also demonstrated that there are many actors who are actively involved in a cluster. The following table shows the main actors involved in a cluster. Only if there is active involvement of all actors will the regional innovation system function.

Major challenges or opportunities for action if you look at the innovative performance of our initial Bergisch City Triangle must be considered in the following fields:

- An initiative to accelerate innovation in the automotive sector. The University of Wuppertal has to be part of the innovation system. There are different possibilities to promote innovative activity in the automotive sector—specific research activities as part of externally funded projects and an affiliated institute.
- Development of continual university education programs for the qualification of managers and senior administrative staff. Objective here should be higher start-up and innovation dynamics.
- The economic development of cities in Solingen, Remscheid, and Wuppertal has to become more internationalized.
- One field is the strengthening and better utilization of existing networks and networks between scientific institutions.
- The communication between scientific institutions and businesses must be improved.
- Scientific institutions need to improve incentives to focus on the needs of local companies and organizations.
- Innovation-oriented firms must be supported to settle (e.g., subsidiaries)—also new scientific facilities and institutions (university and nonuniversity).
- Building cross-border networks (with other regions).
- Promoting start-ups—from the university or research and scientific institutions.

Future analysis will show whether there is change toward a stronger fragmentation in mobility and cooperation networks. It is likely that the current state will suffer an increasing fragmentation of networks.

## Mobility and Cooperation Networks

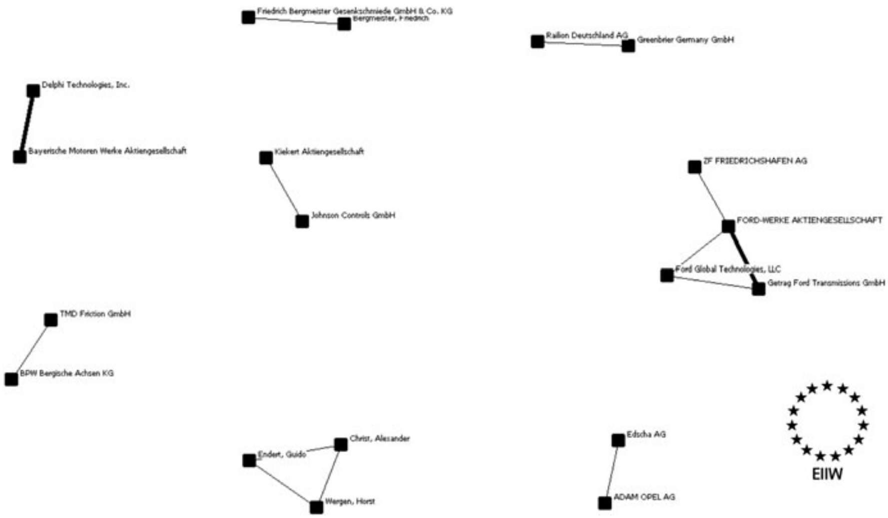


**Fig. 6.11** Cooperation network—Bergisch City Triangle 2000–2007. Source: own calculations

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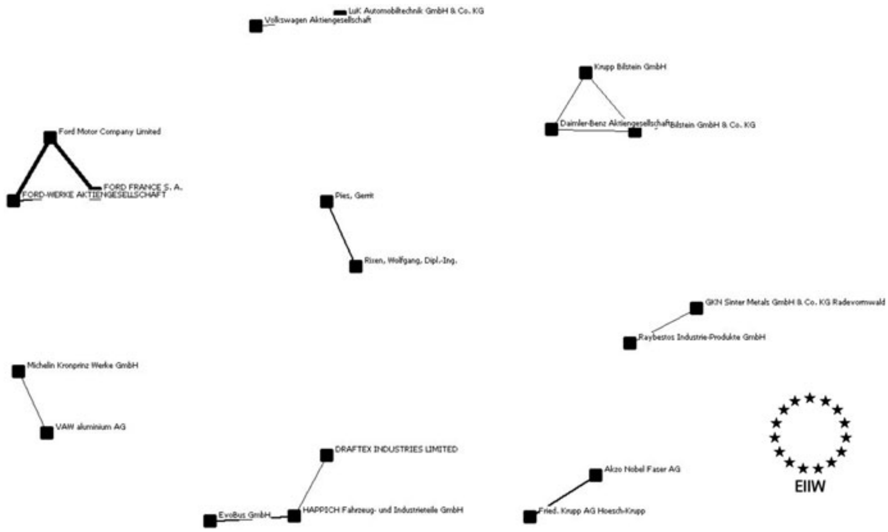



**Fig. 6.12** Cooperation network—Bergisch City Triangle 1992–1999. Source: own calculations

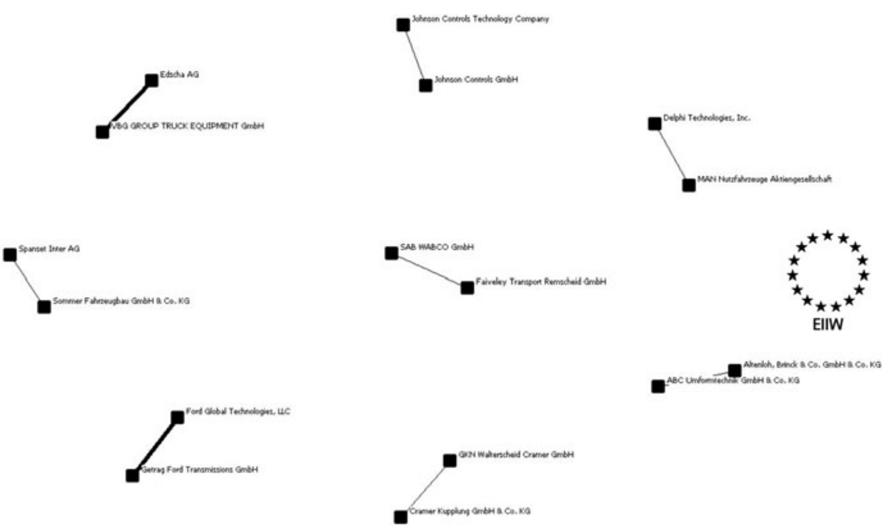



**Fig. 6.13** Mobility network—Bergisch City Triangle 2000–2007. Source: own calculations

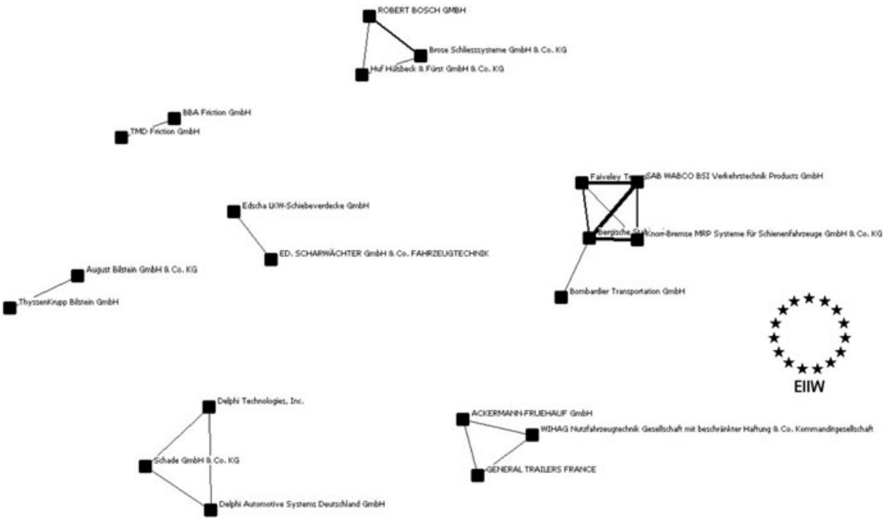



**Fig. 6.14** Mobility network—Bergisch City Triangle 1992–1999. Source: own calculations

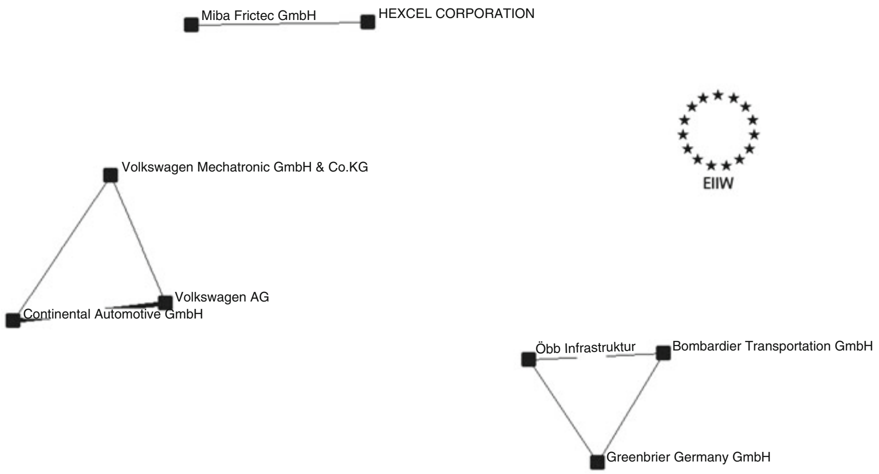



**Fig. 6.15** Cooperation network—Vienna 2000–2007. Source: own calculations

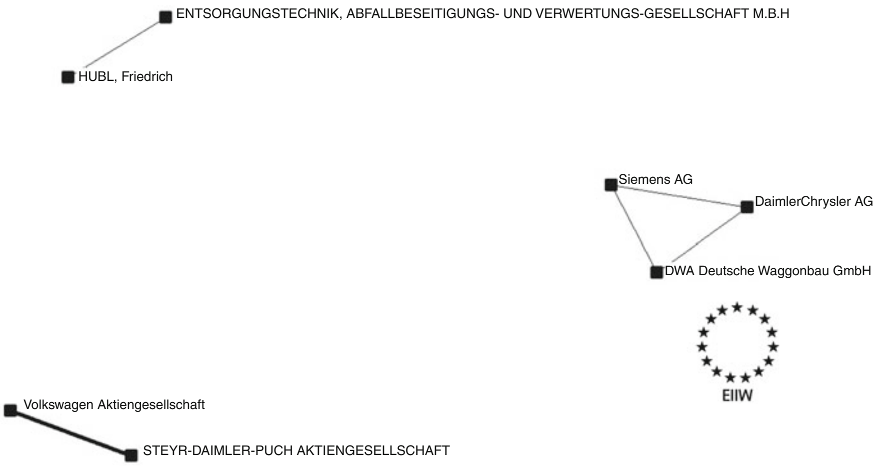
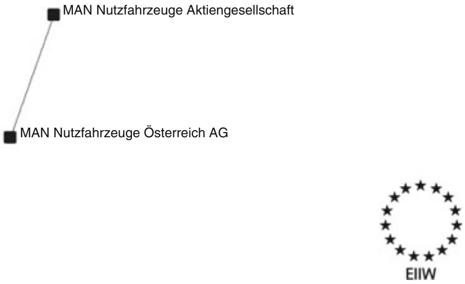



**Fig. 6.16** Cooperation network—Vienna 1992–1999. Source: own calculations

Fig. 6.17 Mobility network—Vienna 2000–2007. Source: own calculations



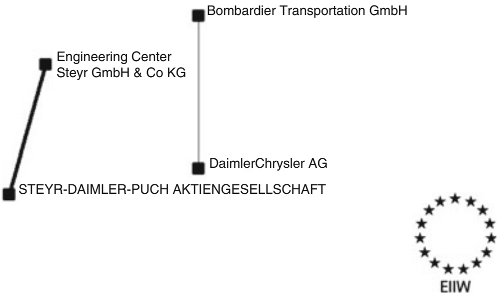




Fig. 6.18 Mobility network—Vienna 1992–1999. Source: own calculations

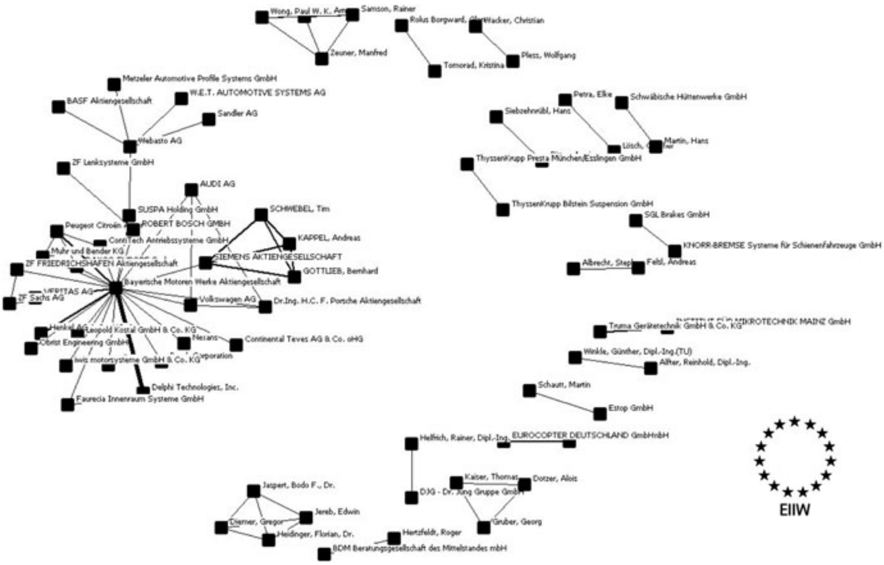



Fig. 6.19 Cooperation network—Munich 2000–2007. Source: own calculations

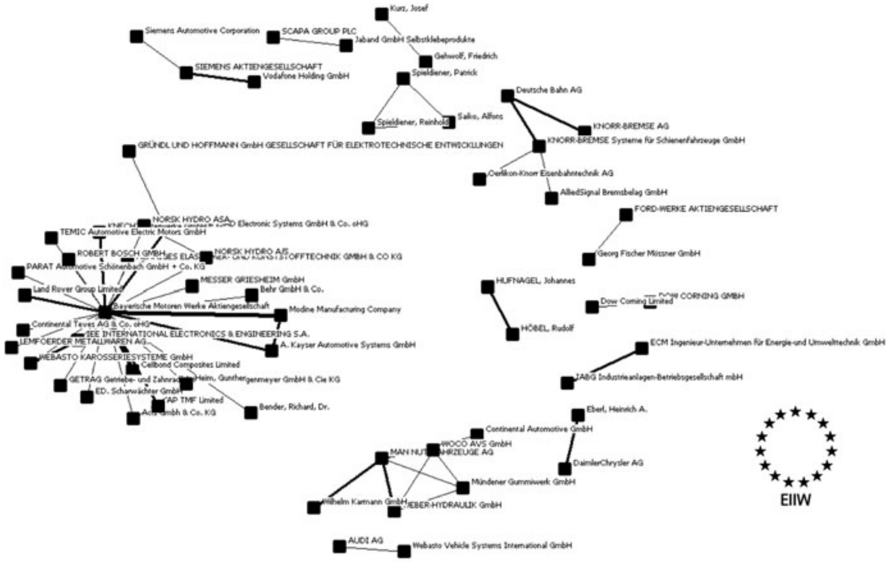



**Fig. 6.20** Cooperation network—Munich 1992–1999. Source: own calculations

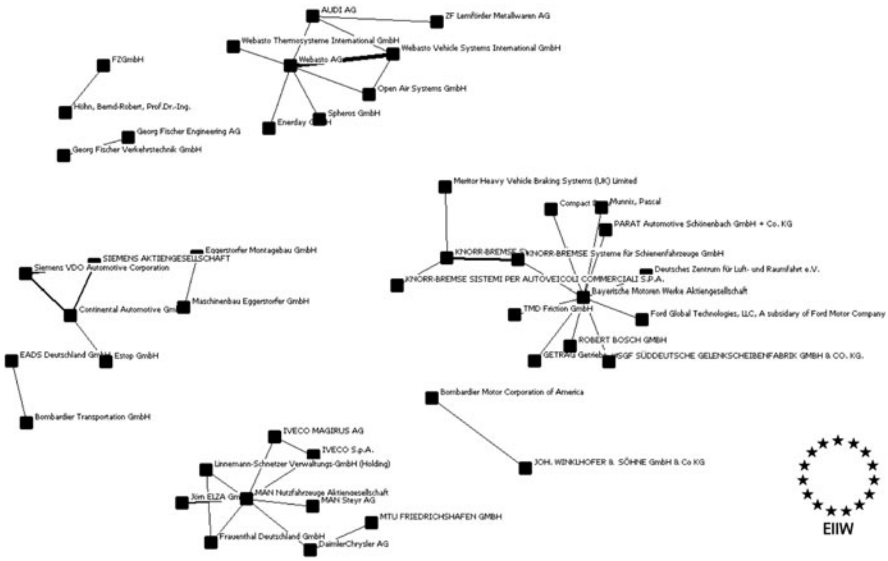



**Fig. 6.21** Mobility network—Munich 2000–2007. Source: own calculations

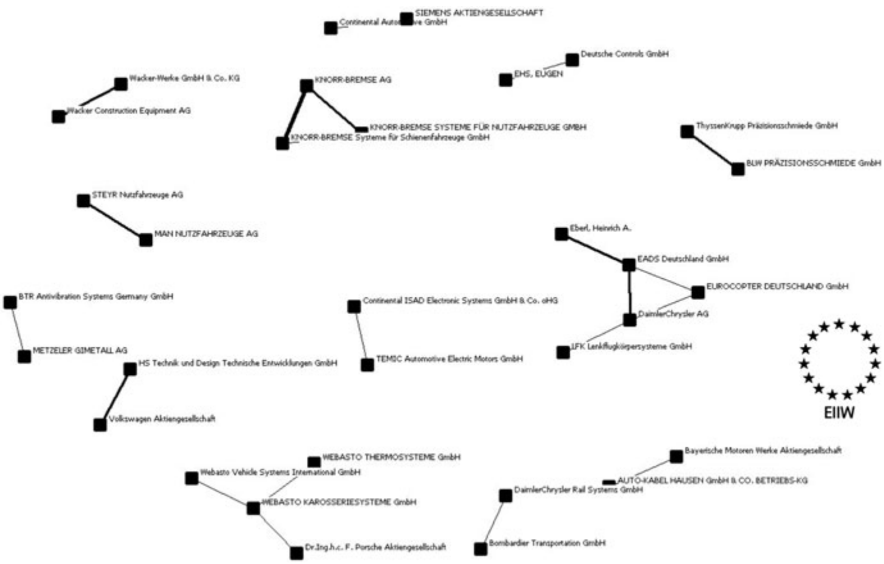



**Fig. 6.22** Mobility network—Munich 1992–1999. Source: own calculations

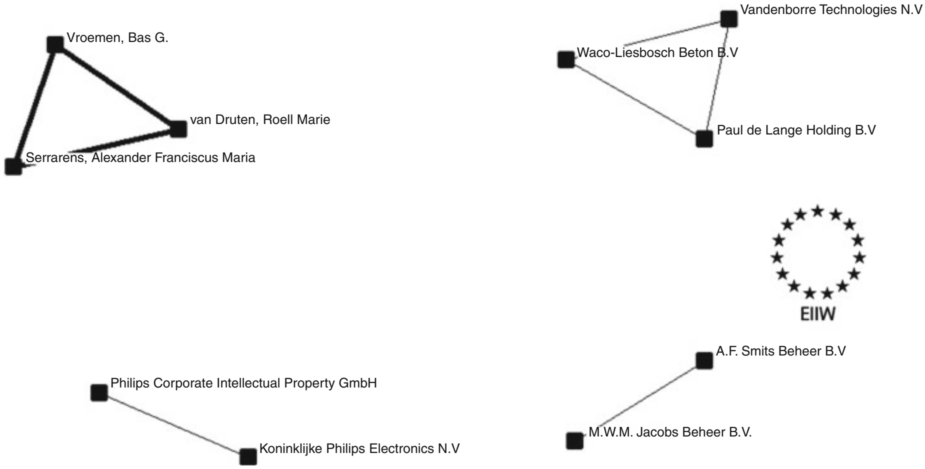



**Fig. 6.23** Cooperation network—Eindhoven 2000–2007. Source: own calculations

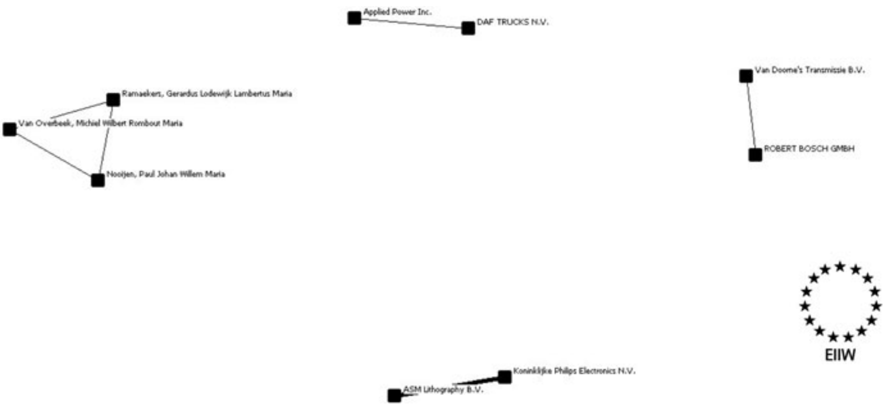



**Fig. 6.24** Cooperation network—Eindhoven 1992–1999. Source: own calculations

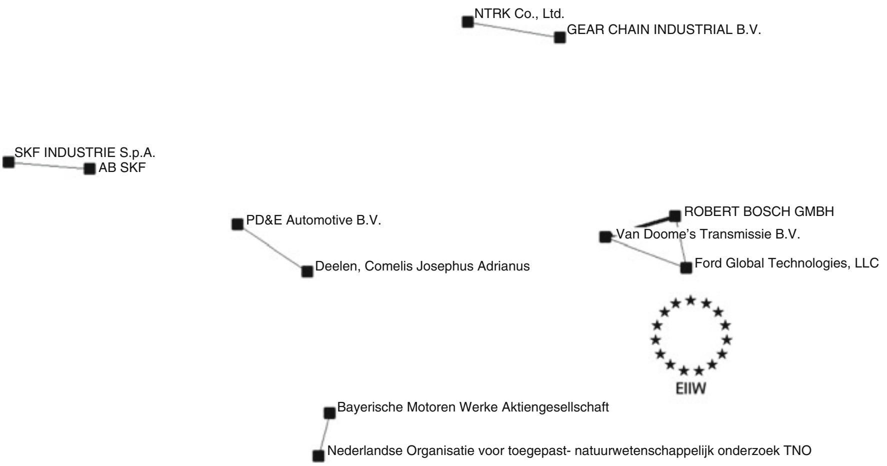



**Fig. 6.25** Mobility network—Eindhoven 2000–2007. Source: own calculations

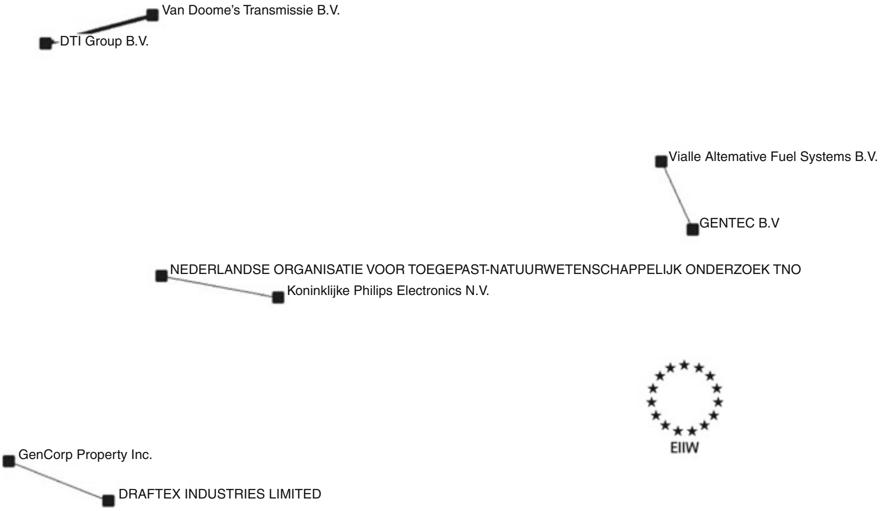



**Fig. 6.26** Mobility network—Eindhoven 1992–1999. Source: own calculations

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# Chapter 7
# The Hungarian Automotive Sector: A Comparative CEE Perspective with Special Emphasis on Structural Change

**Andrea Szalavetz**

## 7.1 Introduction and Overview

The past decades and especially the last 2 years were marked by sweeping changes in the global automotive industry. In the maturity phase for a long time, this industry does not only show trends that characterize overall consolidation but also features signs of revitalization (at least up until the global financial crisis and the collapse of the automotive markets). On the one hand, this has included major shifts in the global geography of production (Dicken 2003), increasing market segmentation and fragmentation, new entrants from emerging economies, large global merger and acquisition deals, and rationalization and restructuring; on the other hand, continuous product, process and organizational innovations, and the incorporation of emerging technologies into the maturing product characterize the present evolution phase of the industry.

Global competition increases consumer choice and expectations not only in the small high-end segments characterized by affluent and environmentally conscious buyers, fascinated with new technical and design solutions. In the low-end segments, competitive pressure has also substantially increased: offensive new entrants, the so-called dragon multinationals (Mathews 2002), capture an increasing global market share with their better-than-the-average ability to keep a tight grip on costs. Producer efforts at cost cutting at the time of falling car prices is thwarted by rising material and capital costs—increasing complexity of the products themselves—and by the ever stricter environmental and safety regulations with which car manufacturers must comply. These phenomena trigger continuously and rapidly increasing R&D efforts both in product, process, and organizational senses.

One key aspect of innovation efforts—impacting products, processes, and the global organization of operations—is modularization and outsourcing (Hoetker 2006). Outsourcing has provided enormous impetus to low-cost peripheral locations that have been trying to attract efficiency-seeking foreign investors willing to transfer technology and know-how together with relocated production. The relocation of car assembly and of automotive parts and components production

P.J.J. Welfens (ed.), *Clusters in Automotive and Information & Communication Technology*, 
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has not only improved recipient countries' macroeconomic performance indicators but also led to significant capability accumulation in the case of actors newly integrated into global production networks.

Following the change of the regime, CEE countries have rapidly become integrated into European automotive production networks (Lung 2004; Radosevic and Rozeik 2005). European investors—many of which have had long-established ties with local car manufacturing companies—have immediately recognized the significant market potential of these countries (in contrast to their saturated markets, here, they encounter immense unsatisfied demand—note that during the socialist regime, consumers had to wait 5–10 years to buy a new car).[1] Furthermore, investors have recognized the opportunity offered by major privatization deals[2] as well as by the generous investment promotion programs (subsidies, tax holidays, customs free zones, etc.) with which CEE governments tried to attract investors. However, economic and political alignment was present not only in FDI-recipient CEE economies. As summarized by Tulder (2008), investor companies' governments were also heavily involved in these deals in the first phase of entry, as bilateral governmental negotiations of the highest level tried to support investor firms' entry.

On the other hand, non-European investors' rush to CEE was prompted by these countries' prospective integration with the European Union which allowed them to overcome European trade barriers by establishing/acquiring local production facilities. Moreover, a highly important opportunity the opening of CEE offered to Western investors was to cut production costs by relocating labor-intensive processing phases to transforming economies,[3] many of which have had significant historical legacies in automotive production or at least in related industries.

As for Hungary, its historical legacy with respect to the automotive industry is ambiguous. On the one hand, cars assembled from imported kits had already been produced in the first decade of the 1900s[4] (a Hungarian designer, János Csonka,

[1] Nevertheless, as several analysts noted, the growth of local demand was unstable, which soon made market-seeking investors turn into efficiency-seeking ones. Investors have reoriented the production and the sales of their local facilities to export markets. As a complementary strategy, they have "stepped back" along the value chain and specialized on high-volume, labor-intensive part and components production for export, instead of or complementary to the final assembly of cars designated for the domestic market (Domanski and Lung 2009).

[2] The opportunities privatization deals offered cannot be restricted to efficiency-seeking ones. Tulder (2008) provides several examples to demonstrate that the market-seeking motive was equally important; here, I quote only one: "Acquiring Dacia in Romania resulted in an immediate market share of more than 70% in 2000 (for Renault) and an additionally dominant position in the imported car market" (p. 588).

[3] With the establishment of Hyundai's Nosovice plant in the Czech Republic in 2008 and Mercedes' Kecskemét plant in Hungary in 2009, practically, all the major manufacturers have carried out greenfield car manufacturing investments in the region. Relocation decisions allowed older and more expensive plants to be closed such as PSA's Ryton and GM's Luton plants in the UK (PSA opened new plant in Slovakia and GM in Poland).

[4] This paragraph draws on Havas (2000).

designed and built a car in 1905). Buses have been produced since 1909. The world wars boosted the local manufacturing of both military vehicles and car parts.

On the other hand, Hungary stopped car production after WWII. Within the CMEA division of labor, Hungary was assigned the production of buses[5] and lorries, but not that of cars.[6] Car assembly and parts production were reestablished in Hungary after the change of the regime as a result of foreign investors' location decisions.

This chapter explores the role automotive investors have played in the structural upgrading and modernization of the Hungarian economy in a comparative (CEE) perspective. We examine whether Hungarian stakeholders (local subsidiaries, supporting organizations/institutions, local suppliers, etc.), following several subsequent investment decisions, have managed to upgrade their activities or if they have instead been stuck in cost-based competition. Another objective of the chapter is to review the policy efforts and the evolution of policy instruments by exploring the manner by which quantity- and quality-type development of the industry has been promoted and supported.

Section 7.2 presents the current status of the industry in Hungary in a CEE perspective. Section 7.3 reviews the industry's evolution after the change of the regime and its contribution to Hungary's and other CEE economies' structural upgrading. Section 7.4 is concerned with the general and specific policy measures that have had, or are expected to have, an impact on the sector's performance in Hungary. Section 7.5 develops predictions about the industry's perspectives following the global financial crisis. Section 7.6 outlines our main conclusions.

Our research is based on three pillars. First, we compile, summarize, and analyze secondary sources (international academic literature) related to the situation and to the perspectives of the Hungarian and CEE automotive industries. The second pillar is the compilation and analysis of industry-related statistics, and the third is field research. In November 2009, we carried out an interview-based investigation at a German-owned local subsidiary of a first-tier automotive supplier, a large transnational corporation. We inquired about the evolution and quality upgrading of the local subsidiary's activities. We conducted three interviews with selected representatives of the management. The incorporation of case-study findings into this descriptive chapter does not intend to prove, rather to illustrate our arguments.

## 7.2 Current Status of the Automotive Industry in CEE

With the incorporation of CEE automotive actors into global production networks and massive production relocation to the newly integrated regions, Central and Eastern Europe has become a production location of major importance.

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[5] Ikarus was on the other hand the largest bus manufacturer supplying the whole CMEA with a yearly production of over 14,000 buses in the 1980s.

[6] Manufacturing of some car parts and components continued during the socialist era—delivered mainly to Western manufacturers for hard currency.

Privatization has brought about the spectacular turnaround of ailing and inefficient car factories, for example, in the case of the Czech Skoda, acquired by Volkswagen or the Romanian Dacia, acquired by Renault.[7] Furthermore, with respect to assembly facilities, many of the local parts suppliers were also taken over by foreign investors. Local components supply capacity was also expanded by key global actors' greenfield investments.

The Czech Republic, Poland, and Slovakia have become the major hubs of OEM assembly (Hungary will catch up following the start of Mercedes' production), but all other CEE countries[8] have foreign-owned OEM manufacturing facilities. While FDI in car assembly was mainly privatization-driven, many local automotive supplier firms were also created through greenfield investment by efficiency-seeking foreign investors. Parts makers set up operations partly in order to be close to local assembly plants and partly with the purpose of achieving flexibility and cutting costs through outsourcing. This process has accelerated what analysts refer to as "the Europeanization of automotive manufacturing" (Pavlínek et al. 2009).[9]

Figure 7.1 depicts changes in the FDI stock in CEE countries' automotive sectors.

Table 7.1 overviews the increase of automotive production in Central and Eastern European economies in unit terms.

As for Hungary, the overwhelming share of assembled vehicles was passenger cars: 282,000 Suzukis and 60,000 Audis.[10] This number is expected to double with the starting and rapidly expanding production of Mercedes-Benz Manufacturing Hungary Ltd. as of 2011 (by 2013, its output is expected to be 300,000 cars annually). On the other hand, the number of assembled buses keeps shrinking: while in 2000, 800 buses were assembled in Hungary; this number decreased to 629 in 2008 (Ikarus stopped bus production. At present, the main bus manufacturers are Nabi and Kravtex).

[7] Similar turnaround stories can be mentioned in Serbia, where Zastava was acquired by Fiat, in Romania, where Automobile Craiova was recently acquired by Ford (following a short period in the ownership of Daewoo that has also invested in turning around the inefficient plant), and earlier in Poland, where FSM was taken over by Fiat (for a detailed elaboration of this latter story as well as the analysis of Fiat's internationalization strategy, see Dallago (2000)).

[8] The most recent country to join the "club of OEM manufacturers" is Bulgaria. So far Bulgaria specialized only in automotive parts and components manufacturing—a strong growth industry with producers including EPIQ Group (Belgium—electronic modules); VW Electric Systems (Turkey—cables), Grammer (Germany—seats), Yazaki Corp. (wire harnesses), Melexis (microelectronics) etc. Local final assembly of passenger cars is expected to start in 2010. OEM manufacturing will start as a result of the investment of Great Wall Motor Co. Ltd. a Chinese sport-utility vehicles manufacturer.

[9] A number of comprehensive surveys tackle the evolution of the national automotive industries in selected CEE countries [see e.g., Havas (2000) and Somai (2002) for Hungary; Pavlínek (2008) for the Czech Republic; and Domanski et al. (2008) for Poland].

[10] GM used to have Opels assembled in Hungary, but this activity stopped in 1998. Altogether, 90,000 Opels were assembled in Szentgotthárd between 1992 and 1998.

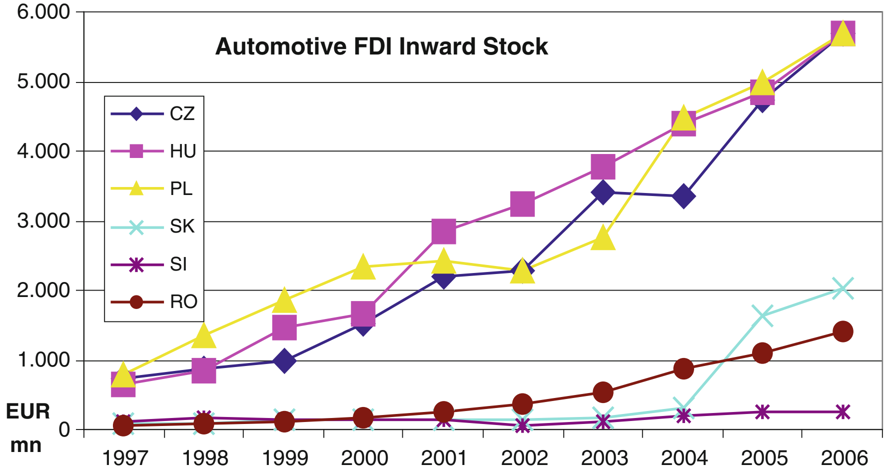


**Fig. 7.1** Increasing stock of automotive FDI in CEE countries (1997–2006, EUR million). Source: Haiss et al. (2009), p. 117

**Table 7.1** Automotive production statistics

| Country | Number of cars | | Total number of vehicles | |
|---|---|---|---|---|
| | 2000 | 2008 | 2000 | 2008 |
| Hungary | 134,029 | 342,359 | 137,398 | 346,055 |
| Czech Republic | 428,224 | 933,312 | 455,292 | 945,822 |
| Poland | 481,689 | 840,000 | 504,972 | 950,908 |
| Slovakia[a] | 181,333 | 575,776 | 181,783 | 575,776 |
| Romania | 64,181 | 231,056 | 78,165 | 245,308 |

Source: OICA Statistics
[a]According to Pavlínek et al.'s (2009) calculations, at present, Slovakia has the largest passenger car production per capita in the world (106 cars per capita in 2007)

In a comparative CEE perspective, Hungary can be considered an automotive parts and components producer country, rather than one specialized in the assembly of passenger cars. Hungary is strongly specialized in manufacturing engines (in 2007, 1.9 million Audi engines and 450,000 GM engines were manufactured in Hungary),[11] brake systems, steering systems, and the like. Beyond passenger cars as well as their parts and components, Hungary has become the production location of several first-tier suppliers of light truck and heavy-duty truck manufacturers. Major first-tier suppliers include, among others, Rába,[12] Knorr Bremse, Bosch, ZF,

[11] According to the Polish Information and Foreign Investment Agency, the respective figure for Poland was 1.8 million engines in 2007. The main engine manufacturers are Volkswagen Motor, Polska; Toyota Motor Industries, Poland; Toyota Motor Manufacturing, Poland; Isuzu Motor, Polska; and Fiat–GM Powertrain, Polska.

[12] Rába also assembles military trucks.

**Table 7.2** Top 15 automotive producers in Hungary (net sales in HUF million), 2008

| No. | Producer | Net sales | No. | Producer | Net sales |
|---|---|---|---|---|---|
| 1 | Audi Hungária Motor Kft. | 1,484,507 | 9 | Rába Holding Nyrt. | 58,863 |
| 2 | Magyar Suzuki Kft. | 609,414 | 10 | Hammerstein Bt. | 57,484 |
| 3 | Lear Corporation Kft. | 142,969 | 11 | ZF Hungária Kft. | 48,639 |
| 4 | Denso Kft. | 110,788 | 12 | SMR Automotive Mirror Technology Bt. | 46,967 |
| 5 | Luk Savaria Kft. | 104,309 | 13 | Knorr Bremse Fékrendszerek Kft. | 34,283 |
| 6 | Visteon Hungary Kft. | 82,251 | 14 | Delphi Thermal Hungary Kft. | 32,869 |
| 7 | BorgWarner Turbo Systems Kft. | 69,721 | 15 | Knorr Bremse Vasúti Jármű Kft. | 32,758 |
| 8 | BPW-Hungária Kft | 61,374 | ...19 | GM Powertrain Kft. | 26,796 |

Source: Figyelő TOP 200 (2009)

Luk Savaria (Schaeffler Group), ZF Lenksysteme, Visteon, and Denso Corporation. Table 7.2 presents the top 15 Hungarian automotive producers.

Specialization in parts and components and especially the presence of first-tier suppliers is especially important because of the modular organization according to which global production is restructured. As Domanski and Gwosdz (2009, p. 454) remarked, value creation in the car industry is partly shifting away from original equipment manufacturers to first-tier suppliers—system integrators—who deliver complete modules and further "down" in the hierarchy to second-tier suppliers. Structural upgrading (in terms of higher value-adding activities, competence improvement and broadened corporate mandates—see Sect. 7.3) is therefore often easier at parts and components manufacturing local subsidiaries than at local OEM facilities entrusted with final assembly.

In the following paragraphs, we present some detailed performance data for Hungary. Gross output of the transport equipment (TE) industry[13] amounted to HUF 3597.2 billion in 2007 (~EUR 14.5 billion), 90% of which was exported (source: CSO). The share of TE value added in total manufacturing value added is the fourth highest in Europe; in 2007, it amounted to 15.4%, preceded by Germany (17.4%), the Czech Republic (16.1%), and Slovakia (16.0%).[14]

Table 7.3 presents the export intensity of the automotive industry in a comparative perspective. High values reflect that a dominant part of local production capacities has been established with efficiency-seeking objectives as well as the fact that the growth of local markets has remained below the expectations, so part of local production had to be converted. The manufacturing of export-oriented

[13] In this chapter, we use automotive industry and transport equipment industry (ISIC 34-35) as synonyms.

[14] Source: Zoltán Pitti's data, based on Eurostat Data Bank data services (October 2009). The respective value of this indicator was 9.6 in Poland and 13.1 in Romania (source: ibid.). Compare these data with the EU 27 average of 11.6%.

**Table 7.3** Export intensity (export over production) of the TE industry (%), 2008

| | |
|---|---|
| Czech Republic | 71.3 |
| Hungary[a] | 89.8 |
| Poland[a] | 81.5 |
| Slovakia | 83.85 |

Source: Author's calculations based on OECD STAN database (2009)
[a]2007

products was substituted for local market-oriented ones. Skoda, as reflected by the Czech data, is an exception with higher-than-average local market orientation. Furthermore, in contrast to the export orientation of Hungarian and Polish component manufacturing, a larger-than-CEE average share of components manufactured in the Czech Republic are assembled into passenger cars within the country (Pavlínek et al. 2009, p. 51).

The number of registered limited-liability companies and joint-stock companies (in TE) in 2008 was 602 and 26, respectively. Foreign capital was involved in 127 TE companies in 2007. A dominant portion of foreign-owned companies is in 100% foreign ownership, which is well reflected by the equity data; total equity of companies with foreign capital was HUF 1667.5 billion in 2007 (approximately EURO 6.5 billion) of which foreign equity capital is HUF 1638.7 billion.

The TE industry had 63,500 employees in 2007, which represents 2.3% of the total workforce. Of course, this number understates the size of the workforce related to this industry since the number of people employed in the automobile value chain[15] is much higher than that which is directly employed. (According to Dicken (2003), the number of total automobile-related employment is five to six times higher than the number of those directly employed—p. 355.)

Zoltán Pitti's data, based on Eurostat Data Bank data services, are slightly different from CSO's official figures, yet they nevertheless provide an adequate basis for comparison. Table 7.4 summarizes the basic corporate demographic and employment data of the automotive sector. It is interesting to compare the rapid sectoral employment growth of the countries in question, which is in sharp contrast to Romanian performance. In the first half of the 2000s, employment in this latter country reflected the results of downsizing and restructuring efforts, and the expansionary effects of FDI inflows became manifest only gradually, after 2005.

Table 7.5 presents performance comparisons, providing data on output and value added. In order to put CEE data in a comparative perspective, we provided respective German data as well.

In the case of Poland and Slovenia, the relation between country size and output is conspicuous. The data demonstrate an outstandingly rapid expansion of output in the case of all CEE economies. Nevertheless, the German comparison is telling,

[15] The automotive value chain includes both downstream and upstream activities: the former is represented mainly by knowledge-intensive services such as car financing, sales, marketing, insurance, logistics, and maintenance.

**Table 7.4** Number of companies and employment in the TE industry

| Country | Number of companies | | | Number of employees | | |
|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2007 | 2000 | 2005 | 2007 |
| Hungary | 289 | 824 | 804 | 40,466 | 51,664 | 65,162 |
| Czech Republic | 735 | 896 | 979 | 102,057 | 125,539 | 143,690 |
| Poland | 3,270 | 3,583 | 5,133 | 163,954 | 178,499 | 209,165 |
| Slovakia | 90 | 144 | 198 | 24,106 | 31,044 | 41,393 |
| Slovenia | 223 | 222 | 274 | 10,878 | 11,018 | 12,744 |
| Romania | 562 | 1,011 | 1,119 | 143,688 | 121,411 | 124,744 |

Source: Zoltán Pitti's data, based on Eurostat Data Bank data services

**Table 7.5** Gross output and gross value added in CEE automotive industry (EURO million, current prices)

| Country | Gross output | | | Gross value added | | |
|---|---|---|---|---|---|---|
| | 2000 | 2005 | 2007 | 2000 | 2005 | 2007 |
| Hungary | 5,996.1 | 9,868.1 | 14,604.3 | 1,263.6 | 1,920.1 | 2,885.7 |
| Czech Republic | 7,678.4 | 15,781.8 | 23,228.9 | 1,537.6 | 3,196.6 | 4,781.0 |
| Poland | 11,034.5 | 18,423.9 | 25,158.7 | 2,147.8 | 4,071.3 | 5,207.5 |
| Slovakia | 2,399.5 | 5,652.3 | 11,615.2 | 323.2 | 629.1 | 1,356.4 |
| Slovenia | 1,409.5 | 2,015.6 | 2,444.5 | 157.7 | 325.2 | 446.3 |
| Romania | 1,611.1 | 3,905.2 | 6,970.2 | 559.2 | 874.4 | 1,806.0 |
| Germany | 236,658.3 | 294,140.0 | 346,877.1 | 57,191.6 | 71,760.3 | 84,270.9 |

Source: Zoltán Pitti's data, based on Eurostat Data Bank data services

despite the tripling of output in the Czech Republic (and the more than fourfold increase in Romania) as well as the spectacular expansion both in Poland and in Hungary, CEE economies' automotive output is just a fragment of that of Germany—note that the latter is rapidly increasing its performance despite all deindustrialization and "bazaar economy" complaints. If we add up the surveyed economies' output, it still represents less than one-fourth that of Germany (in 2007).

Despite being a mature industry, the automotive industry is highly research intensive since its complex products make use of various emerging technologies and incorporate the innovative results of several emerging industries. The share of the industry in total R&D is significant in Hungary. In 2007, HUF 13.7 billion was spent on R&D, which represents 11.8% of total BERD. The industry employed 890 researchers (FTE), and there were 18 patent applications in the motor vehicles branch.[16]

For a comparative perspective (absolute values of R&D expenditures), we rely on ANBERD database (Table 7.6).

Absolute values are telling, though, they should be compared to production values. Since these latter indicators are in Euros, we calculated ratios instead. Table 7.7

[16] The numbers in these paragraphs were taken from CSO's 2008 yearbook on Hungary as well as from the "Action plan to promote the Hungarian transport equipment industry," prepared by the Ministry for Development and the Economy and accepted in July 2009.

**Table 7.6** R&D expenditures in the automotive industry

| | 2006 |
|---|---|
| Czech Republic | 625.4 |
| Hungary | 52.6 |
| Poland | 161.2 |

(Millions of PPP USD, current prices, ISIC 34-35)
Source: Author's calculation from OECD ANBERD database (2009)

**Table 7.7** Production (*Y*) and R&D comparisons in the automotive industry (Czech Republic = 100)

| | *Y* | R&D |
|---|---|---|
| Country | 2006 | 2006 |
| Czech Republic | 100 | 100 |
| Hungary | 59.7 | 8.4 |
| Poland | 109.0 | 25.8 |

Source: Author's calculations based on Zoltán Pitti's data (Eurostat Data Bank data services) and on OECD ANBERD database (2009)

presents R&D and production ratios utilizing the Czech Republic as a benchmark economy. This table makes the qualitative superiority of the Czechs, as well as Hungary's relative backwardness—measured in terms of the local research intensity of local production—even more obvious than the absolute values in Table 7.6.[17]

Comparisons of the local research intensity of production are strongly related to the issue examined in Sect. 7.3, namely, the contribution of the FDI-based rapid expansion of the automotive industry to CEE countries' structural upgrading.

## 7.3 Contribution of Automotive Industry to Structural Upgrading in CEE

### *7.3.1 Quantity Aspects*

The contribution of the industry to CEE's structural upgrading performance can be analyzed not only with respect to the changing industry mix and changes in

[17] Nevertheless, in CEE economies, the R&D intensity of production (R&D over net sales) is far below that of the industry average of advanced economies. According to NSF data, for example, in the USA, company R&D expenditures over net sales in motor vehicle trailers and parts industry were 2.4% between 2003 and 2007 (2.5% in 2005). Companies in this industry reported performing $16 billion of company-funded R&D in 2007. We have also calculated data for Germany. Automotive companies were reported performing EUR 12,392 million of R&D in 2006 (ANBERD database 2009). Production value amounted to EUR 315,820.5 million (Zoltán Pitti's data based on Eurostat Data Bank data services) which results in an R&D intensity of 3.9%.

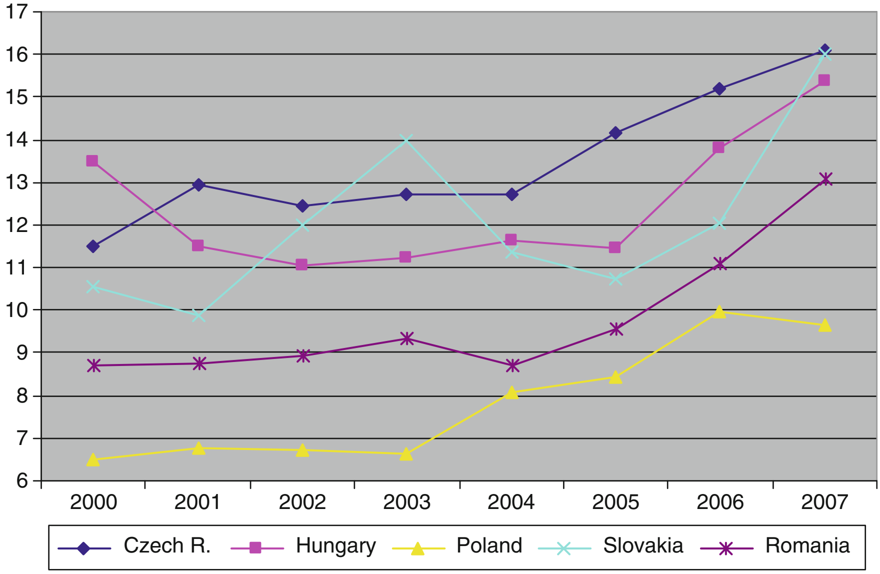


**Fig. 7.2** The share of the automotive industry in manufacturing value added (%). Source: Author's calculations from data made available by Zoltán Pitti

production and export specialization but also from the vantage point of the quality of structural transformation.

As for the quantity aspects, statistics show a rapidly increasing share of the transport equipment industry within total manufacturing value added. Figure 7.2 quantifies the increasing value-added shares and illustrates in a conspicuous manner the rapid growth of the industry's weight and thereby the extent of structural change.

For a nonmisleading evaluation of the data presented in Fig. 7.2, recall that differences between transforming economies in the extent of structural change have been subject to a large number of analytical papers that related these countries' restructuring and competitive performance to FDI involvement by branches and to the technological features of both the new industry mix and trade specialization (e.g., Guerrieri 1999; Landesmann and Stehrer 2002). Early papers usually praised the countries with extensive structural change. The performance of transforming economies with an increasing specialization in high-technology industries and in some mature ones like the automotive industry was particularly acknowledged. This latter industry is considered of key importance because of its strong linkages with other industries, which thereby facilitates technology spillovers. Structural upgrading performance has been measured, among others, by the degree of export similarity (compared to the export structure of advanced economies). High values of export-similarity index suggested an advanced stage in the catching-up process.

Later papers, however, have pointed to substantial quality differences hidden behind the surprisingly high values of export similarity indices of transforming countries (e.g., Dulleck et al. 2005; Welfens and Borbély 2009). The similarity of the production structure may hide important quality differentials. Hence, these papers used other indicators to measure quality differences: export-unit values, quality-segment indicators, and indicators referring to the prevailing and very slowly diminishing productivity gap between the transforming and the advanced economies. It is now a widely shared view that what countries/regions produce cannot be assessed as good or bad in itself. Instead, it is rather how they produce it that matters. It is not what countries/regions specialize in, but rather the quality indicators of the production activity that have explanatory and predictive power concerning performance (Feser 2003).

Since the expansion of the automotive industry in the CEE economies has been related to foreign investors' successive location decisions and to the run-up of their local production—it is important to explore whether this quantity type of expansion, which has of course produced spectacular structural upgrading in a quantity term, has been accompanied by quality upgrading as well. Does these countries' specialization in the automotive sector reflect quality upgrading, or does the similarity between advanced and CEE economies' production and export specialization continue to hide important quality differentials?

### *7.3.2 Quality Aspects*

International academic literature distinguishes between high-road and low-road catching-up and adaptation strategies (Pyke and Sengenberger 1992). While low-road adaptation seeks restructuring based on cost competitiveness mainly through low labor costs, high-road strategies are based on efficiency enhancement, long-term skill development, and innovations. Following the change of the regime, CEE countries successfully reoriented their exports and upgraded their production and export structures through low-road adaptation by attracting relocated production. This implied nonnegligible investment into technological modernization, learning, and capability accumulation—the latter mainly in terms of production capability.

However, cost competitiveness started to erode in line with improved overall economic performance and catching-up. By the early 2000s, the spectacular improvement of CEE countries' structural upgrading performance slowed. The more advanced an economy was, the earlier this process happened. Changes in the adaptation strategy and a switch towards high-road approaches have become increasingly urgent.

As for the industry subject to our present investigation, these changes were prompted also by transformations in the division of labor within the automobile systems: In order to maintain their position within the global production network they are integrated in, suppliers nowadays have to move up the value chain and assume responsibility of not only the physical operations but also of design, logistics, and supply chain management.[18] A high-road strategy in this respect

[18] These requirements apply to suppliers at all levels, while first-tier suppliers also assume responsibility of the design and development of whole modules.

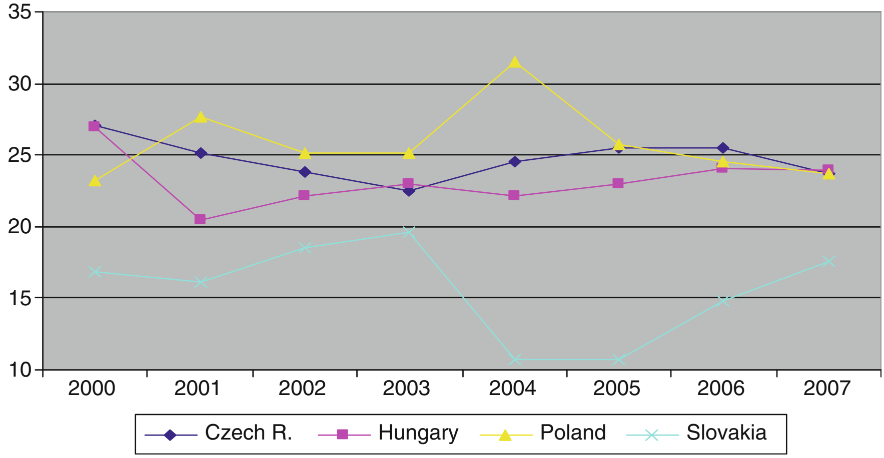


**Fig. 7.3** Value added over output in CEE automotive industries (%). Source: Author's calculations from data made available by Zoltán Pitti

refers to the extension of the local value chain by assuming additional corporate functions beyond production and by increasing local value added through the integration of an increasing number of local suppliers.

In the following sections, we investigate the state of and changes in selected aspects and indicators that refer to CEE economies' quality upgrading performance in the automotive sector.

#### 7.3.2.1 Value Added Over Output

Figure 7.3 depicts the extent of local automotive producers' quality upgrading, measured by the indicator of value added over output. Problems related to the use of this indicator in the transformation period are well reflected by the large fluctuations the values show. Instead of a linear growth, which would refer to gradual quality upgrading and increasing local content, each consecutive investment decision pushed the values down because output (i.e., the denominator) increased sharply and the high import intensity of production caused value added to follow suit. Nevertheless, substantial intercountry differences are well represented. Slovakia's values are lower than the CEE average, which can be explained by a higher-than-average share of import-intensive assembly operations within total output. Note that value added is also influenced by the rate of profit, which is determined by companies' transfer pricing strategies. This may also cause some intercountry differences.

It is interesting to compare CEE performance with one of selected advanced economies (Fig. 7.4). In the case of the latter group, it is the shift to a modular production accompanied by increasing outsourcing that accounts for a more or less

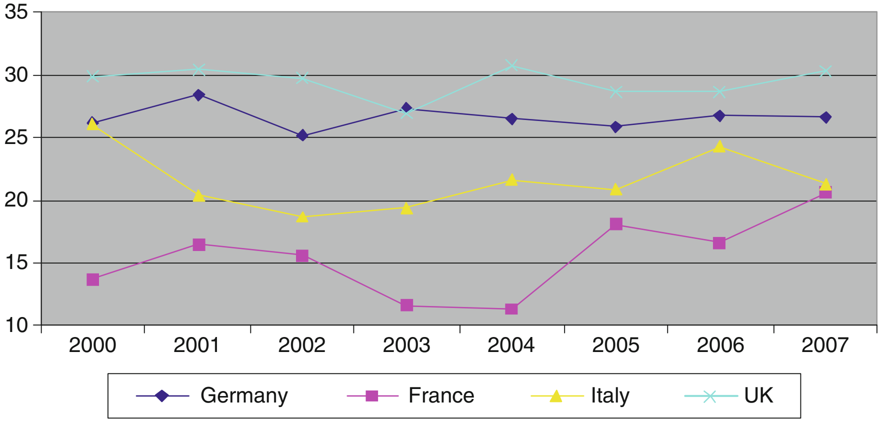


**Fig. 7.4** Value added over output in advanced economies' automotive industries (%). Source: Author's calculations from data made available by Zoltán Pitti

stagnating value of the indicator (i.e., it compensates for the increase of the value-added share as a result of high-road strategies). In summary, although the qualitative evolution of the two-country groups is not similar,[19] the values of the indicator are not significantly different, which calls for caution with respect to hurried and misleading interpretations based on this single indicator.

#### 7.3.2.2 Changes in the Product Mix and the Technological Level of Production

While academic literature usually mentions the diversification of production and the moving into upmarket (or at least middle-market) niches (from cost-based mass production of cars for low-price segments) as key elements of a high-road strategy, we do not consider these indicators adequate. With the shortening of product cycles and the acceleration of peripheral subsidiaries' learning curves (Lung 2004), the geographic division of labor is no longer determined by the "mature and low-end products to the periphery, new and high-end products to the center" scheme.[20]

In line with Pries and Dehnen's (2009) arguments, we claim that decisions concerning the location where individual new products will be manufactured within the multinational companies' global production network is much more complex than the above-described scheme, influenced by several strategic, technical, political, and institutional factors [not least by the entrepreneurial behavior of local

[19] Both country groups upgrade, but their respective development trajectories are divergent.

[20] Although CEE economies "mainly specialize in the assembly of high-volume, low-end, inexpensive vehicles and engines, they also host the manufacturing of a number of high-end, low-volume niche products" (Frigant and Layan 2009, p. 16).

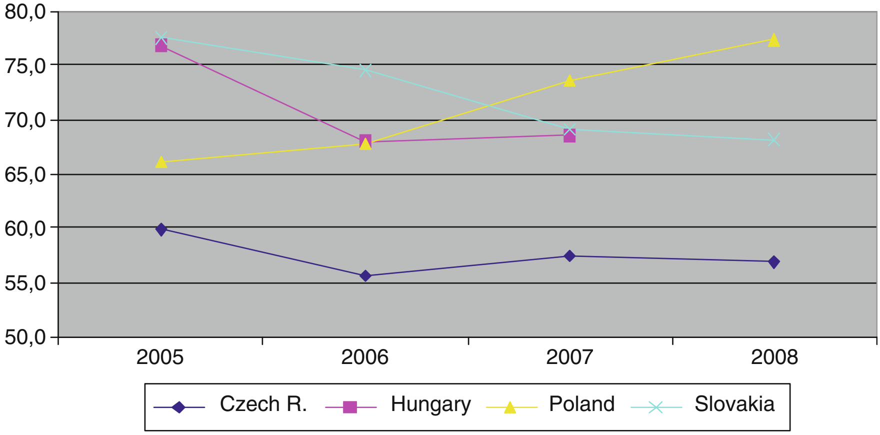


**Fig. 7.5** Import over export in CEE's automotive industry (%). Source: Author's calculations based on OECD STAN bilateral trade database

subsidiaries, cf. Birkinshaw (2000)]. Therefore, product diversification into upmarket niches does not necessarily reflect the results of high-road strategies.

Similarly, in the case of automotive components, the shift to increasingly sophisticated products reflects only apparent upgrading (but not necessarily a high-road strategy). In a thorough analysis, Pavlínek et al. (2009) demonstrate the spectacular structural change that has taken place in CEE's automotive component export mix between 1996 and 2006. The share of high-value-added, technologically sophisticated products (e.g., steering systems, braking systems) has greatly increased at the expense of low value added ones (e.g., wire harnesses, seats, bodies, exhaust pipes, windscreen wipers). The most spectacular change occurred in Poland and Hungary[21] (a more than eightfold increase—to 33.3%—in the share of high-value-added components within total component exports and a nearly fourfold increase to 58.4%, respectively), while in Slovakia, the share of high-value-added components has even decreased slightly within total component export (Fig. 7.5, p. 49). Nevertheless, in an era within which highly automated, sophisticated production equipment reduces the knowledge and skill intensities of the production process, changes in the composition of the product mix cannot be regarded as a trustworthy proxy for local high-road integration strategies. Neither the knowledge intensity of local production nor the local value-added ratio

[21] The relatively low value of this indicator in the Czech Republic (10%) can be explained by the (already mentioned) fact that in contrast to the export orientation of Hungarian and Polish high-value-added component manufacturing, high-value-added components manufactured in the Czech Republic are assembled into passenger cars within the country (Pavlínek et al. 2009, p. 51). Again, this explanation underlines the necessity of being cautious with conclusions drawn from indicators referring to the composition of or changes in the product mix.

increases automatically in line with the shift to the production of technologically more sophisticated products.

In a similar vein, in contrast to Domanski et al. (2008) who draw positive conclusions from the fact that selected investors have introduced capital-intensive, advanced technologies in the Polish automotive industries, we do not consider technological level and capital intensity good proxies for local high-road integration strategies, albeit changes therein are somewhat more telling (though they still may refer to industry-specific tendencies and not to the results of local adaptation and skill accumulation).

#### 7.3.2.3 Local Content

Instead, three other indicators can be considered reliable proxies for the assessment of local adaptation and integration strategies: local content; labor productivity; and knowledge (skill) intensity of local production. First, in line with Pavlínek et al. (2009), we acknowledge that analysis of import-intensity data or rather the local content of production (as well as changes therein) is indispensable for a reliable assessment of FDI-recipient countries' upgrading performance. However, these latter data are unavailable at the product level. Figure 7.5 presents industry level import to export data. Note that CEE-Germany bilateral import/export ratios are higher than the average depicted in Fig. 7.5, ranging from 76.9% (Czech Republic 2008) to 118.1% (Slovakia 2008). (The respective figure for Hungary is 80.7%, and for Poland 112.5%—source: author's calculations based on OECD STAN bilateral trade database.)

Table 7.8 provides industry level import-intensity (import to production) data. Skoda's extensive local supplier base is well reflected by the numbers.

For a nonmisleading interpretation of the data, it is important to recall Pavlínek et al.'s (2009) arguments. Although the authors develop the argument below based on the case of VW Slovakia, it can be applied to a larger or smaller extent to each major OEM manufacturer operating in a CEE economy.

> VW Slovakia switched its sourcing strategy from imports of the vast majority of components to local sourcing from its established Western suppliers in order to accommodate an increase in the scale of its car assembly. However, these suppliers in many cases assemble modules from imported components on site rather than manufacture components in host countries . . . What this means is that high local content does not necessarily translate into strong supplier linkages with domestic companies. (Pavlínek et al. 2009, p. 54)

**Table 7.8** Import intensity (import over production) of the TE industry (%), 2008

| | |
|---|---|
| Czech Republic | 40.6 |
| Hungary[a] | 61.5 |
| Poland[a] | 60.0 |
| Slovakia | 57.2 |

[a]2007

Source: Author's calculations based on OECD STAN Database (2009)

The results of our field investigations[22] support the claim that, irrespective of the value of local content, linkages with domestic suppliers are weak in the case of most automotive companies operating in CEE economies, and this is bound to change very slowly.

> The interviewed company has been making considerable "localization efforts." Out of its 140 suppliers there are on the average 10 new ones each year, partly because of inclusion of new products and partly as a result of localization efforts, when changes in suppliers lead to cost cutting. At the MNC's level only 75% of procurement is centralized. Similarly to other local facilities, the Hungarian subsidiary has also acquired the competence of purchasing, i.e. carrying out the lengthy formal process of supplier selection, audit, monitoring etc. The results of ambitious localization efforts are however meager from the point of view of Hungarian domestic SMEs. On the one hand, the initially 99% share of German suppliers has been reduced to 80% since the establishment of the local subsidiary in 2003. However, the majority of new suppliers are not Hungarian ones but Italian, French and Spanish companies—this is also referred to as localization! The Hungarian subsidiary has one Czech and one Slovakian supplier and three Hungarian ones (though the formal selection and audit process is still going on in the case of five additional Hungarian companies). None of the three Hungarian suppliers are domestic SMEs (there is a Hungarian owned large company and two Hungary-based subsidiaries of a Swedish and a German automotive companies).

Major exceptions include the Czech Skoda (as well as some other nonpassenger car manufacturing companies as surveyed by Pavlínek et al. (2009, p. 56)), Fiat in Poland, and Suzuki in Hungary—each with relatively strong domestic market orientation and historical local ties (with the exception of Suzuki, for which investor's country of origin and its European sales orientation forced it to increase local content).

#### 7.3.2.4 Labor Productivity

One of the most telling and easily quantifiable measure of quality upgrading is the increase (and level) of labor productivity. Tables 7.9 and 7.10 present the evolution of these indicators in a comparative perspective. It is obvious that countries which started from a comparatively low productivity level showed an above-average productivity improvement during their catching-up process. CEE data also reflect the results of know-how transfer and the absorption of modern techniques to increase productivity and quality (e.g., kaizen, continuous development, etc.). Still the gap between CEEs and advanced EU economies' productivity levels is strikingly huge, with the exception of Hungary productivity levels that are below 50% of the benchmark case (Germany). The gap was too large to be significantly narrowed even after 1 decade of higher-than-average productivity growth of the former country group.

[22] The interviewed German company, a first-tier system supplier, insisted on not revealing its name.

**Table 7.9** Value added per employee in the TE industry (EUR '000)

| Country | 2000 | 2007 | Country | 2000 | 2007 |
|---|---|---|---|---|---|
| Belgium | 60.2 | 68.9 | UK | 63.9 | 85.2 |
| Germany | 57.8 | 84.9 | Czech Republic | 15.1 | 33.3 |
| France | 65.5 | 72.8 | Hungary | 31.2 | 44.3 |
| Italy | 45.0 | 55.6 | Poland | 13.1 | 24.9 |
| Netherlands | 50.9 | 100.3 | Slovakia | 13.4 | 32.7 |
| Portugal | 31.6 | 31.0 | Slovenia | 14.5 | 35.0 |
| Spain | 47.0 | 59.8 | Romania | 3.9 | 14.5 |
| Sweden | 76.7 | 70.4 | Bulgaria | 1.9 | 8.2 |

Source: Zoltán Pitti's calculations, based on Eurostat Data Bank data services

**Table 7.10** Comparative levels (Germany = 100) of value added per employee in the TE industry

| Country | 2000 | 2007 |
|---|---|---|
| Czech Republic | 26.1 | 39.2 |
| Hungary | 54.0 | 52.1 |
| Poland | 22.7 | 29.3 |
| Slovakia | 23.2 | 38.6 |
| Slovenia | 25.1 | 41.2 |
| Romania | 6.7 | 17.0 |
| Bulgaria | 3.3 | 9.6 |
| Italy | 77.9 | 65.4 |
| UK | 110.5 | 100.3 |
| France | 113.2 | 85.7 |

Source: Author's calculations from data made available by Zoltán Pitti

#### 7.3.2.5 Skill Intensity of Local Production

As for the skill distribution, Table 7.11 demonstrates that the largest gap between CEE and core EU economies is in terms of the share of high-skilled workers in total employment. The remarkably large values of this indicator in Germany, France, and the UK show that although the relocation of low-value labor-intensive production has hit the automotive industries of these countries, it has nevertheless prompted the quality upgrading of the workforce, which ensures sustainable competitiveness in the longer term.

For a nonmisleading evaluation of the data presented in Table 7.11, analysts have to bear in mind that the content of qualifications may show a large intercountry variation: the skills of employees with tertiary educational attainment may be different in different countries, as well as the content of their occupations.

A method to investigate quality changes in the labor input (and thereby qualitative structural upgrading) is to compare the increase of labor services—an indicator that combines both the quality and the quantity of labor as a production input—with that of the pure quantity indicator of labor input (hours worked). In cases of skill upgrading (i.e., quality changes in employees' skill mix), increases in labor services exceed increases in hours worked. Similarly, if in a given industry total labor input

**Table 7.11** Average share of high-skilled, medium-skilled, and low-skilled workers in total employment of the transport equipment industry (in percent), 1998–2004

| Country | High-skilled | Medium-skilled | Low-skilled |
|---|---|---|---|
| Czech Republic | 6.5 | 84.7 | 8.8 |
| Hungary | 8.0 | 77.1 | 14.9 |
| Poland | 11.8 | 82.2 | 6.0 |
| Slovakia | 5.0 | 90.1 | 4.8 |
| Slovenia | 9.1 | 66.8 | 24.1 |
| Portugal | 5.2 | 17.9 | 76.9 |
| Spain | 31.4 | 20.1 | 48.5 |
| Germany | 20.5 | 53.5 | 26.0 |
| Italy | 5.8 | 41.1 | 53.1 |
| UK | 21.3 | 52.8 | 25.9 |
| France | 20.7 | 50.5 | 28.8 |

Source: Landesmann et al. (2009), pp. 16–17

**Table 7.12** Labor services and hours worked (by persons engaged), volume indices, 2007 (1995 = 100)

| | Labor services | Hours worked |
|---|---|---|
| Czech Republic | 150.1 | 147.2 |
| Hungary | 217.6 | 215.4 |
| Slovakia | 166.2 | 161.3 |
| Slovenia (2006) | 93.8 | 88.7 |
| Spain | 120.2 | 114.3 |
| Germany | 102.0 | 99.4 |
| Italy | 95.6 | 94.0 |
| UK | 97.8 | 89.1 |
| France | 97.1 | 90.3 |

Source: EU KLEMS database, November, 2009 release, author's calculations

decreases but in the meantime skill upgrading occurs, the reduction of labor services is inferior to the decrease in hours worked (Szalavetz 2007). Table 7.12 compares the gap between the increase of labor services and that of hours worked in CEE and advanced economies' automotive sectors. It is interesting to observe the differences between CEE and advanced economies with respect to hours worked. The data do suggest some loss of employment in advanced economies and substantial expansion as a result of the relocation of production in CEE (with Slovenia and Spain as outliers). Nevertheless, in contrast to the expectations, changes in advanced economies' labor composition have not always been significantly larger in advanced economies than in CEE (though France and the UK could boast higher-than-average performance in this respect).

#### 7.3.2.6 Local Site Competence

Beyond the dynamics of labor input quality, qualitative upgrading can be approached by examining the evolution of local subsidiary mandates (site competence). Are local corporate functions still limited to pure physical processing, or have subsidiary mandates become more diversified, including logistics, purchasing, process engineering, product development, and other R&D functions, as well as various other production-related services functions?

According to Jürgens and Krzywdzinski (2009), there was some broadening of CEE site competence in the automotive sector; however, its extent remained quite limited, especially with respect to knowledge intensive, high-value-adding activities, like R&D.

According to our past and recent interviews, local production facilities are quickly (after inception) assigned auxiliary corporate functions, including HR, accounting, payroll calculation, controlling, customs management, etc. Later on, more sophisticated functions, including IT, logistics, inventory management, and process engineering, are usually also located to the subsidiaries, and expatriates taking part in these processes are called home or sent to other newly opened subsidiaries.

Other tasks including purchasing and after-sales services may also become to some extent localized—at least this is the main finding of our interview-based investigation. In a continuous effort to save costs, the purchase of selected parts and components is expected to be localized, which reduces not only material costs but also logistics and transportation costs. Local subsidiaries assume the knowledge-intensive task of supplier selection and audit, which implies substantial learning both from the part of the subsidiaries themselves and from that of local suppliers.

#### 7.3.2.7 The Local Research Intensity of Local Production

As for the cream of production-related strategic corporate functions—R&D—both the number of local R&D facilities and the depth of the research undertaken by individual R&D units are increasing in CEE. This is in contrast to Jürgens and Krzywdzinski's (2009) above claim (concerning the limited extent of site competence). In our view, investors do try to profit from local (low cost) engineering skills. If an FDI-recipient country invests in technical (engineering, manufacturing, and science) education and in developing local innovation potential, it can quickly profit from the virtuous circle provided by investors' broadening local commitment (cf. Belderbos et al. (2009)).

In the first phase of integration, engineers in local manufacturing facilities were entrusted only with technical support and process engineering tasks. Later, they could also take part in the design of the cars and the car parts they manufactured of which bring entrusted to the given local subsidiaries.[23] Nowadays, nearly all local

[23] One example: At VW Poznan's R&D center in Poland, engineers participate in the development of special purpose vehicles (e.g., VW Caddy Tramper, fire brigade cars).

automotive facilities employ engineers entrusted with process engineering, testing, and with other smaller-scale applied (routine) R&D tasks.[24] R&D departments are in most cases colocated with manufacturing facilities. However, although engineers do carry out R&D type of tasks—in several cases, they are not labeled as "R&D employees" and their departments as R&D department—formal denomination is often related to specific fiscal incentives tied to R&D activity.[25]

Sizeable automotive R&D activity is rather carried out in stand-alone R&D centers.[26] Investors have gradually recognized that the wage gap between highly skilled engineers and researchers in advanced and in CEE economies is even larger than the gap in the case of blue-collar production workers, and investments into local R&D capacity offer good return. In addition to firms' own R&D centers, industry–university relations (i.e., formal research contracts and the existence of automotive-related centers of excellence) should likewise be analyzed to assess the importance and the depth of R&D.

Pavlínek et al. (2009, pp. 51–53) survey the specialization of major CEE automotive R&D and design and technology centers. The authors' 2006 data can be updated by CzechInvest's more recent information (automotive industry in the Czech Republic. CzechInvest 2009). According to both sources, the Czech

[24] Even Audi, with an evil reputation among Hungarian analysts of having one of the lowest local content ratios and refraining from any expenditures that would contribute to site competence broadening and quality upgrading of its local subsidiary—highly important for Hungary in a quantity term—recently invested into the establishment of a testing laboratory. This evil reputation is to some extent exaggerated: Audi invests considerable amount in local human capital development. One example is the establishment of an "Audi Faculty" at the Széchenyi University of Győr with an initial investment of EUR 40,000. Academic curriculum includes production technology, aspects of product development, mechatronics, etc. (for an overview of automotive companies' investments in human capital development, see Jürgens and Krzywdzinski (2009), p. 37).

[25] The interviewed automotive company also employs process engineers: to improve material flows, rationalize the production process, etc. Furthermore, its project engineers take part in the design of new products, the manufacturing of which the local company will be entrusted. Note that in most cases, the term "new product" refers to small incremental changes (some new parameters) within the existing product. All changes relating to the process or the products have to be incorporated in the information system: this is the task of local software developers. Nevertheless, this company would answer with "no" to questionnaires, inquiring whether it carries out local R&D, employs R&D staff, or whether it has an R&D department.

[26] Nevertheless, the claim that colocated R&D and manufacturing implies small-scale applied research, while stand-alone centers carry out prospective basic research would be oversimplified: Visteon Autopal's (two local) R&D center are located within the premises of its manufacturing facility in the Czech Republic, and these centers are the mother company's European R&D centers for lighting and air-conditioning systems. Similarly, Tenneco, Wabco, and Valeo's R&D centers in Poland are colocated with the manufacturing facility, and they carry out important R&D tasks (Pavlínek et al. 2009). On the other hand, both Knorr Bremse and Bosch established stand-alone research centers in Hungary; research tasks carried out there are of a higher level and of a more strategic character than the ones carried out at R&D departments colocated with local automotive subsidiaries.

Republic hosts the largest number of automotive R&D and technology centers, which can be explained by a strong local engineering tradition and a high tertiary enrolment in engineering and manufacturing studies. There are nine automotive-related faculties in the Czech Republic. The most notable research cooperations include the Josef Bozek Research Center of Automotive Technology at the Czech Technical University and the Jan Perner Transport Faculty at the University of Pardubice. The former center focuses on thermodynamics, aerodynamics, turbocharging, and supercharging of engines, emissions reduction, etc. Its industry partners include Bosch, AVX, Cadence, and the like. The main research areas of the latter center are driving dynamics/stability, tire properties, etc., with industry partners including, among others, Skoda and Continental Teves.

As for Poland, Domanski and Gwosdz (2009) present data on the increasing importance of local R&D and the expansion of automotive technology centers, the most notable being Delphi Corporation's center in Cracow.[27] The authors' data can be complemented and updated by the Polish Information and Foreign Investment Agency's most recent figures. According to their data, in addition to the above-mentioned facility, major R&D centers include Wabco's center in Wroclaw, where engineers are engaged in the development of pneumatic braking systems and suspension parts, and Valeo's center in Skawina, focusing on the development of engine cooling systems. Furthermore, several investors have established product-related incremental development facilities (TRW: seatbelts and airbags; Remy Automotive: starters and alternators; Tenneco: exhaust systems, etc.).

When describing the Hungarian situation with respect to automotive R&D, analysts usually mention some individual outstanding cases which conceal an overall meager performance with respect to local R&D. The fist case usually mentioned is Knorr Bremse's commitment to local basic research. It established a stand-alone research center in Budapest employing currently 120 researchers who develop software and brake control systems. Knorr Bremse's local R&D activity (see details in Szalavetz 2000) can really be labeled home-based augmenting (Kuemmerle 1999). Furthermore, the company has large-scale joint R&D projects with Budapest University of Technology and Economics (BUTE) and cooperates with five additional Hungarian tertiary educational institutions. Knorr Bremse's manufacturing facility in Kecskemét also employs engineers entrusted with the design and technical support of electropneumatic brake systems.[28] Another significant stand-alone R&D center is that of Robert Bosch (its Budapest Engineering Center), which focuses on software development and product development.

[27] The main research areas include software development, electric solutions for vehicle control systems, and suspension solutions.

[28] Knorr Bremse expands its local activities even at time of crisis; its Rail System Division is in the process of building a new manufacturing facility in Budapest.

Hungary has two automotive-related, university-based centers of excellence: the Advanced Vehicles and Vehicle Control Knowledge Center[29] at BUTE and the Regional University Knowledge Center for the Vehicle Industry (JRET) at Széchenyi University in Győr, with industrial consortium partners including Rába Axle Manufacturing Ltd., Schefenacker Automotive LP. (currently Visiocorp LP.), and Borsodi Műhely Ltd. This list shows that other than a few outstanding cases, there are other companies, even Hungarian owned SMEs, that are engaged in automotive R&D. These two centers are the main drivers of regional innovation efforts in the automotive industry. Nevertheless, these research efforts remain below a critical mass[30] which would allow for attractive individual scientific results, which however remain too sporadic to push the Hungarian automotive sector on a knowledge and innovation-driven, high-road development path.[31]

## 7.4 Policy Measures to Promote Expansion and Quality Upgrading in the CEE Automotive Industry

Throughout the history of the "industry of industries" (as Drucker 1993, p. 176 labeled it), the catalyzing and promoting role of the state has always been indispensable, irrespective of time, economic thinking and the geography of production.

In the FDI-driven restructuring, expansion, and upgrading of the CEE automotive industry, the primary role of the state was to attract investors. The main channels of early state intervention were privatization and investment promotion. Early movers (in terms of opening) and countries whose automotive actors have had historical ties with Western automotive producers were particularly successful in attracting front-runner investors. By the end of the first decade of transformation, locational competition for automotive investment among CEE economies has considerably intensified, and governments offer increasingly generous investment incentives in order to capture additional investments.

In fact, the mentality of CEE governments, even those of the relatively most advanced economies, is still one-sided; most incentives are aimed at attracting new investors rather than at improving the upgrading potential of existing facilities.

[29] Beyond Knorr Bremse, industrial consortium partners include ThyssenKrupp Presta (this company itself has a stand-alone development center in Budapest specialized in the development of steering systems), Inventure Automotive Electronics R&D Inc. (a Hungarian-owned private automotive R&D firm), a Hungarian consultancy company (Informin.Hu Ltd.) specializing in automotive-related IT solutions, and TÜV-NORD KTI Ltd. established by the German TÜV Nord Group and the Hungarian Institute for Transport Sciences.

[30] State's support together with consortium partners' own contribution at JRET amounted to ~EUR 2 million in 2008 (Source: JRET's annual report).

[31] Although the automotive sector in the Czech Republic features R&D outlays that are nearly by an order of magnitude larger than the ones of Hungary (see Table 7.6), it is still far from a par excellence high-road strategy as well.

This is understandable since the establishment of a new manufacturing site is an easy-to-document political achievement, while the increase of the local innovation potential and/or the augmentation of automotive-related graduates' number and skills as a result of sizeable investments in research and education are difficult to measure; positive consequences are not immediate.

The first measures that went beyond promoting the expansion of automotive production through new investments were aimed at increasing automotive subsidiaries' local embeddedness, that is, at promoting the integration of local SMEs into subsidiaries' production networks. There were several programs aimed at improving suppliers' capabilities and developing linkages between foreign firms and domestic suppliers. Programs supported the establishment of electronic data interchange and corporate information systems at SMEs, their acquisition of the necessary quality control certificates, the marketing of their products and capabilities, and the like. Some of the supplier programs even supported existing or potential suppliers' investment into technological upgrading. SMEs were also granted support in the frame of export promotion or job creation. Similar programs were decided upon in practically all CEE economies. A common feature of these programs is that they do not specifically target the automotive industry, with programs instead formulating horizontal objectives (job creation, export promotion, development of supply capability, human capital development, etc.).

Recently, in line with similar efforts in advanced economies, however, CEE economies try to identify "strategic industries" in the case of which industry-specific development policies are acceptable alongside to horizontal ones. The automotive industry figures in each country's list of strategic industries, which makes targeted developmental interventions possible, include such things as negotiations about the specific requirements of selected large automotive investors and the formulation of support schemes.

A related targeted policy effort is investment into industry-specific human capital. Surveys have identified increasing skill gaps, which hinder both the expansion and the upgrading of the industry. Improvement of technical education (engineering and manufacturing faculties as well as secondary-level educational institutions) has therefore been recognized as indispensable, as well as the targeting of students into the given educational institutions instead of the ones that are specialized in related occupations (especially in Hungary, where the gap between observed and required education is one of the largest in CEE—cf. Szalavetz 2010).

A skill formation initiative bound to become best practice is the pilot automotive education center scheme in Slovakia (there are already 13 centers in Slovakia). The Automotive Industry Association of the Slovak Republic and the Slovakian Association of Dealers and Motor Workshops provide professional expertise and contribute to the upgrading of existing secondary educational institutions' curricula according to potential automotive employers' requirements.

A further policy objective aimed at the upgrading of local subsidiaries was to increase the local research intensity of local production. This coincided with automotive investors' aim at decentralizing at least routine R&D tasks. Demand-oriented measures aimed at encouraging local R&D activity, specifying R&D-related tax allowances, additional tax deduction possibilities, etc. However, the bulk of R&D-oriented measures targeted supply and supported existing research centers engaged in automotive-related research. As for Hungary, several policy measures were adopted in the 2000s, seeking to increase university commitments to engage in industrially relevant applied research, commercialize technological findings, and enhance industry–academia collaboration (for an overview of the programs, see Havas and Nyiri 2008). Cooperation-based research centers (CRCs) and regional university knowledge centers (RUKCs) were established with the government's financial support. Funding was allocated to cofinance industry–university research programs. Investment into universities' R&D infrastructure also received financial assistance.

Finally, a key automotive-related support mechanism targets clusters, i.e., geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions in particular fields that both compete with each other and cooperate (Porter 1998). Clustering tendencies and cluster policies in CEE automotive industry are detailed in Szanyi's (2010) paper prepared in the frame of this project.

## 7.5 After-Crisis Perspectives

Although dependence on TNCs' activity and the automotive sector's GDP share (i.e., the dependence of the business cycle on the performance of the automotive sector) is the highest in Slovakia, the plunge in the automobile sector that accompanied the global financial crisis and the consecutive recession was one of the strongest in Hungary within the CEE region; demand shrunk particularly rapidly.

In 2008, new car sales fell by 10.4% to 158,628—according to the statistics of the Hungarian Association of Vehicle Importers. Demand continued to fall sharply in the 2009. Table 7.13 shows a cross-country comparison for the first half-year results.

The crisis of the sector proved particularly strong in Hungary because governments in other countries (e.g., in the Czech Republic, Slovakia,[32] and Romania) have launched car-scrapping bonus schemes to lift the market and help the auto industry recover (OECD 2009). Because of its large budget deficits, Hungary could not afford this type of intervention.[33] As a result, around 110–120 car showrooms have been forced to close so far this year out of a total 600

[32] The total amount spent on scrapping schemes in Slovakia was EUR 55.3 million in 2009. 44,200 cars with an average age of 21 years were scrapped. Up to 30 May 2009, 31,589 cars with subsidy from this scheme were sold or ordered (OECD 2009, Table 2.3).

[33] Furthermore, Hungary's rocketing consumer credit stock denominated in foreign currency aggravated the crisis. Recession was accompanied by a sharp currency crisis at the end of 2008, early 2009 in Hungary. The Hungarian Forint weakened rapidly which increased consumers' debt burden.

**Table 7.13** Falling new car sales in the CEE region

| Country | H1 2009 | H1 2008 | Difference | % Change |
|---|---|---|---|---|
| Poland | 168,888 | 168,645 | 243 | 0.1% |
| Czech Republic | 85,608 | 93,765 | −8,157 | −8.7% |
| Romania | 70,612 | 144,988 | −74,376 | −51.3% |
| Slovakia | 45,728 | 44,118 | 1,610 | 3.6% |
| Slovenia | 29,446 | 39,070 | −9,624 | −24.6% |
| Hungary | 39,613 | 82,003 | −42,390 | −51.7% |

Source: http://www.just-auto.com

nationwide. Overcapacity[34] forced local manufacturers to cut working hours (some of them like Audi decided on shorter or longer production halts), and many of them introduced 4-day-week shifts. Despite substantial layoffs, no major divestment has occurred thus far.

Overcapacity problems emerged of course not because of declining local sales. Up until the crisis, local sales showed little correlation with local production (the crisis has only apparently increased the value of this indicator). In contrast, local production shows strong correlation with local GDP—note that "automobile and business cycles usually move in line with each other" (OECD 2009, p. 109).

In this respect, countries with relatively low GDP levels and thereby a higher "automotive industry value added over GDP" indicator are harder hit by the collapse of the automotive market. Consider a recent news post on the Slovakian situation: "A fall in car production in local plants run by Volkswagen, PSA Peugeot Citroen and Kia Motors - now seen as the engine of the local economy—of 10.1 percent year on year in October, after a 19.1 drop in September, contributed to a 3.8% overall dip in Slovakia's industrial output" (SLOVAKIA: Car output fall contributes to industrial dip, 8th December, 2009, http://www.just-auto.com).

Although a rebound in car sales is likely in the medium run in selected advanced economies (OECD 2009), medium-term projections do not foresee a rapid recovery in the Central and Eastern European automotive sector. Quoting the findings of CSM Worldwide Automotive Forecasting, Bursa (2009) claims that it will take more than half a decade for CEE car production to recover to prerecession levels. Amidst a massive shakeout of the sector with large-scale global mergers and acquisition deals and further streamlining of the production, CEE economies will gradually lose their cost competitiveness—especially new EU member states. In this latter country group, wage increases are bound to erode the attractiveness of the locations.

Table 7.14 quantifies the increase of labor costs (measured by average gross earnings) in selected CEE economies.

Although wages (except Slovenia) are still much lower than in old EU member states, both the shakeout of the industry and the slowly converging wage levels will

[34] According to the most recent Commission Staff Working Document (Commission 2009, p. 9), substantial investments in capacity in Central and Eastern Europe have created sizeable overcapacity. Whereas capacity utilization in previous years was around 80%, it has dropped to 65% at the beginning of 2009.

**Table 7.14** Average monthly gross earnings (MGE) and increases over preceding year, 2008

| Country | MGE (EUR) | % Change 2008/2007 |
|---|---|---|
| Bulgaria | 267 | 21.4 |
| Czech Republic | 969 | 24.1 |
| Hungary | 791 | 7.5 |
| Poland | 856 | 20.45 |
| Romania | 472 | 11.8 |
| Slovakia | 698 | 17.3 |
| Slovenia | 1,398 | 8.8 |

Source: Bursa (2009), p.11

prompt CEE countries to accelerate their quality upgrading efforts and their switch to a high-road strategy. As for Hungary, its present switch to "survival mode"—according to which both innovation financing and regional cluster-based development are subordinated to the objective of improving the fiscal position—hinders local actors' entrepreneurial moves upward along the value chain.

Since the dominant trend in the geography of production is regional integration (Sturgeon and Van Biesebroeck 2009) and only some segments are global, overseas locations with lower operating costs are still not likely to capture the production tasks from CEE economies with the coming reconfiguration of the existing geographical division of labor. Within Central and Eastern Europe, however, major shifts of production are likely, from relatively high-labor cost locations to the lower ones.

Relocation of labor-intensive, low-value-added component production (e.g., wire harnesses) from Central Europe to relatively backward low-cost Eastern locations will be accelerated by increasing labor scarcity (especially in Hungary, the Czech Republic, and Slovakia), which at present hinders existing investors' further local expansionary moves. In the future, this can already influence decisions to relocate production.

Consider the analogous example of Spain and to a lesser extent that of Portugal. Following a period of growth and successive efficiency-seeking foreign investments, both countries experienced massive losses (i.e., the relocation of car components production and import orders mainly by German investors and car manufacturers whose outsourcing moved to the newly opened CEE facilities (Jürgens and Krzywdzinski 2009).[35]

Although in-depth analyses suggest that the dynamics of location decisions within the automotive sector are quite complex and cannot be simply described as "from the north and west towards the south and east"[36] and, later, "from the east towards further to the east," since several recent examples of location decisions point to the opposite sense (Pries and Dehnen 2009), these general structural shifts in the geographical division of labor are likely to continue. Furthermore, even some

[35] According to the cited authors, the share of CEE in German automotive component imports rose from 9 to 37% between 1995 and 2005 (Jürgens and Krzywdzinski 2009, p. 32).

[36] Include also the moves from the south (i.e., the southern periphery of advanced Europe) to the east, i.e., to the advanced eastern (Central European) periphery.

North African countries could challenge CEE's assembly position in the near future (Domanski and Lung 2009). Neither Hungary nor other, relatively high-cost CEE locations should try to withstand these tendencies. Instead, efforts to accelerate quality upgrading ought to be increased, and local suppliers' ambitions to establish linkages with regional production clusters promoted.

## 7.6 Conclusions

In this chapter, we have explored the contribution of the automotive industry to the structural upgrading and modernization of the CEE economies. We found that the surveyed economies could benefit spectacularly from their cost-based competitiveness and have accomplished nontrivial FDI-driven structural upgrading. They all experienced a dynamic expansion of production, export, and employment in the automotive industry.

Despite nonnegligible policy efforts and irrespective of the fact that local actors have all stepped on the path of slow quality upgrading, the CEE automotive industry—with some country-specific variations—has been stuck in cost-based competition. Local actors have been slow to develop dynamic capabilities that would allow them to enter into dynamic competition conducted in nonprice terms. Local research resources have remained fragmented.

In the automotive industry, there is limited opportunity for autonomous development in the sense of Hobday's (1994) "climbing the ladder of technological complexity" model.[37] Nevertheless, within TNCs' global production networks, there is sizable opportunity to increase local value-added, local content, local productivity, local subsidiaries' site competence, and last but not least, the knowledge intensity of local production. This presumes, however, the development of dynamic localized capabilities (Domanski and Gwosdz 2009), which actors in CEE were slow to develop.

This claim needs some further clarification in order to avoid charges of oversimplification. Local actors were successful in understanding, assimilating, and applying new technologies and knowledge transferred by their TNC owners.

[37] According to Hobday's (1994) "stages of technological capability accumulation" model, autonomous development implies the acquiring and upgrading of technical and engineering skills in the course of original equipment manufacturer (OEM). While local subcontractors manufacture complete, finished products following the exact technological specification of the buyer (often their transnational corporation owner), they assimilate and improve existing technology (process engineering). The next stage is marked by the acquiring of design capabilities and the shift from OEM to ODM (own design manufacture). While ODM implies minor product development skills, in the next, OBM stage (own brand manufacture: the most advanced stage of technology recipient firms' capability development), local firms become capable to carry out R&D activities for new product or process innovation. They assume all production-related corporate functions, market their own brands autonomously, and compete head on with established lead producers.

Their technological learning and absorption capability proved impeccable. On the other hand, they were not required to develop technology acquisition capability (identification, selection, and acquiring of appropriate technologies); as in most cases, embodied technology was identified and selected either by their owners or contractors.

What local actors were weak at does not fit in the taxonomy of the "technological capabilities" literature (e.g., Bell and Pavitt 1993). According to this taxonomy, the missing element in CEE actors' upgrading would be the transformation and the exploitation capabilities of the transferred technology (i.e., new product development, organizational, and marketing innovations). Nevertheless, the most advanced stage of this taxonomy cannot be applied to CEE automotive actors. While this type of development may be possible in certain electronics industries in specific South-East Asian economies, it is very rare in the automotive sector and requires not only huge developmental interventions by the state but also huge domestic markets like those in China and India. Without both of these preconditions, national automobile projects end up failing and must be dropped.[38] CEE economies have neither the economic wherewithal nor sufficiently large domestic markets to establish and sustain indigenous, autonomous automotive industries—not even the upstream parts of it (i.e., automotive supplier industries). Only through the value chains of established transnational players can they enter into international markets.

Therefore, the dynamic capabilities local actors were slow to develop can be described rather in terms of quality upgrading and position improvement within the TNC owners' networks, mainly through the broadening of site competence (subsidiary mandates).

Local subsidiaries' capability accumulation can in principle be stimulated through partnerships between TNCs and government agencies if the latter elaborate well-designed incentives that increase TNC commitment to local quality upgrading. However, government agencies in most countries refrained from becoming collaborative facilitators of existing subsidiaries' quality upgrading and considered the number of newly attracted FDI ventures the only indicator of success.

Drawing upon its long-standing engineering and automotive tradition, well-designed privatization and FDI-promotion policies and the systematic development of local design, technological support, and R&D capabilities, the Czech Republic is unique in its ability to switch to a partially knowledge-driven growth path in the automotive sector in the medium term. Even in the Czech's case, the relatively outstanding local research efforts may remain below the critical mass for such a switch. Other CEE economies will have to contend with individual outstanding R&D achievements and small (in terms of the volume of research expenditures) university-based automotive centers of excellence which are unable to ensure sustained regional innovation.

[38] cf. Wad's (2009) comparison of the Thai and the Malaysian automotive industries that have been pursuing different integration strategies: integration through foreign MNCs' value chains versus a national champion policy.

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# Chapter 8
# Specialization and Structural Change in the Automotive Industry in Selected European Regions

**Jens K. Perret**

## 8.1 Introduction

The Bergisch City Triangle, consisting of the cities of Wuppertal, Solingen, and Remscheid, shows tendencies of being in a phase of active structural change. After its acceptance as a Goal 2 region in the context of the structural policy of the EU especially structural funding, the region has a chance to further this process and determine industry branches that for one are deemed future oriented and are already established in the region.

In a study by Welfens et al. (2007), it has been concluded that one of the sectors that are already well established in the Bergisch City Triangle and that show the potential to catalyze a positive structural development is the automotive supplier industry. The fact that Wuppertal and the surrounding cities are, in this context, also well positioned geographically is underlined by the nearby cites of Bochum and Cologne and the automotive manufacturers Opel and Ford located therein.

Based on these insights about the Bergisch City Triangle, the following study will take a look at the position and development of the automotive industry as well as in parts the supplier industry; the position of the Bergisch City Triangle will be shown via indicator-based figures in a Germany-wide as well as a Europe-wide context. The central indicators applied are the RCA indicator by Balassa (1965) and the Moran's I indicator by Moran (1950), two established statistical tools. The RCA indicator relates to international trade theory and the analysis of processes of structural change which will be structurally modified to be applicable to the present situation, whereas the Moran's I indicator originates from the field of spatial econometrics.

Findings are discussed in detail due to their significance, but nonetheless the goal to deduce applicable policy options for a goal-oriented structural policy that will strengthen development trends present. Furthermore, areas where there is still a high need for action will be pointed out, and it will be discussed how structural policy in those areas has to be designed.

P.J.J. Welfens (ed.), *Clusters in Automotive and Information & Communication Technology*, 271
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In the following second chapter, the modifications of the RCA indicator will be deduced starting from the original indicator, and the Moran's I indicator is introduced. Both indicators will be motivated by their fitness for purpose. Additionally, the used data will be commented. The application of the indicators to the present data as well as discussion of the results will take place in Chap. 3. The fourth chapter deduces policy options, and the fifth chapter concludes and points out still open questions and research options motivated by the study.

## 8.2 Measures of Specialization and Structural Change

### *8.2.1 The Revealed Comparative Advantage (RCA) Indicator*

The traditional RCA (revealed comparative advantage) indicator, as given by (8.1), has been introduced by Balassa (1965) for the analysis of international trade links or corresponding comparative advantages. By setting the relative relation of exports in a sector of the observed country and the imports in the same sector of this country as well as the relation of all export and all imports in the country, the comparative advantages of the observed sector can be calculated:

$$RCA_j = \frac{x_j / \sum_{j=1}^{n} x_j}{m_j / \sum_{j=1}^{n} m_j} = \frac{x_j / m_j}{\sum_{j=1}^{n} x_j / \sum_{j=1}^{n} m_j}. \tag{8.1}$$

The variable $x_j$ gives the export in sector $j$, whereas $m_j$ gives the imports in sector $j$. An indicator value in the interval [0, 1) indicates a comparative disadvantage, and a value in the interval (1, ∞), a comparative advantage. As shown by Hoen and Oosterhaven (2006), indicator (8.1) has some inherent statistical faults. For alleviation of the faults, the authors propose the following alternative indicator:

$$SRCA_j = \frac{x_j}{\sum_{j=1}^{n} x_j} - \frac{m_j}{\sum_{j=1}^{n} m_j}. \tag{8.2}$$

Using indicator (8.2), an indicator value in the interval [−1, 0) marks a comparative disadvantage, and a value in the interval (0, 1], a comparative advantage. Additionally, Borbély (2006) proposes another alternative indicator that accounts as well for the faults mentioned by Hoen and Oosterhaven of the original indicator:

$$MRCA_{c,j} = \text{tanhyp}\left(\ln\left(\frac{x_{c,j}}{\sum_{j=1}^{n} x_{c,j}}\right) - \ln\left(\frac{x_{I,j}}{\sum_{j=1}^{n} x_{I,j}}\right)\right). \tag{8.3}$$

In analogy to indicator (8.2), an indicator value in the interval [−1, 0) accounts for a comparative disadvantage, while a value in the interval (0, 1] accounts for a comparative advantage. In analogy to the original indicator, the variable $x_{c,j}$ gives the exports in sector $j$ and region $c$, while $x_{I,j}$ gives the exports of the sector in a reference market $I$. While indicator (8.2) is a direct adaptation of the original indicator, indicator (8.3) does change not only the form of calculation of comparative advantages but also the way these advantages are measured.

Instead of a comparison of exports and imports in a given country, the relevance of one sector in the total exports of a country is compared to the relevance the same sector has in the reference market.

Indicators (8.1) and (8.2) have the disadvantage that they are one-dimensional indicators. In the course of an analysis, this means that a decision has to be made whether the comparison is across sectors or across regions. While it is possible to substitute the sectoral component with a regional one, it is not possible to have a sectoral as well as regional observation at once. This is the point where indicator (8.3) comes into play. It is two-dimensional and allows the comparison of different sectors in different regions without generating problems of comparability for the results. Furthermore, indicator (8.3) in contrast to indicators (8.1) and (8.2) can be applied to measure comparative advantages in other fields but international trade, as will be discussed in the following section.

Finally, special care is necessary when setting the reference market for indicator (8.3) as it decides on the informative value of the indicator. The reference market needs to especially consider the trade relations of the observed regions and fit the basic research paradigm. In the context of a study on regions of the European Union as—done here—it is fitting to consider the EU 27 or the EU 15 (member states before 2004) market, because a major share of export and import flows are between member states of the European Union themselves. In the following chapters, both reference markets will be considered, as member states of the European Union are considered as necessary and the EU therefore offers a fitting comparison.

### *8.2.2 Alternative Indicators*

Besides the calculation of comparative advantages and disadvantages in international trade, it is also possible to modify the aforementioned indicators to measure processes of structural change. Though, in the way they are presented above, it is only possible to observe processes of structural change and specialization as reflected by international trade. The downside of this is that the domestic market is being kept out, and consequentially, only an incomplete picture of the changes in a region is painted. This problem can be alleviated quite elegantly by modifying indicator (8.3). Aside from the already mentioned advantages of this indicator, it also does possess the advantage that only a single economic variable (the exports in the original case) is used in the calculation. If the exports are substituted by any other economic variable, insights in the process of its regionally and sectorally structural change can be gained. Possible alternative variables might be the regionally and sectorally disaggregated GDP (GRP—gross regional product), the production value or disaggregated levels of labor. Using the last two of the variables, the indicators (8.4) and (8.5) can be derived, which are structurally similar to indicator (8.3):

$$PRCA_{c,j} = \operatorname{tanhyp}\left(\ln\left(\frac{p_{c,j}}{\sum_{j=1}^{n} p_{c,j}}\right) - \ln\left(\frac{p_{I,j}}{\sum_{j=1}^{n} p_{I,j}}\right)\right), \tag{8.4}$$

$$LRCA_{c,j} = \operatorname{tanhyp}\left(\ln\left(\frac{l_{c,j}}{\sum_{j=1}^{n} l_{c,j}}\right) - \ln\left(\frac{l_{I,j}}{\sum_{j=1}^{n} l_{I,j}}\right)\right). \tag{8.5}$$

The variable $p$ gives the value of goods produced in the respective sector and region, while $l$ gives the number of persons employed in the sector and region. In analogy to indicator (8.3), values in the interval $[-1, 0)$ signify a comparative disadvantage, while values in the interval $(0, 1]$ signify comparative advantages.

### *8.2.3 Moran's I*

While the global Moran's index (Moran 1950) is in essence a measure of spatial autocorrelation (Anselin 1988) and therefore measures the level of spatial interaction, the local Moran's I index offers the possibility to measure the influence of individual regions on their environment. The basis of the index is a so-called spatial weight matrix, which defines the relevant neighborhood for all regions. The neighborhood that is used in the following paper is given as follows.

For every region, the center is defined by the administrative capital. If it is not possible to assign an administrative capital, as the borders of the region are arbitrarily given by the implemented NUTS 2 classification of regions, the center is defined by the largest (by population standards) city in the region.

The distance between two regions is given by the direct distance of their centers. In the context of this study, the implemented neighborhood is given by the matrix that reports at position $(i, j)$ a 1 if the distance between region $i$ and region $j$ is less than 300 km and reports a 0 if the distance between region $i$ and region $j$ is larger than 300 km. The distance of 300 km is introduced as a number of publications show that interregional spillovers in the EU can only be accounted for inside a radius of 300 km (Bottazzi and Peri 2003; Doering 2004). After generation of the spatial weight matrix $W$, it is necessary to row-normalize it. This means that for the matrix $W = (w_{i,j})_{i,j}$, the following equation must hold:

$$\sum_{j=1}^{n} w_{i,j} = 1 \qquad \forall i = 1, \ldots, n. \tag{8.6}$$

Using the resulting weight matrix $W$, the local Moran's I index can be calculated as follows[1]—whereas an overline does signify taking the mean, and $x_j$ is the respective variable for region $j$:

$$I_i = (x_i - \bar{x}) \sum_{j=1}^{n} w_{i,j}(x_j - \bar{x}). \quad (8.7)$$

### 8.2.4 Data Sources

The data used in this analysis come for one from the databases of Eurostat, especially parts of the REGIO database, while the data for the Bergisch City Triangle come from the statistics service of the city of Wuppertal.

In the study undertaken in the following chapter, where only a country-specific point of view is assumed, data on the value of produced goods are used, while in the sectorally and regionally disaggregated analysis, data on the number of employed persons need to be used as production data at this disaggregated level have not been available.

## 8.3 Descriptive Analysis

### 8.3.1 The Bergisch City Triangle

The Bergisch City Triangle is comprised of the cities Wuppertal, Solingen, and Remscheid and can be seen as a closed labor market region in the sense of the NUTS classification of the EU (NUTS 4 level). This aspect is relevant insofar as due to restrictions of data availability on a Germany- and European-wide level, an analysis can only be conducted on a NUTS 0 or NUTS 2 level, respectively.

The table above shows that the labor force in the Bergisch City Triangle is concentrated to a large part in the manufacturing industry. About one third of the labor force is employed in that sector. If it is furthermore taken into account that a central part of the industry in the Bergisch City Triangle is the sector of automotive suppliers (Welfens et al. 2007), the relevance of this sector for the whole regions gets even more pronounced.

Additionally, sector G shows the third highest levels of employment and is also related to the automotive industry even if the wholesale market takes up a big portion of this sector (Table 8.1).

[1] See for this Moran (1950) or Schulze (1993).

**Table 8.1** Sectoral distribution of labor in the Bergisch City Triangle (2. Quarter 2005–2. Quarter 2006)

| Sector | Labor force | Percentage |
|---|---|---|
| A Agriculture, hunting, and forestry | 0 | 0.00 |
| C Mining and quarrying | 0 | 0.00 |
| D Manufacturing | 33,918 | 30.07 |
| E Electricity, gas, and water supply | 2,617 | 2.32 |
| F Construction | 4,049 | 3.59 |
| G Wholesale and retail trade; repair of Motor vehicles, motorcycles, and personal and household goods | 16,492 | 14.62 |
| H Hotels and restaurants | 1,991 | 1.77 |
| I Transport, storage, and communication | 5,578 | 4.95 |
| J Financial intermediation | 5,275 | 4.68 |
| K Real estate, renting, and business activities | 12,377 | 10.97 |
| L Public administration and defense, compulsory social security | 8,445 | 7.49 |
| O Other community, social, and personal service activities | 21,370 | 18.95 |
| Z Other branches | 668 | 0.59 |
| Sum | 112,780 | 100.00 |

*Source*: City of Wuppertal, Statistical Service Office

## *8.3.2 European Reference Regions*

To propose policy options for the Bergisch City Triangle, it is necessary to take a first look at its most prominent sector the automotive industry and related branches in the neighborhood of the region. It is also important to study how countries and regions that have a similar structure are positioned. Such a comparison allows to identify areas of high competition and areas in which there exist chances for an interregional intra-sectoral cooperation.

### 8.3.2.1 The National Perspective

In a first step, the position of the automotive industry, which can be divided in the manufacturing of motor vehicles, the manufacturing of bodies for motor vehicles, and the manufacture of trailers and semi-trailers, as well as the manufacture of parts and accessories and engines, is observed on a national level.

Figures 8.1–8.3 show the distribution of specialization and despecialization in the automotive industry in the countries Germany, Austria, Hungary, Sweden, the United Kingdom, and the Netherlands. The countries have been selected, as in all six countries there are regions with a pattern of specialization reminiscent of that of the Bergisch City Triangle.

In the course of the analysis of the sectoral specialization of the six countries, we discriminate between an international specialization as given by a specialization of the export structure as well as a national domestic specialization as measured by the structure of production in the countries.

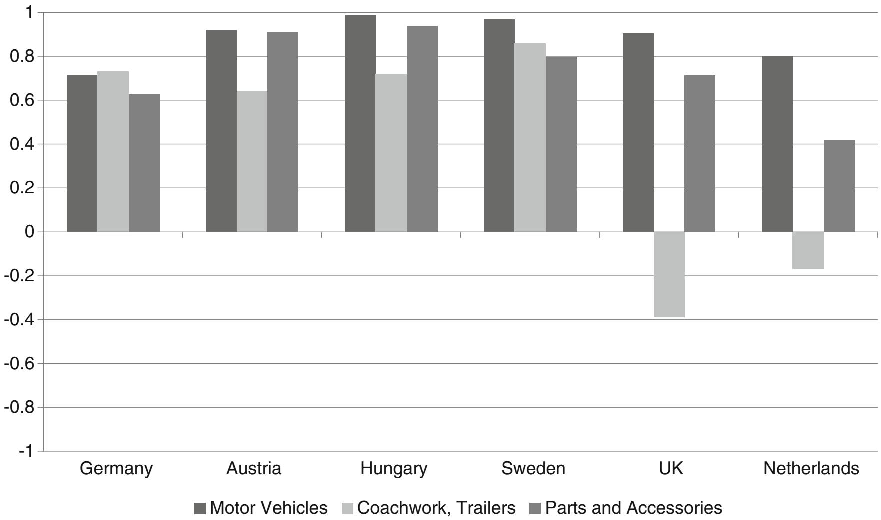


**Fig. 8.1** MRCAs in selected countries in 2008

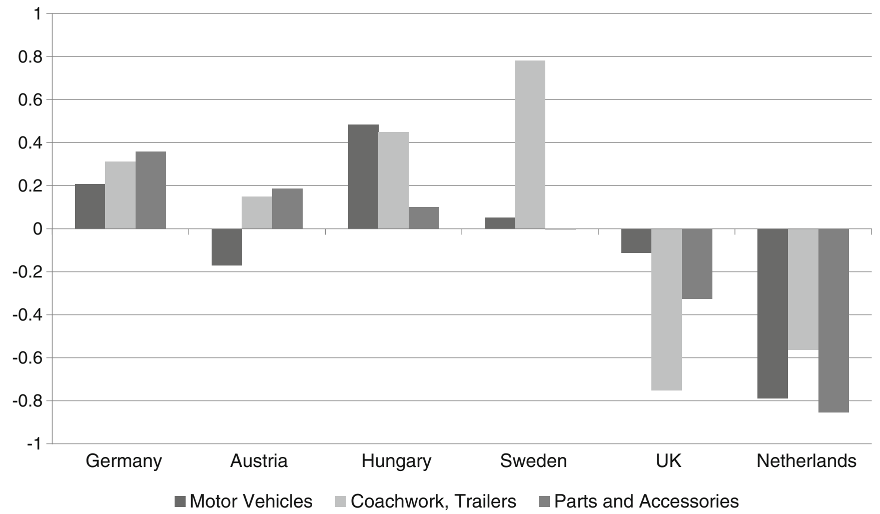


**Fig. 8.2** PRCAs in selected countries in 2006

The export specialization has been measured with the EU 15 market as reference market; the main idea is the reliability of the data used. Even though it might be prudent as to assume that Hungary as a non-EU 15 member country necessitates the use of EU 27 data, reliable results can as well be gained on basis of the EU 15 market.

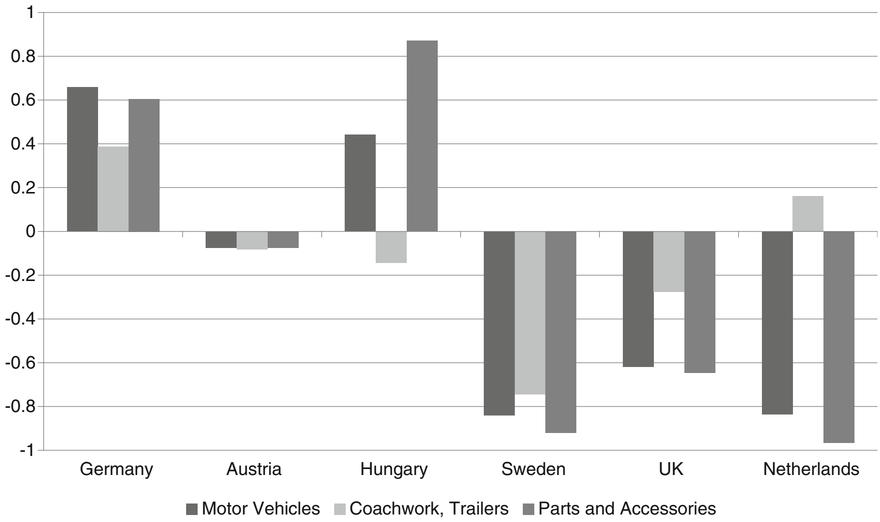


**Fig. 8.3** PRCAs in selected countries in 2007

Figure 8.1 shows the specialization of the export structure for the year 2008. It can be seen that all of the six selected countries have a distinct positive comparative advantage in the manufacturing of automotives as compared to the EU 15 market. The same holds true for the manufacture of parts and accessories, and only in the sector of manufacture of bodies and trailers the United Kingdom and the Netherlands show a disadvantage—Austria does show neither an advantage nor a disadvantage in that area. This is an a posteriori validation of the selection of the six countries as references, as it clearly shows that all six countries are specialized in the automotive industry, while in general theory, have slightly different specialization patterns. Furthermore, it is shown that in the selected countries, the automotive industry does not depend solely on the domestic demand but, for a huge part, also on the foreign demand. Whereas it needs to be mentioned that the positive MRCA value for the Netherlands might be mostly due to the port of Rotterdam which handles a major part of European exports and imports, this is even more so, as in the later parts it is shown that the international position of the automotive industry in the Netherlands differs from its domestic one and concerning labor specialization the Netherlands report a rather weak position.

All in all, in the course of the development of the automotive industry, especially in times of an international economic and financial crisis, a high international interdependence may lead in times of positive economic development to an additional boost, but in times of an international recession, the demand will be additionally lower, and effects for involved industries will be even more severe.

The high advantages of specialization shown by the observed countries can only keep for a longer period of time if at the same time the demand is correspondingly strengthened. In Germany, this has been achieved at least in the short run by introduction of the so-called Umweltprämie, even though it was no medium- or long-term solution, to strengthen the demand, as it has mostly just been moved forward in the end only mildly if at all been strengthened. The consolidation of the German automotive industry has only been moved to the near future and still needs to be accomplished. Therefore, it is only partially possible to give reliable comments on the development of the comparative advantages for the next years. Also in the other observed countries, the consolidation has not been finished yet, and reliable comments are just as hard to come by.

One aspect influencing this development is the growth of the markets in the Middle and Eastern European transition countries. While the production in countries like Hungary, the Czech Republic, or Poland, especially in the field of high-quality goods, is very highly export oriented, the domestic demand in these countries is steadily growing, and it is up to these countries to set out on a path that will on the one hand generate a strong and steady basis of domestic demand, while on the other hand, it might try to still be able to compete as a location with highly qualified but cost-efficient labor. If this can be achieved, it will be possible for countries such as Hungary to keep their high specialization advantages.

In industrialized countries like Germany or the United Kingdom that show a long tradition in the area of automotive production and can account for high-quality goods, it is necessary of not only trying to keep their advantages but to also to conduct steady research and development to advance their position and keep their technological advantage steady. If the industrialized countries do not succeed in doing so, they will in time be overtaken by the catching up countries from Eastern Europe. Competing against the Eastern European countries, the Western European countries (as all of them being industrialized ones) will lose, as the labor conditions are more favorable in Eastern Europe, especially concerning labor costs. If this happens, a movement of even more manufacturers to Middle and Eastern Europe can be expected, and an exchange of comparative advantages might be inevitable.

While export specialization allows only for insights on the foreign market position of a sector in a country, the domestic relevance of a sector can better be measured by other indicators. For this case, the PRCA indicator has been introduced in Chap. 2. We apply the indicator to production data for the above-mentioned countries and the respective sector and present the results for the year 2006 and the year 2007 in Figs. 8.2 and 8.3.

Combined with the MRCA indicator calculated above, this allows for a comment on whether the international export position of a country is backed by an equivalent in domestic demand.

The figures show that with the exception of Germany, no other of the six countries can account for steady positive comparative advantages in the automotive sector regarding the PRCA indicator. Especially the Netherlands accounts for ongoing comparative disadvantages. It is strange for Hungary to show in both years a stable comparative advantage in the manufacture of motor vehicles. Combined with the insights gained from the analysis of Hungary's export specialization, it can be stated that Hungary is on a positive development path to account not only for a solid international trade position but also to base it on a stable domestic demand. This might be an indicator that compared to other Eastern European countries, the Hungarian automotive industry will be less influenced by the global economic and financial crisis and will leave the times of crisis in a much better state than similarly specialized countries—especially regarding their trade position. The same can be said about Germany, but even though it is to be assumed that the crisis will lead to some consolidation in the automotive industry, Germany can still be supposed to keep its leadership role throughout the crisis and into times beyond.

For Germany regions as the Bergisch City Triangle, this accounts for two consequences. First, structural policy should help present enterprises of the automotive industry with an innovation-oriented especially innovation-enhancing policy. Secondly, regions that show potential for the establishment of new innovative enterprises from the field of automotive manufacturing should be helped by programs to strengthen small- and medium-sized enterprises or by offering them advantageous financing tools like venture capital. Especially the second option would make the region itself more attractive for future investors and enterprises.

#### 8.3.2.2 The Regional Perspective (Revealed Comparative Advantage)

Up to this point, only very general conclusions could be drawn and those only on a national scale, so that in the following section we will disaggregate our data to describe the regional buildup in more detail. The downside of such a disaggregation is that data, due to publication directives of Eurostat, are only partially available on a regional scale. Additionally, there are regions for which no data are available at all. Even for regions that provide acceptable data, they are mostly only available with a lag of 2 years, so that the present study could not integrate and describe recent trends in the automotive industry.

The analysis will focus on data from the years 2005, 2006, and 2007, whereas the data are sectorally disaggregated at the NACE 2 digit level. This implies that concerning the automotive industry, only specialization in the NACE sector DM 34 (manufacture in motor vehicles and trailers) can be observed.

A partition of the RCA values in four groups (as well as the group of regions for which no data were present) is based on the RCA indicator in the year 2005. The first group consists of regions in which no significant industry in sector DM 34 is present ($LRCA < -0.9$). In contrast to them in the regions of the second group ($-0.9 < LRCA < -0.15$), an automotive industry is present, but the sector is no essential part of the industrial structure of the region. The third group ($-0.15 < LRCA < 0.15$) consists of the regions that neither show a distinct comparative advantage nor a distinct disadvantage. The regions in this third group are potential regions where with a suitable structural policy, a comparative advantage can be established. Finally, the last group ($LRCA > 0.15$) consists of those regions that in a European context show a distinct positive advantage in the sector DM34, meaning that this sector is already well established in these countries. Here, the job of structural policy is to strengthen present advantages and advance them or invest in measures to keep the present leadership position (Figs. 8.4–8.6).

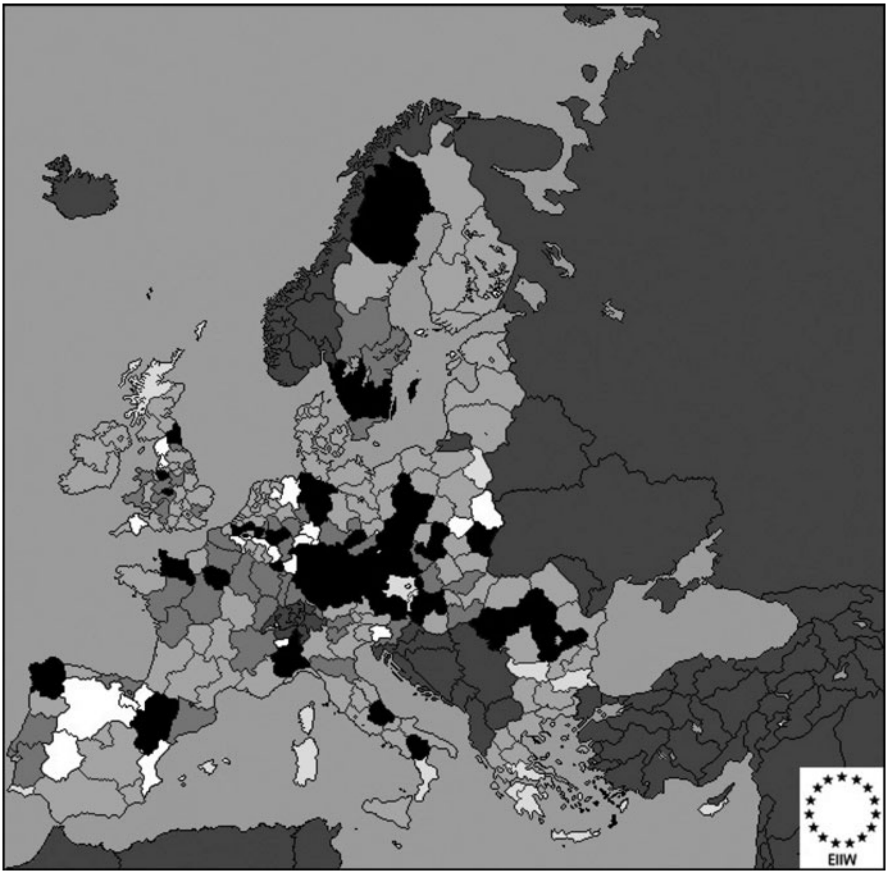


**Fig. 8.4** LRCAs in the European Union (NUTS 2 Level) in 2005. *Black* significant comparative advantages (LRCA $> 0.15$), *dark gray* insignificant comparative advantages or disadvantages ($-0.15 < \text{LRCA} < 0.15$), *light gray* distinct comparative disadvantages, but industry in sector 34 ($-0.9 < \text{LRCA} < -0.15$), *very light* insignificant industry in sector 34 present Gray: (LRCA $< -0.9$), *white* data not available or no industry in sector 34 present

All three figures indicate that there is a distinct cluster of regions with a high degree of specialization in the automotive industry in Central Europe. Furthermore, it can be seen that the periphery is mostly marked by regions with a significant despecialization. Such a distribution of the economic structure goes hand in hand with the insights from new economic geography (Krugman 1991) that proposes the rise of a core region and a periphery.

The Central European cluster consists of regions ranging from Belgium, Germany, and Austria to the east of Europe, especially Poland, the Czech Republic, Hungary, and the Slovak Republic. Additionally, a few regions in the periphery report a high specialization. With the exception of Romania and parts of Spain, it seems reasonable to assume that those mark centers of traditional national

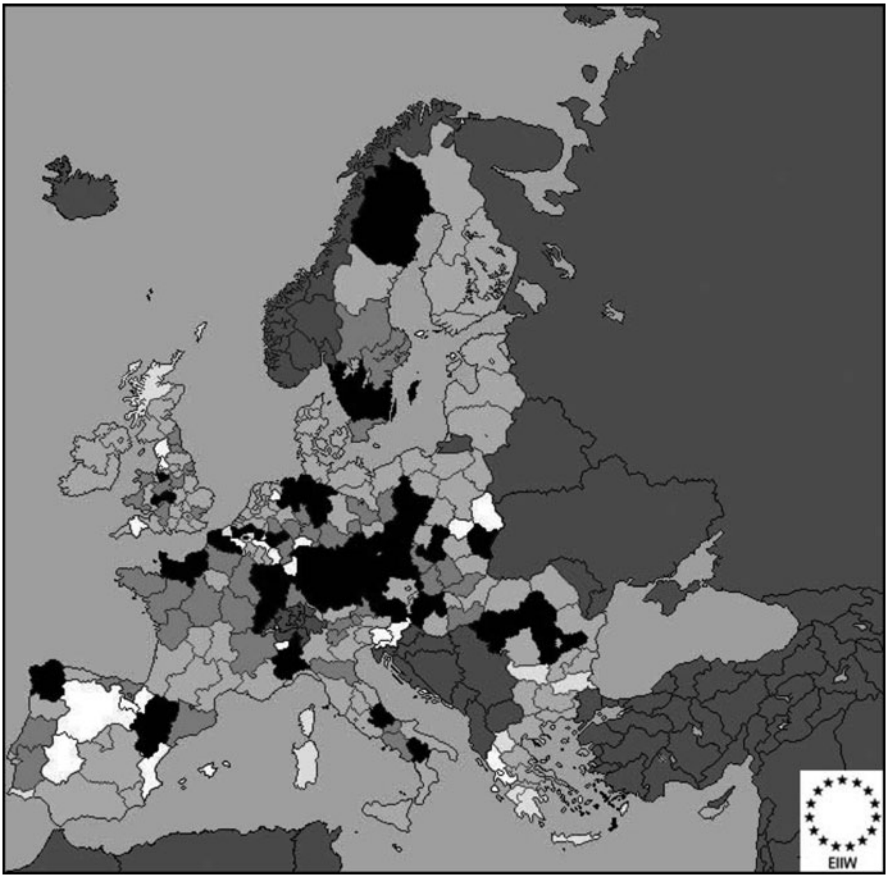


**Fig. 8.5** LRCAs in the European Union (NUTS 2 Level) in 2006. *Black* significant comparative advantages (LRCA $> 0.15$), *dark gray* insignificant comparative advantages or disadvantages ($-0.15 <$ LRCA $< 0.15$), *light gray* distinct comparative disadvantages, but industry in sector 34 ($-0.9 <$ LRCA $< -0.15$), *very light* insignificant industry in sector 34 present Gray: (LRCA $< -0.9$), *white* data not available or no industry in sector 34 present

automotive industries. In Spain and Romania, they mark locations where multinational enterprises—like Ford in Spain—have erected production sites for vehicles or manufacturers of preliminary products that despite their location in the periphery can account for cost advantages that outweigh the transportation costs—as is the case in Romania.

While the structure changed little from 2005 by 2006 to 2007, it can be seen that change took place especially in the northern regions of France as well as in regions of the Czech Republic, Slovakia, and Hungary.

Altogether, it can be seen that a trend is present of a rise in the degree of specialization in a few regions. As the RCA indicator is referenced to the European Union, not all of its regions can account for comparative advantages at once.

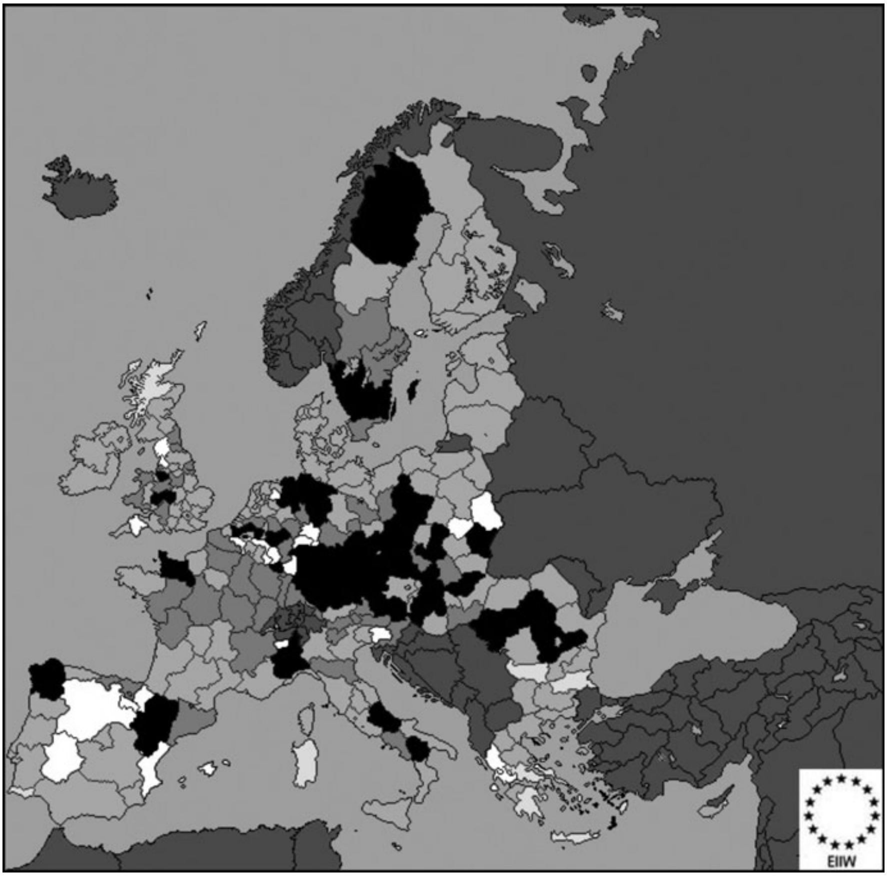

**Fig. 8.6** LRCAs in the European Union (NUTS 2 Level) in 2007

Though, a possible explanation can be found in the third group which is like an area of fuzziness of the LRCA between specialization and despecialization. By raising the LRCA by a marginal degree, it is possible for a region to change its group membership, though to account for this, it would be necessary to use an even finer disaggregation which by itself would not be applicable due to a lack of data, or a lack of space in the present study.

For regions, especially in Germany and the center of Europe, the problem arises that they have to keep their relatively high level of specialization or comparative advantages, respectively. In this context, similar arguments might be brought forth as already mentioned in the national context. Additionally, this regional analysis does imply that for German regions and the Bergisch City Triangle in particular, it will be relatively easier to keep their position. As a large part of regions surrounding the Bergisch City Triangle show positive comparative advantages, it can be assumed that the region does profit not only from knowledge spillovers generated inside the regions but also from those generated in the surrounding regions. An in-depth analysis of regional knowledge spillovers and their effects, however, is not part of this study. Even though, growth theory does imply that regions which are surrounded or near to fast growing regions might themselves gain a growth enhancement. This idea is also explicable to the case of highly specialized regions and corresponding spillovers.

Finally, the consequences from the preceding analysis of the domestic and the international trade position of the automotive industry have to be reevaluated in this context. In the first part of this chapter, it has been shown that the German automotive industry, at least in the area of exports, reports consequent positive comparative advantages. In the second part, it has been shown that this development is mirrored on a domestic level for the regional level as well (excluding some regions in northeastern Germany)—even though here only the sector of manufacture of motor vehicles in general is observed. If both parts are combined and it is considered that the automotive industry in Germany is strongly export oriented, so that the export structure represents the sector as a whole, the following conclusions can be drawn.

The regions in the surroundings of the Bergisch City Triangle are all highly specialized in the automotive industry. This implies that the area can be seen as a cluster of producers of the final good—in this case motor vehicles—as well as of suppliers. For enterprises situated in the Bergisch City Triangle, therefore, there exists a high cooperation potential that would profit not only from the presence of the sector itself but as well from the regional nearness of partners and the advanced infrastructure present.

#### 8.3.2.3 The Regional Perspective (Moran's I)

Based on the comments on the role of spillovers in the development of the European Union, the local Moran's I has been calculated for all regions. Though, instead of depicting the indicator itself, its changes from 2005 to 2006 and from 2006 to 2007 are presented.

In the figures, the regions are divided into four groups, where the regions in the first group are those that in both periods are growth enhancing to their neighborhood (Moran's I positive in both periods). The second group consists of those regions that have been growth diminishing in the past but due to inner regional changes became growth enhancing in the second period (Moran's I negative in the first and positive in the second period). The exact opposite is true for the third group where the positive influence is changed to a negative one (Moran's I positive in the first and negative in the second period). Finally, the fourth group consists of those regions that act growth diminishing on their environment in both periods (Moran's I negative in both periods).

Seen from the point of view of makers of structural policy, it is especially necessary to take action in those regions that are located in the third or fourth group. Even though structural policy should only get active insofar as process

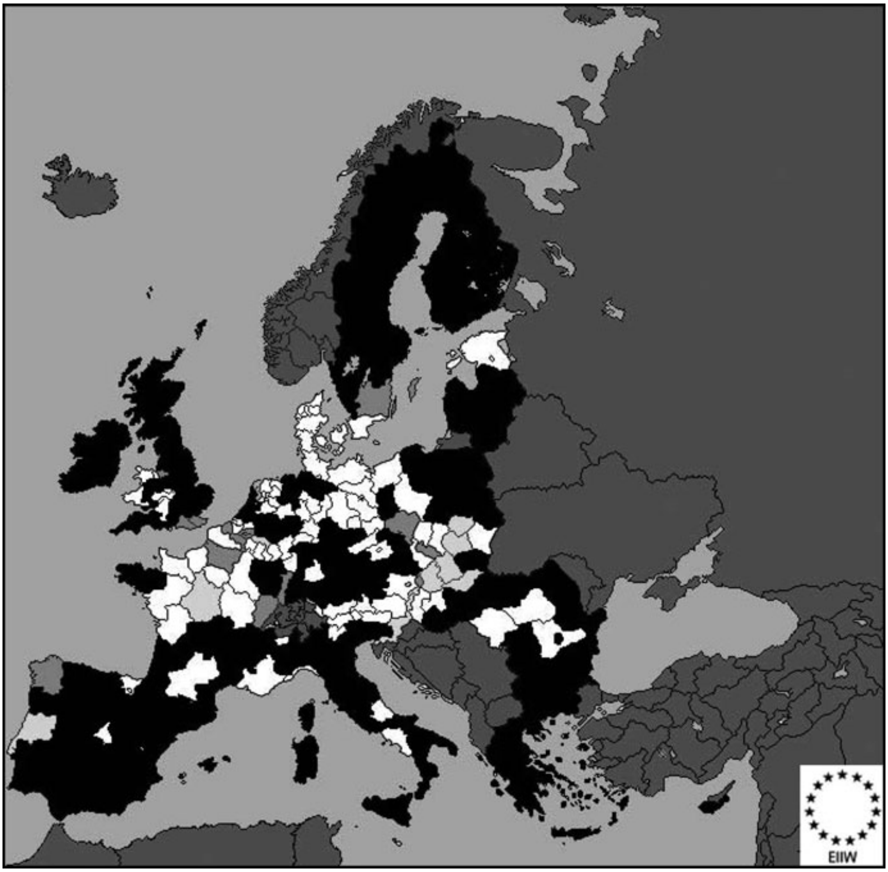


**Fig. 8.7** Moran's I—Changes 2005–2006. *Black* positive indicator in both years, *dark gray* negative indicator that becomes positive, *light gray* positive indicator that becomes negative, *white* negative indicator in both years

initiated in the second group is not hindered, else it might be that the growth trend in the regions of the second group might only have been a short term one.

Comparing Figs. 8.7 and 8.8, it can be seen that the primary core of dynamics lies in Eastern Europe, especially in Poland, Hungary, and the Czech Republic, as well as in France. Most other regions keep their influence steady, be it positive or negative. It is remarkable that a large part of the region in Central Europe reported a negative influence on their neighborhood. While for the eastern part of Germany this can be explained by hard going structural funding or corresponding implementation respectively, it is rather hard to explain for regions in Austria, Denmark, and France. One possible explanation might lie in the fact that only sector 34 is observed and therefore not the whole potential of the regions is represented, so that white regions only indicate a poor inclusion of the region in the international net of the automotive industry.

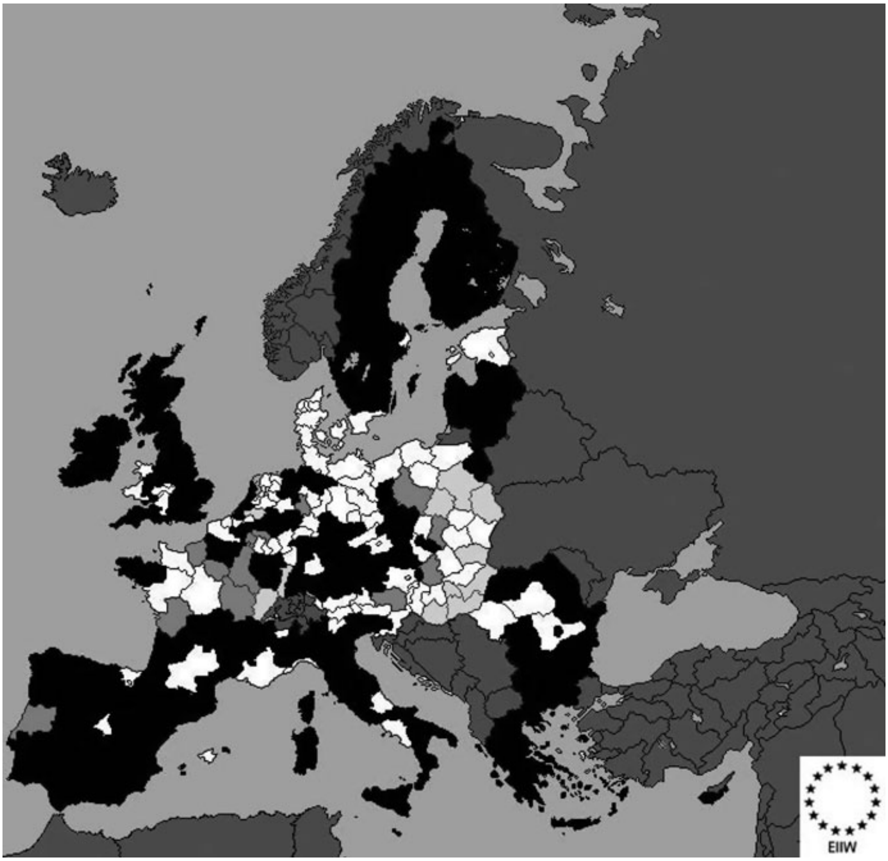

**Fig. 8.8** Moran's I—Changes 2006–2007. *Black* positive indicator in both years, *dark gray* negative indicator that becomes positive, *light gray* positive indicator that becomes negative, *white* negative indicator in both years

## 8.4 Economic and Structural Policy Options

As stated in the previous chapter, it is a prerogative not only for the Bergisch City Triangle but for all German regions with an economic emphasis on the automotive industry to focus their production portfolio on innovative and technologically as well as qualitatively advanced aspects of their value chain. Germany in general benefits in this aspect from the fact that it reports high comparative advantages in all major subsectors of the automotive sector, so that it is possible to broaden its overall portfolio without the need of the establishment of some sectors.

Concerning German regional as well as national policy, this implies that the change to an innovative location for producers needs to be facilitated. In this context, initiating cooperations between the producers and the users of the innovative improvements might be a prudent starting point. In particular, this aims at the cooperation of universities and colleges on the one hand and of enterprises in the surrounding region on the other hand. Such cooperations could happen on a technical–methodological level as well as being cooperations of an administrative kind. A way of initiating or supporting such cooperation might be by direct financial aid of joint ventures or by financing cooperative research projects with a background of practical implementation. By facilitating the administration process of cooperation initiatives, the cooperation initiatives can also be aided—an example might be the facilitation of the patenting process of inventions resulting from research activities.

For the policy makers concerned with regional structural policy, the RCA approach presented above offers a means to develop a concept of regional and sectoral aids. The sorting of the regions according to the LRCA can be used to furthermore classify the structural policy measures.

The group of regions without any significant industrial activity (LRCA $< -0.9$ or a continuing negative Moran's I) can only profit from aids to the founding of new enterprises. Different ways of any such aid include programs for small- and medium-sized enterprises and the subsidization of venture capitalists. The job in these regions is to establish a sufficient industry before this industry can be strengthened.

For the regions in the group, where there is an industry already present, but it is relatively underdeveloped compared to the other sectors of the region, it is necessary to differentiate according to two criteria. For one, it is necessary for a distinction of the development status of the sector—whether the sector is in a developing phase or whether it is declining. Additionally, it is important to take a look at the future potential of the sector as a whole. Structural policy in the region should only take action to supplicate a developing sector if the sector shows a high potential for the near future and can at least account for mediocre growth tendencies, as in these phases, most processes of structural change take place.

The third group ($-0.15 <$ LRCA $< 0.15$) is quite similar as it contains regions with no distinct advantage or disadvantage. Here the possibilities for structural policy are highest, and a well-coordinated policy of aids could improve the overall situation of the whole region.

Finally, what remains is the group of regions that report a distinct comparative advantage. In the context of this group, there is little need for action concerning structural policy as the sector in these regions is already at an above average position. Politically, it might just be favorable to preserve the status quo of the region.

For the Bergisch City Triangle, there therefore exists a broad range of possibilities. On the one hand, its geographical location and the well-established infrastructure positions are near two major producers of the automotive industry—Ford and Opel. In this context, it might be helpful to communicate these positive aspects of its location more clearly, and even though both locations of Ford and Opel are already well established, it is still possible to compete against these locations on the level of innovativeness. It might therefore be useful for the

Bergische Städtedreieck to use its elaborate university and college infrastructure and facilitate and initiate cooperations with the industry. The University of Wuppertal in the center of the Bergisch City Triangle offers a good starting point which could be supported by the services of other institutions in the region whose focus is to be found in a field near to the automotive industry and for the Bergisch City Triangle in particular the supplier industry for automotive parts and accessories.

Additionally, the Bergisch City Triangle has the potential of financial means due to its status as a Goal 2 region in the context of the structural aid program by the European Union. In this context, it is possible for it to together with other similar regions apply for funding. It is also possible to use these funds to establish, develop, and aid interregional clusters.

## 8.5 Conclusions

By means of analyzing comparative advantages, it has been shown how the automotive industry is situated sectorally and regionally disaggregated across the European Union. During all stages of the analysis, the position of the Bergisch City Triangle has been discussed. Such a referential analysis allows for insight on the position of the Bergisch City Triangle in Europe and the possibilities to change this position or rather the political possibilities to strengthen that position.

Even though, the analysis did not allow for a deeper insight into recent developments in the industry. Nevertheless, the consequences of the present crisis have been argued, and possibilities for Germany, the Bergisch City Triangle, as well as the European Union as a whole to get through the crisis with a minimum of negative effects have been discussed.

In-depth predictions and resulting policy recommendation that go beyond the scope of the present study cannot be given, as a consolidation of the automotive industry is still underway and the sector is still in a process of ongoing change. Nonetheless, a continuation of the analysis added by insight gained from the crisis seems necessary to deduct an effective development path for the German regions and the Bergisch City Triangle in particular.

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