



Fraunhofer Institute
Systems and
Innovation Research

Arbeitspapiere Unternehmen und Region
Working Papers Firms and Region
No. R2/2000

**Socio-economic Analysis of
North Rhine-Westphalia**

**Joint Research Project
INCO-COPERNICUS**

Ulrike Bross
Günter H. Walter

ISSN 1438-9843

Contact:

Fraunhofer Institute for Systems
and Innovation Research (ISI)
Department "Innovation Services
and Regional Development"
Breslauer Strasse 48
D-76139 Karlsruhe
Telephone: +49 / 721 / 6809-138
Telefax: +49 / 721 / 6809-176
e-mail: cs@isi.fhg.de
URL: www.isi.fhg.de/ir/departm.htm

Karlsruhe 2000
ISSN 1438-9843

Contents	Page
Preface	1
1 Regional characteristics of the case study region	2
1.1 Location and size of the Ruhr area.....	2
1.2 Administrative borders and entities	3
2 Historic development, economic decline and transition process.....	5
2.1 Brief overview of the historic development.....	5
2.2 Causes for economic decline.....	7
2.3 Phases of the transition process.....	8
2.4 Transferability of experiences to CEECs.....	10
3 Relevant indicators	11
3.1 Demographic figures	11
3.2 Economic and industrial structure.....	12
3.3 Labour market	16
3.3.1 Employment	16
3.3.2 Education and human capital	17
3.3.3 Unemployment	18
4 The development efforts and policies in the region.....	19
4.1 Former development efforts.....	19
4.1.1 Policy action during the 80s and 90s	19
4.1.1.1 Theory based strategies	22
4.1.1.2 Applied policy instruments	24
4.1.1.3 Key institutions and actors	27
4.2 Current development efforts	28
4.2.1 Current (regional) development strategies and policy efforts.....	28
4.2.1.1 Introduction	28

4.2.1.2	Education, qualification and R&D	28
4.2.1.3	Basic infrastructure	31
4.2.1.4	Support for the regional technology and innovation infrastructure	33
4.2.1.5	Labour market policies and vocational training.....	36
4.2.2	Key projects	36
4.3	The role of the regional infrastructure	38
4.3.1	Regional research & development infrastructure.....	38
4.3.2	Universities and polytechnics	41
4.3.3	Innovation and technology transfer centres, business incubators	42
4.3.4	Regional educational and vocational training institutions	43
5	Conclusion and summary	44
	References	48

Tables

Table 1:	Phases of economic growth and decline in the Ruhr area.....	6
Table 2:	Phases of the transition process.....	9
Table 3:	Composition of the service sector in North Rhine- Westphalia	15
Table 4:	Qualification of the workforce	18
Table 5:	Political initiatives to restructure the Ruhr area	24
Table 6:	Overview of past industrial and technology programmes of North Rhine-Westphalia.....	27
Table 7:	List of higher education institutes in NRW.....	29
Table 8:	R&D expenditure by actor	39
Table 9:	Growth of R&D expenditures 1987-1993	40
Table 10:	Regional characteristics before and after transition	45
Table 11:	Summary of selected quantitative indicators for the Ruhr area	46

Figures

Figure 1:	Location of North-Rhine-Westphalia and the Ruhr area	3
Figure 2:	Administrative structure of the Ruhr area	4
Figure 3:	Migration development	11
Figure 4:	Industry structure in North Rhine-Westphalia	12
Figure 5:	Employment in the coal and steel industry	13
Figure 6:	Share of sectors in North Rhine-Westphalia	14
Figure 7:	Employment development in the service sector.....	15
Figure 8:	Employment development in industry	16
Figure 9:	Development of annual turnover in industry per employee in the Ruhr area	17
Figure 10:	Development of students	18
Figure 11:	Unemployment	19
Figure 12:	Technology transfer in North Rhine-Westphalia	34
Figure 13:	Development of private funding of research at universities	41

Preface

Old industrial areas pose a severe challenge to advanced market economies and former socialist countries in Central and Eastern Europe. All of those regions share the same features of the "ageing process" which are the dominance of large enterprises, closure of factories, high unemployment rates, outward migration, low environmental standards, outdated infrastructure and image problems. Most old industrial areas are characterised by traditional industries such as mining, steel production, chemistry, paper or textiles. These industries once founded the prosperity of the industrial area, they now impede structural change. Examples of such regions are the Ruhr area, Liverpool, South Wales, Nord-Pas de Calais, Upper Silesia.

During the past decades some of the mentioned western regions succeeded in achieving structural change and renewal. On the other hand, old industrial areas in Central and Eastern European Countries are still facing severe economic problems and need restructuring. The focus of the early phases of the transition process has been more on macroeconomic stabilisation and institutional reform such as privatisation. Also, regional entities only recently gained political responsibilities after being tightly integrated in a centralised administrative structure under the socialist regime. Therefore, western experiences with transforming old industrial areas offer lessons transferable to Central and Eastern European regions in structural crisis.

The following case study on the Ruhr area in the German federal state North Rhine-Westphalia is part of a joint research project within the frame of INCO-COPERNICUS: "Modernisation of traditional industries in transition on the basis of the knowledge from the restructuring of old industrial areas in Austria and Germany – the case of Slovenia, Hungary and Poland". The project is carried out by the Fraunhofer Institute for Systems and Innovation Research (ISI; Karlsruhe), the Institute for Technology and Regional Policy (InTeReg; Graz), the Institute for Economic Research (IER; Ljubljana), the Institute for World Economics (IWE; Budapest), the University of the German Army (Munich) and the Nicholas Copernicus University (Torun). The project aims at a know-how-transfer on the restructuring of Western European regions to economies in transition. The empirical part of the research consists of two case studies of the Ruhr area and Upper Styria and deep field studies in Slovenia, Hungary and Poland. On this basis, policy recommendations will be formulated and disseminated to local actors.

The case study of the Ruhr area proceeds in the following way: After a description of the region (chapter 1), a brief overview over the history, the reasons for economic decline and the transition are given in chapter 2. The chapters 3 and 4 focus on the relevant indicators in order to analyse the structural problems and give a detailed inven-

tory of the political instruments which steered the renewal process. Chapter 5 concludes with the main findings on methodology and policy lessons.

1 Regional characteristics of the case study region

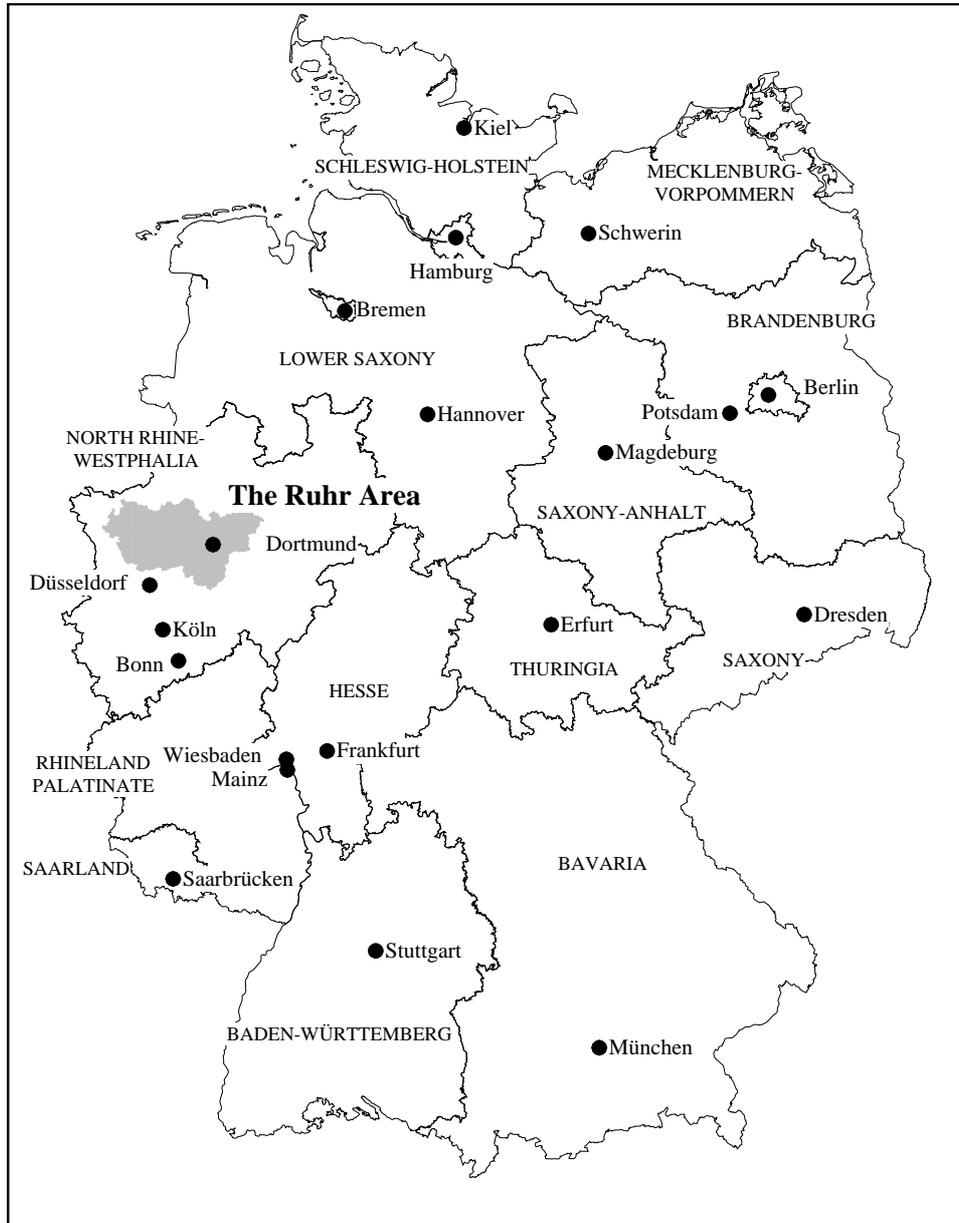
1.1 Location and size of the Ruhr area

North Rhine-Westphalia (NRW) is one of 16 German federal states. With its 17 947 000 inhabitants (1996) and Gross Domestic Product (GDP) of 799 bill. DM in 1997, the region accounts for about 22 percent of the population and of the GDP of Germany (LDS NRW 1999).

The industrial structure of the federal state today is highly differentiated, covering a wide range of sectors. The Ruhr area with its coal and steel complex and other regions, e.g. with a declining textiles industry have meant considerable development challenges to North Rhine-Westphalia over the past decades.

The Ruhr area with 5.4 mill inhabitants is still one of the world's largest industrial agglomerations and benefits from a very central geographic location at the intersection of various North-South and West-East axes. The region can be characterised as an old industrial area with strong focus on coal mining, steel and energy which has lasted for many years. While the Ruhr area will be the core case study region in the following, references to the broader economic region of North Rhine-Westphalia will be made, since close relations exist.

Figure 1: Location of North-Rhine-Westphalia and the Ruhr area



1.2 Administrative borders and entities

As the Ruhr area does not constitute an independent administrative entity (such as a county) it can be considered as comprising the territory of the "Kommunalverband Ruhr" (KVR), which consists of the cities Essen, Dortmund, Duisburg, Bochum, Gelsenkirchen, Oberhausen, Hagen, Mühlheim, Herne, Hamm and Bottrop as well as the districts Ennepe-Ruhr-Kreis, Recklinghausen, Unna and Wesel (see figure 2). The

KVR was founded in 1979, but its forerunner organisation already dates back to 1920. This is an institutionalised collaboration between the cities and districts.

Figure 2: Administrative structure of the Ruhr area



As a second characteristic, the Ruhr area itself consists of heterogeneously structured sub-regions. From South to North four sub-regions can be distinguished according to the northward shift of coal mining and the related cycles of industrial development and the North: the Ruhr zone, the Hellweg zone, the Emscher zone and the Lippe zone.

Since the region is partitioned into three traditional counties ("Regierungsbezirk"), important decisions are made outside of the region. Recent attempts at administrative reform, which aimed at creating a common administrative entity, did not materialise. This peculiarity has to be kept in mind when assessing the levels of industrial technology policy in the Ruhr area.

2 Historic development, economic decline and transition process

2.1 Brief overview of the historic development

The success story of the Ruhr area started during the industrialisation phase in the 19th century. It was made possible by five major factors (Schrader 1998, 437):

- technological innovations, which were mostly imported from Great Britain
- improved transport infrastructure, namely an extended railway network and channels
- import of capital
- political and economic liberalisation
- dynamic entrepreneurship.

The growth of the Ruhr economy relied to a large extent on technological innovations which made large scale coal mining and steel production possible. In the course of industrialisation until the start of the twentieth century, more and more industries were integrated into the coal and steel industrial complex ("Montankomplex"): such as power generation and the chemical industry (e.g. Heinze et al. 1998, 267). The formation of the coal and steel complex was mainly resource-based. Large scale coal mining was a location factor supporting steel production and made relatively cheap production of energy possible, furthermore at that time, many chemical processes relied on coal.

The phases of economic growth and decline of the Ruhr economy can be seen in table 1.

Table 1: Phases of economic growth and decline in the Ruhr area

Time period	Phase	Characteristics
before 1840	pre-industrialisation	<ul style="list-style-type: none"> • small coal mines, iron and textile factories • agricultural areas with low population density
from 1840	industrialisation with strongest growth phase between 1894 – 1914	<ul style="list-style-type: none"> • large-scale coal mining and development of coal chemistry • introduction of mass production of iron and steel • foundation of large enterprises • strong immigration
1914 – 1945	first signs of crisis	<ul style="list-style-type: none"> • economic depression, world wars I and II, dismantling of product lines after WW II • end of product cycle of coal mining
1945 – end of 1950s	rapid growth	<ul style="list-style-type: none"> • temporary demand pull due to reconstruction and Korean war caused over-capacities
1960s – today	restructuring and transition	<ul style="list-style-type: none"> • crisis of coal mining and closure of pits: international competition and locational disadvantages due to changed technology • absorption of workers in other sectors (1960s) • steel crisis in 1974 with overall decline of the region

Source: based on Hassink (1992, 48f); Butzin (1993b)

After the first signs of decline of the Ruhr economy which can be observed as early as between the First and Second World Wars, the reconstruction which began in the late 1940s and external factors such as the Korean War only postponed the crisis. Schlieper for instance argues that the industry on which the Ruhr area relied had reached the end of its life cycle already in the 1940s (1986, 145). While the external events affecting the coal and steel complex most visibly are the coal crisis in 1957 and the steel crisis in 1974, the decline of the region has to be understood as a process of which the causes were created as early as in the days of industrialisation (see also Dege/Kerkemeyer 1993).

From 1957 several political measures on a regional, federal state, national and European level have been undertaken in order to bring the restructuring process about. Since one main goal has been to minimise social disparities, the process has taken a long time and even in the 1990s the Ruhr area has still not entirely overcome its structural crisis. While first signs of recovery were visible during the 1980s, the world recession in 1992/93 had a very strong impact on the Ruhr economy.

2.2 Causes for economic decline

When assessing the causes of economic decline of the Ruhr area, external as well as internal factors have to be distinguished. Among the external factors rank changed demand, for example through technological innovations which made coal obsolete for many uses and cheaper coal and steel from developing countries and later from Central and Eastern European Countries (CEECs), related to the diminishing importance of transportation costs.

Besides these external factors, the internal factors that impeded a timely reaction to changes in external conditions should not be under-evaluated. These are mainly structural characteristics that evolved during the years of success (Schrader 1998):

- large organisational structures (conglomerates and cartels),
- hierarchical structure between SMEs (especially mechanical engineering) and dominant large firms,
- evolution of a disorganised and unplanned urban structure with deficiencies in infrastructure,
- strong political lobby in favour of the traditional industries.

In an industrial regime that relied on economies of scale and strong vertical integration, the existence of small and medium sized enterprises (SMEs) was not as widespread as in other German regions, e.g. Southern regions such as Baden-Wuerttemberg. A characteristic of the Ruhr area was that SMEs were extremely specialised and often depended entirely on their main customers from the coal and steel complex. Research and development (R&D) efforts were localised in large enterprises with only very limited impact on the region and so most SMEs did not perform their own R&D activities. This structural disadvantage meant that preconditions for mobilising endogenous potential in the local industrial fabric were relatively weak. In addition, network relationships to regional or global partners outside the industry were underdeveloped or non-existent. This industry structure has resulted in a heavy legacy that hindered flexible adaptation and reorientation of the dominant production cluster.

Besides the industrial relations of the Ruhr area, the structure of human capital is very specific. Already at the beginning of the industrialisation phase, the innovations used were imported from elsewhere as were highly skilled engineers from the technical universities which were situated outside the Ruhr area. In the early days, there was also a huge majority of workers in heavy industry who were unskilled or semi-skilled. Later on, coal and steel enterprises competed for the highly skilled labour force on the local market. However, despite the prevailing high qualification, the skills of the local labour force were specifically related to the needs of traditional industries, limiting the scope of their possible employment in other sectors.

An active structural change was also impeded by the early availability of attractive business space. This can partly be attributed to the reservation of space for the traditional industries. Furthermore, the Ruhr area suffered from locational disadvantages because of contaminated soil, inadequate infrastructure and unfavourable "soft" regional factors such as a poor image.

Another factor contributing to the sclerosis and hampering the restructuring process was the political texture, evolving with the formation of the coal and steel complex (e.g. Grabher 1993). A strong lobby made up of large conglomerates, local and regional politicians and trade unions repeatedly voted against major economic changes and reorientation of the production cluster.

2.3 Phases of the transition process

While the coal and steel industry approached the end of their life cycles during the first half of this century, the structural problem was overlapped by subsequent temporary demands. Therefore, the regional ruling elite failed to acknowledge the need for a dramatic re-orientation of the Ruhr economy for a long time. Active structural change by means of diversification of the industrial structure was only pursued relatively late (since the 1970s). The phases of the transition process which are also summarised in table 2 can be characterised as follows:

- **Until the 1970s** central planning initiatives on the federal state level and national level prevailed, **perpetuating** the existence of the traditional industries in the region. First (tentative) attempts to attract extra-regional capital were made. Supply-side oriented policy fostered the building of universities in the Ruhr area.
- **From the late 1970s until 1989:** This period was marked by the harsh consequences of the steel crisis in 1974. In 1981, the Hoesch group almost went bankrupt causing heavy cuts in employment (from 24,000 in 1957 to 13,000 in 1987). In 1986/87, the closure of steel plants in Hattingen and Rheinhausen almost threatened social peace in the region. At the same time, large enterprises of the region started to diversify, but mostly outside the region. The focus of industrial and technology policy implied a change of planning focus towards regionalisation. Active structural change in contrast to passive accommodation of declining industries was underlined, such as the role of SMEs and technology transfer in the **diversification** of industry. During this period, first signs of economic recovery could be seen, which was mostly due to the growth in the service sector.
- **From 1990 until the mid 1990s** the Ruhr area first experienced a boom and then a crisis after German unification. The steel industry went through a phase of **consolidation** with strong rationalisation and take-overs or mergers between the major

players (i.e. take-over of Hoesch by Krupp 1993; merger between Krupp and Thyssen in 1997). The economic crisis in 1992/93 had a particularly harsh impact on the North Rhine-Westphalian economy hard since the steel industry and manufacturing are relatively strongly export-oriented: almost half a million jobs were lost (Land Nordrhein-Westfalen 1996, 33). In the 1990s the federal state government pursued an active modernisation policy.

- **The future perspective** is not entirely clear since the coal and steel complex cannot be entirely replaced by a new dominant industry. The emergence of **new clusters**, such as the environmental industry, is taking place rather slowly. Among the important industries in North Rhine-Westphalia are the chemical and automotive industry as well as telecommunications and media (Braczyk/Cooke/Heidenreich, 1998; see also chapter3). However, the federal state government has embarked on newly emerging industrial and technology policies such as actively stimulating foundations.

Table 2: Phases of the transition process

Time span	overall development and indicators	milestones	policy approach
until 1970s	Perpetuation: <ul style="list-style-type: none"> • employment decrease in coal and steel industry • relatively low unemployment 	<ul style="list-style-type: none"> • 1957 and 1974 coal and steel crisis • Opel investment in Bochum 	<ul style="list-style-type: none"> • subsidies • supply-side policies • centralised policy
end 1970s – 1989	Diversification <ul style="list-style-type: none"> • new branches • growth of service sector 	<ul style="list-style-type: none"> • economic crisis of Hoesch • closure of steel plants in Rheinhausen und Hattingen 	<ul style="list-style-type: none"> • regionalisation • decentralisation • SMEs • diversification • attraction of extra-regional investment
1990 – mid 1990s	Consolidation & crisis <p>productivity growth in traditional sectors</p>	<ul style="list-style-type: none"> • mergers • world economic crisis 1992/93 	<ul style="list-style-type: none"> • umbrella projects • bundling resources • initiating networks
future	Cluster approach <p>diversified industrial structure</p>		<ul style="list-style-type: none"> • stimulating foundations • (see above)

As will be shown in the next chapter, the Ruhr area was able to achieve considerable restructuring of its economy through a step-by-step policy over a period of 30 years. This was accompanied by financial support of the national budget and the European Union (EU). The preconditions for further development and diversification of the industrial structure are laid through various measures of industrial and technology policy that mobilised endogenous resources and channelled financial funds into the region. While a clear advantage of the gradual transition was the avoidance of mass unemployment and social conflict to some extent, this has also resulted in huge costs and

financial transfers from other regions. Therefore, in this respect the Ruhr model of conserving large parts of traditional industries cannot be seen as an example for CEECs. A mixture of policies attempting both active restructuring through diversification of the industrial structure and passive restructuring of existing core industries can be acceptable if the life-cycle and the chances for international competitiveness of the latter are promising in the medium- and long-term.

2.4 Transferability of experiences to CEECs

The economic and institutional structure that characterises the economic decline of the Ruhr area and the various attempts at restructuring make it an attractive example from which insights for the reorientation of old industrial areas in CEECs can be drawn. While the Ruhr area is much larger than most regions in Central Europe it shares many decisive features with them. A range of factors are connected to the presence of heavy industries with high capital intensity in the Ruhr area as well as in old industrial areas in CEECs:

- With an industrial mono-structure hierarchical relations exist between large conglomerates and smaller dependent companies. This particular type of industrial organisation is very centralised.
- The weak administrative structure of the Ruhr area can be considered as an obstacle to coherent economic policies with adequate powers. This has parallels in the situation of CEECs, where federal structures and regional administrative levels are only emerging and local authorities have to act very differently from the way they did under socialism.
- Due to the prevailing extensive development strategy under socialism, old industrial areas in CEECs often suffer from heavy environmental burdens and related locational disadvantages which are also typical for the Ruhr area.
- Reactionary coalitions among dominant local enterprises, trade unions and the local political elite, who aim at conserving the status quo, and lobby against restructuring, as well as a lack of innovative vision are likely to be found in CEECs. Similar features in the Ruhr area have slowed down a consequent restructuring process.
- Because of a lack of external funding, many of the initiatives in the Ruhr area attempt to rely on and mobilise endogenous potentials, whenever possible integrating national and EU funding opportunities as well as private capital. This could also be a good alternative for CEECs as they possess only limited resources.

In general North Rhine-Westphalia practised an own technology policy very early. Given the complexity of interwoven problems and initiatives, it can be seen as a labo-

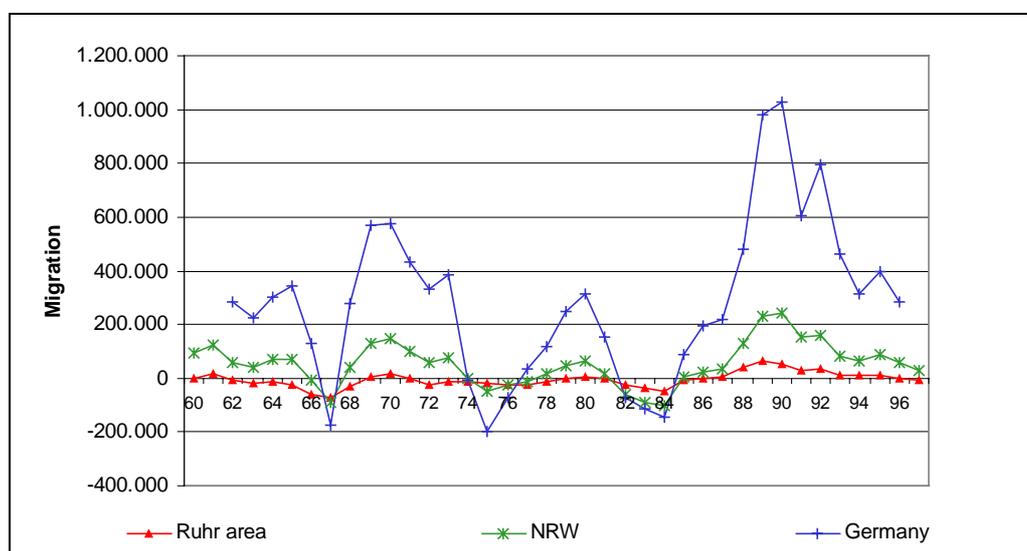
ratory of technology policy from which transferable lessons can be drawn. Due to this complexity and the vast number of instruments, the case study on the Ruhr area gives an overview and stresses individual examples which seem to be transferable to CEECs.

3 Relevant indicators

3.1 Demographic figures

The overall trend of demographic developments in Germany also holds true for North Region-Westphalia (see also Pöhls 1992). Since the early 1950s the population of North Rhine-Westphalia has increased by about 50 percent. During the early years, this development can be attributed to the relocation of Germans from former German settlements outside the Federal Republic and immigrants from the former German Democratic Republic. Especially during the 1960s foreign employees moved to the Ruhr area. In terms of intra-regional migration, the number of inhabitants in the urban agglomerations shows a negative trend in favour of the bordering communities (Pöhls 1992, 38ff).

Figure 3: Migration development



Source: KVR (1999)

Figure 3 shows that the Ruhr area does not diverge much from the overall migration trend in Germany or North Rhine-Westphalia. While positive and negative trends are experienced with less intensity in the Ruhr area, it can however be observed that the

Ruhr area accounted for a negative migration balance at times when a positive trend held for North Rhine-Westphalia and Germany as a whole, such as in the early 1970s. From this it can be said that the migration balance was not a powerful indicator of the stagnation of the region.

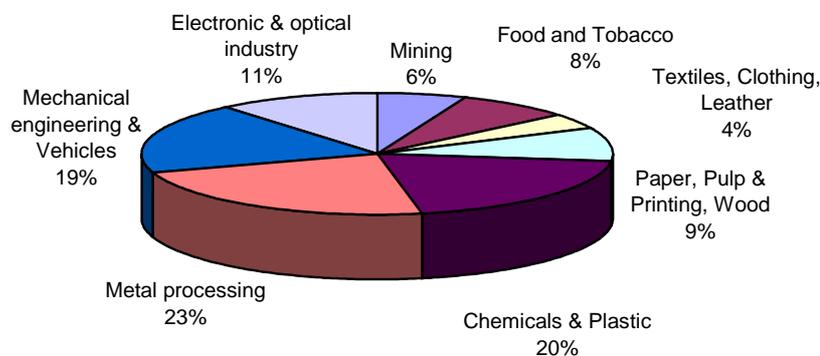
3.2 Economic and industrial structure

The economy of North Rhine-Westphalia and the Ruhr area has undergone significant changes in the last decades. By looking at different indicators, the following can be observed:

- a diversified industry structure in terms of branches
- a reduced importance of the coal and steel industry
- the emergence of new industries and first signs of new clusters
- a highly dynamic rate of firm foundations
- the growing importance of the service sector, especially since the 1980s.

Figure 4 shows a diversified **industry structure**: In 1997, the chemical and plastic producing industry, mechanical engineering and vehicles and the electronic and optical industry together accounted for 50 percent of the employment in North Rhine-Westphalia. Among these there are key sectors with high future potentials.

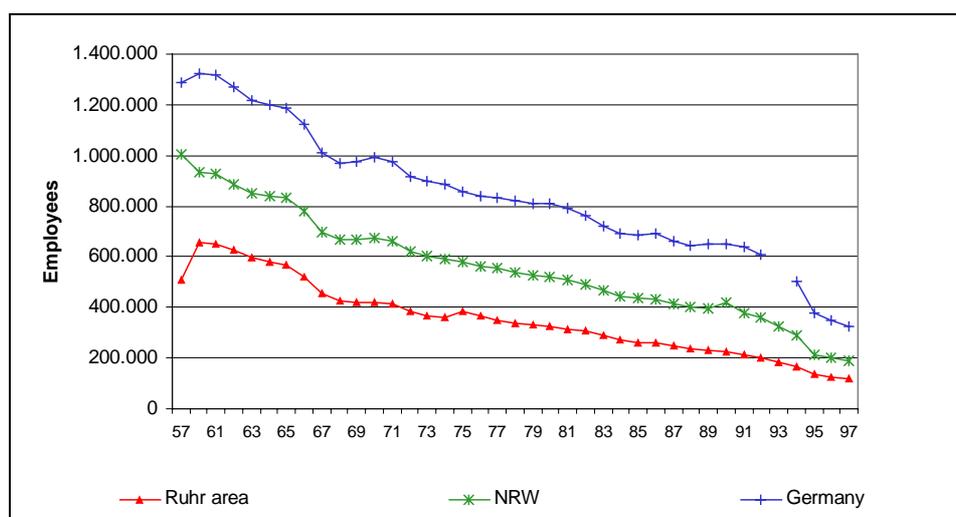
Figure 4: Industry structure in North Rhine-Westphalia (Employment 1997)



Source: LDS NRW (1999)

However, the metal processing and mining industries together still account for almost one third of the employment in the production sector of North Rhine-Westphalia. This indicates that, while the reorientation of the production structure of North Rhine-Westphalia and the Ruhr area has been successful to some extent, and NRW is now characterised by a diversified industry specialisation, the coal and steel industry has only been partially substituted. The gradual transition is also reflected by the relatively slow employment decline in the coal and steel complex.

Figure 5: Employment in the coal and steel industry



Source: KVR (1999)

Several studies on new production **clusters** in the Ruhr area and North Rhine-Westphalia point to newly emerging sectors such as environmental industry, media technology and the social care cluster (e.g. Rehfeld 1995, 92f; Heinze et al. 1998). In addition to environmental technology other new technologies are playing an increasing role for the region's economy, such as new materials, manufacturing technology, power engineering (Dege/Kerkemeyer 1993, 504). While none of these can really substitute for the dominant role of the former traditional industries, especially the environmental industry in the Ruhr area deserves more attention.

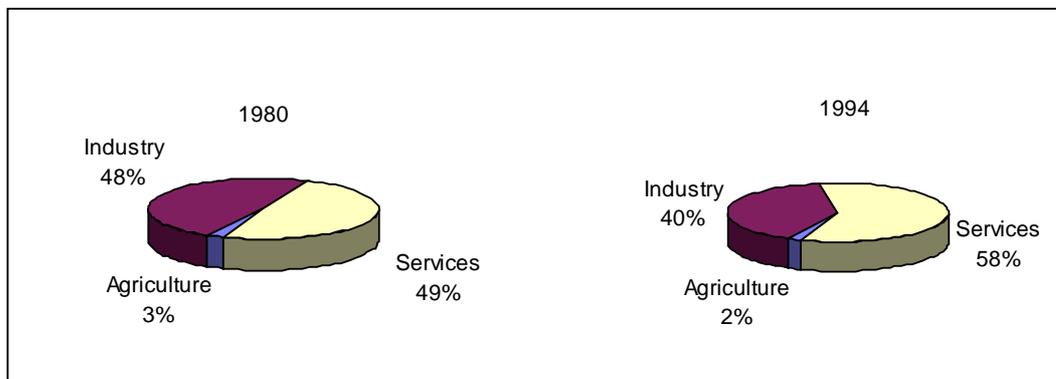
The newly emerged environmental protection cluster has gained quite high significance. The discussion about environmental damage which emerged in the 1970s led to the development of new technologies for the reduction of pollution, contamination and waste. Almost half of the German industrial investment in environmental technologies took place in North Rhine-Westphalia, mostly in the Ruhr area. In 1996 the sector employed about 90,000 people in private businesses. Interestingly, the environmental protection industry is directly inter-linked with the old coal and steel industry since large companies acted as lead-users (Heinze et al. 1998, 270f). Within the environment

protection cluster, co-operation is widespread. This reflects a successful reorientation of traditional competencies and skills in the region. However, this example only seems to be transferable to other regions under specific frame conditions. The environment protection industry in the Ruhr area depended heavily on public investment and promotion schemes as well as on national and international environmental regulation.

The dynamics of a region can also be seen by the **firm foundation rate** which can contribute significantly to the diversification of industry structure in terms of size and sectors. Between 1980-1985 and 1985-1988 the foundation of new enterprises was 41 percent in the Ruhr area and 28 percent in Germany. The share of firms going out of business amounted to 27 percent in Germany and only to 21 percent in the Ruhr area (Dege/Kerkemeyer 1993, 505). While formerly large industrial complexes prevailed, the SMEs sector played an increasing role: Two thirds of the employment in NRW is in SMEs, they also account for 80 percent of the apprenticeships offered; 4.6 mill employees are in 620,000 SMEs (Land NRW 1996, 23).

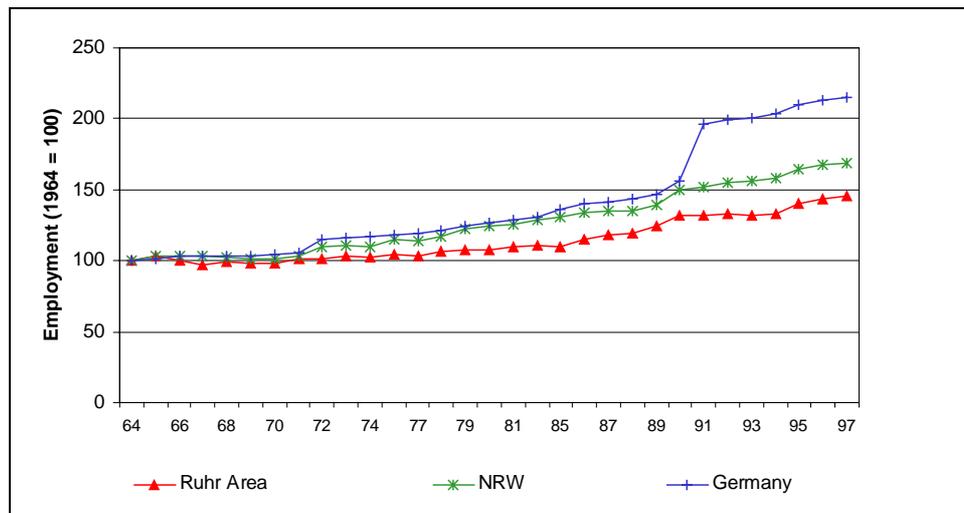
The main motor of economic development in the 1980s was – as in many other regions – the **service sector**. Also, in North Rhine-Westphalia, a clear shift can be observed from the production sector to the service sector (e.g. Heinze 1998, 263).

Figure 6: Share of sectors in North Rhine-Westphalia



Source: Braczyk/Cooke/Heidenreich (1998)

However, the development of the service sector in the Ruhr area was shown not to be as dynamic as in North Rhine-Westphalia or Germany. This indicated that the service sector depends on the underlying development of the production sector (Dege/Kerkemeyer 1993, 505ff; Butzin 1993a, 10).

Figure 7: Employment development in the service sector

Source: KVR (1999)

Hence, the composition of the service sector also shows that production-oriented services only account for a small share of total employment in the service sector, but did experience considerable growth between 1980 and 1994.

Table 3: Composition of the service sector in North Rhine-Westphalia

Service	Employees 1994	growth 1980-1994	share of total employment
Production-oriented	674,556	+49.9%	11.5%
Social	866,152	+52.7%	19.9%
Consumption-related	223,960	+18.1%	3.8%
Distributive	1,172,200	+11.9%	14.7%
Governmental	343,661	+5.5%	5.8%
Total	3280,529		55.7%

Source: Heinze et al. (1996, 46)

Looking at the federal state of North Rhine-Westphalia as a whole, a complementary specialisation between the Ruhr area and the other regions in North Rhine-Westphalia can be observed: While the Rhine area has a high concentration of higher value production oriented services, this is to a much lesser extent the case in the Ruhr area. The same trend can be seen in the development of new technologies: A lot of dynamic activities take place in the region around Aachen with its technical university and in the area of Cologne with its media cluster. In addition, local disparities hold true within the Ruhr area itself, individual cities, such as Dortmund mastered the transition process with greater success than others (Butzin 1993a, 11).

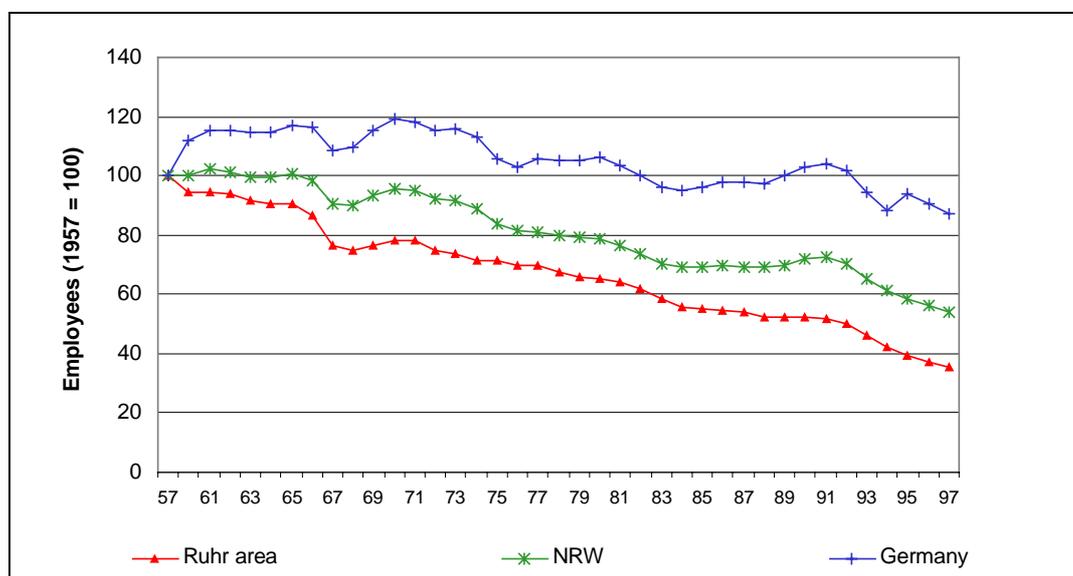
3.3 Labour market

3.3.1 Employment

In comparison to the German average, employment development in the Ruhr area is much below the average in North Rhine-Westphalia and Germany. While the employment level in the Ruhr area amounted in 1997 to only 88,6 percent of the 1964 figures, the number of jobs increased to 103 percent during the same period in North Rhine-Westphalia as a whole.

The employment level in industry shrunk much more in North Rhine-Westphalia and the Ruhr area. The decline of the coal and steel complex and the heavy employment losses in the textile industry from 220,000 employees in 1960 to 49,000 in 1993 (Heinze et al. 1996, 51) contributed to the development in North Rhine-Westphalia. However, the losses in employment since 1957 are impressive in the Ruhr area; in 1997, the employment in industry amounted to only 35 percent of the level in 1957, which was far below the average in North Rhine-Westphalia and Germany. To some extent this can be explained by the extensive use of early retirement schemes in the coal and steel complex but also by the very high unemployment rate (see chapter 3.2.3).

Figure 8: Employment development in industry

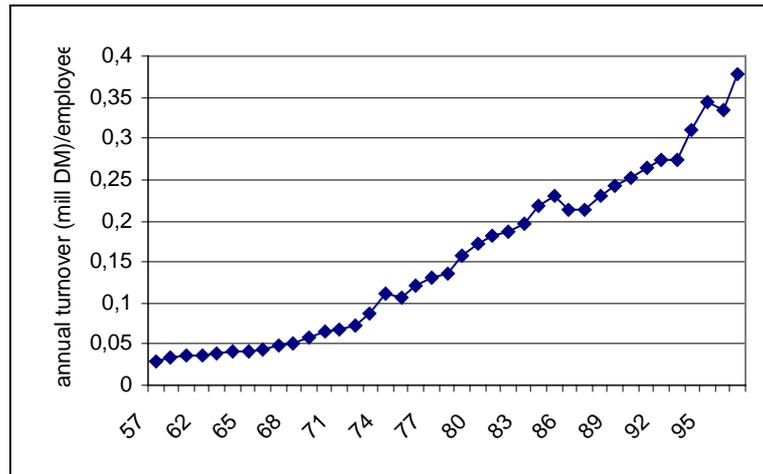


Source: KVR (1999)

This also indicates heavy rationalisation efforts, since the turnover per employee in industry rose from 28,000 DM in 1957 to 378,000 DM in 1997 in the Ruhr area while

slightly less from 29,000 DM to 343,000 in North Rhine-Westphalia during the same period (KVR 1999). Such productivity increases which are most likely due to rationalisation, took place in the transition phases during the 1970s and especially in the 1990s (see overview in table 2), as can be seen in the following figure:

Figure 9: Development of annual turnover in industry per employee in the Ruhr area

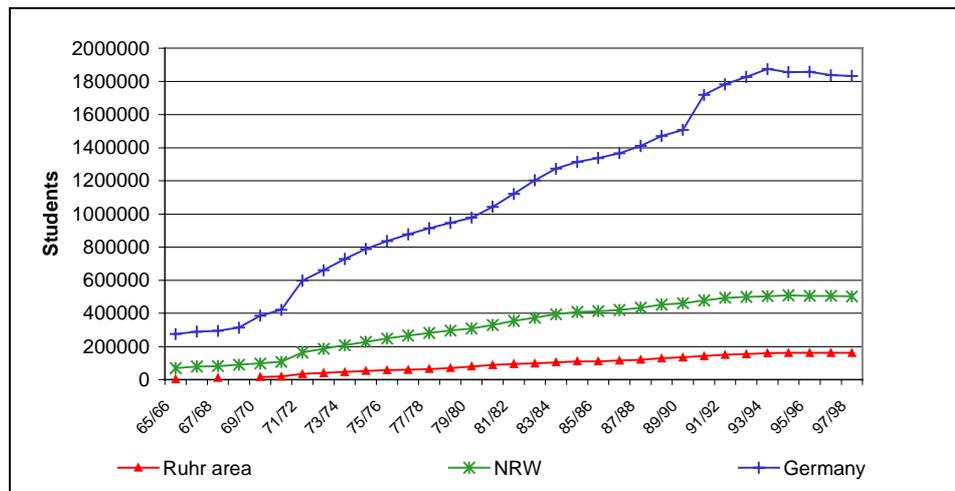


Source: KVR (1999), own calculations

3.3.2 Education and human capital

At the beginning of the coal and steel crisis, the human capital as well as the education and training system were oriented mainly towards the needs of traditional enterprises: The high qualification of skilled workers is, to a large extent, concentrated in the coal and steel complex and traditional industries (Butzin 1993b, 249).

With the foundation of higher education institutes (HEIs) since the 1970s the supply of university students has increased significantly. From 4,276 in 1965/66 their number rose to 162,427 in 1997/98 and in this way, followed the nation-wide trend of increased numbers of students, especially since the 1970s.

Figure 10: Development of students

The development of the qualification of the workforce (see table 4) also clearly shows a rise in qualification level of the workforce. This is an important prerequisite for attracting new firms into the region and also for more flexible adaptation within the region. A higher and more diversified qualification of the workforce facilitates employment in newly emerging industries and service branches but is also a prerequisite for translating R&D results in the scientific sector into industrial application.

Table 4: Qualification of the workforce

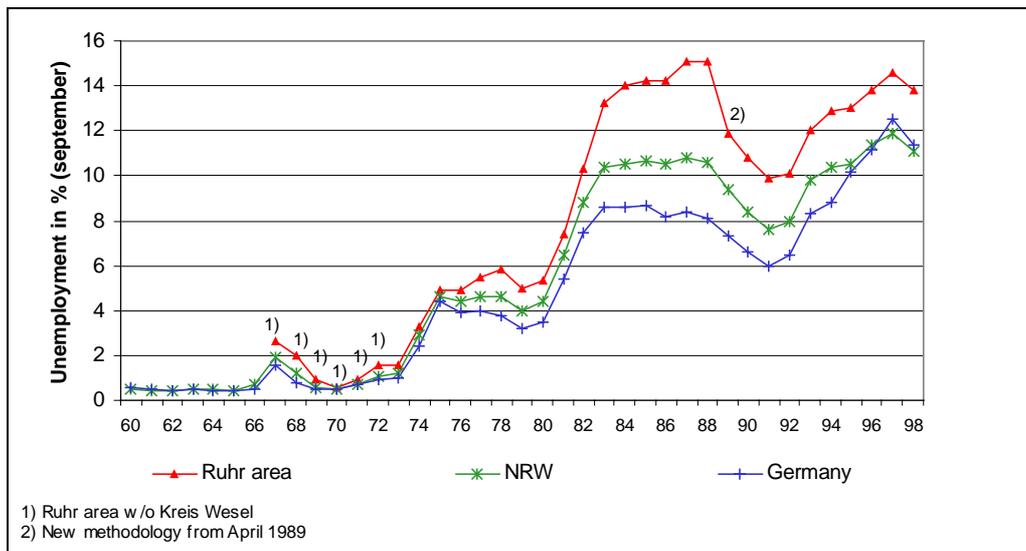
Qualification structure of the workforce	1980		1994	
	(thousand)	(%)	(thousand)	(%)
Without vocational training	1819.8	32.2	1293.1	22.0
With vocational training	3225.4	57.1	3778.9	64.1
University/polytechnic degree	221.9	3.9	378.4	6.4
No answer	381.7	6.7	436.4	7.5
Total	5648.8	100.0	5888.7	100.0

Source: Braczyk/Cooke/Heidenreich (1998)

This qualification was achieved through an active education policy in North Rhine-Westphalia (see chapter 4) and financed by federal, national and supra-national funds.

3.3.3 Unemployment

The unemployment rate in the Ruhr area clearly mirrors the economic decline and still unsolved problems of the region. The deviation from the average level in North Rhine-Westphalia and Germany becomes obvious after the steel crises in the second half of the 1970s and during the 1980s.

Figure 11: Unemployment

Source: KVR (1999)

As Dege and Kerkemeyer observe, the employment take-off in the 1980s lagged about 5 percent behind the German trend (Dege/Kerkemeyer 1993, 505). The signs of economic recovery were therefore not felt as strongly as in other German regions. This shows that the Ruhr economy in general is less flexible than other German regions.

4 The development efforts and policies in the region

4.1 Former development efforts

4.1.1 Policy action during the 80s and 90s

Public policy on various administrative levels (national, regional and local) supports industrial innovations as a driving force behind structural change of the economy. Industrial and technology policy is based on the mission of the state to secure the competitiveness of the regional or national industry, also in the medium- and long-term. Technology policy concentrates primarily on techno-scientific issues but is strongly linked to other policy areas such as industrial, sectoral and educational policy. Technology policy instruments usually consist of institutional support of R&D institutes and universities and of providing financial incentives or advisory services and R&D programmes for industry. This policy uses and mobilises available endogenous resources (Walter 1994) and also concentrates on attracting innovative firms from other

areas into the country or the region, which can stimulate the future competitiveness of the economy. In the case of the Ruhr area, technology policy can be regarded as one of the main driving forces behind structural changes.

Due to the federal structure of Germany, different administrative levels are responsible for industrial and technology policy: the national level (and the EU), the level of the federal state and regional or local initiatives.

National policies with possible influence on the Ruhr economy are in the areas of sectoral, regional and technology policy:

- National technology and research policy supports the establishment and the operation of national and possibly international research organisations, and also basic research and applied research and development in key technology fields with possible strategic importance. The target groups of national research and technology policy are limited – mainly research institutes and large enterprises with considerable in-house R&D capacities. Since R&D activities and thus absorptive capacity are under-represented in the Ruhr area, especially the region's smaller companies can only benefit from most programmes of the Federal Ministry for Research and Technology to a limited extent. Even more applied and industry oriented technology policy measures did not contribute significantly to the restructuring of the Ruhr area, but the financial means of national technology policy were channelled mainly into other federal states in Germany, such as Baden-Wuerttemberg (Hassink 1992, 85).
- Sectoral policies on the national level were mainly oriented towards traditional industries and therefore perpetuated existing structures. As a consequence, the mobility of production factors and the adaptability of the region were hindered (Schrader 1998, 452). On the other hand, supporters claim that a fundamental social crisis was thus avoided (e.g. Heinze 1998, 282). A well-known example for this policy is the "Jahrhundertvertrag", a contract which guaranteed the public demand for domestic coal (SVR 1988).
- Regional policy is – according to the fiscal constitution – a joint task of the national and federal state ("Gemeinschaftsaufgabe"). While the economic development in the Ruhr area lagged behind other German regions for many years, this was not mirrored adequately in the indicators used. Therefore, some cities in the Ruhr area only became eligible for German regional funds in the early 1980s (Hamm und Wienert 1989, 161).

Regional industrial and technology policy and initiatives by the federal state government do not necessarily require huge own financial means but can make use of available resources from outside the region (i.e. national and supra-national funds). In contrast to national industrial and technology policy, regional policy can take the specialities of the region more specifically into account and profit from its direct contacts

with industry and especially SMEs. A specific field of regional policy are action-oriented measures such as co-operation and co-ordination of resources in order to broaden the innovative basis, steering an innovative milieu and supporting innovation networks. Because of less financial means provided by regional industrial and technology policy the state is less actor and more moderater of the different groups involved. From this perspective, the role of policy has to be defined as an "interface" between various regional organisations and stakeholders (Metcalf 1994, 940ff). Public and semi-public actors can only contribute to the development of regional innovation and modernisation strategies by means of "dialogue-oriented instruments" (Braczyk/Heidenreich 1998, 438). In principle, the exchange of innovative regional concepts and the creation of an innovative milieu seems to be possible if it is achieved by training and the stimulation of contacts to initiate co-operation, regional identity, trust and an innovation-orientation (Kamann 1997, 382ff).

The position of Germany and North Rhine-Westphalia with regard to the different administrative levels of innovation, technology and also research policy developed as follows:

After World War II a process of re-structuring first took place. In particular, the research institutions were re-constructed and re-organised after 1945. Support centred on the institutional financing of basic research at universities and in other public research institutions. Industrial R&D and technology development on a regional level were not priorities.

Research and technology policy in the **1960s** attempted to close the "technology gap" that arose in relation to the USA and other industrialised nations, by carrying out large-scale research and technology programmes (e.g. coal processing, nuclear technology, aviation and space technology) in national research centres. In particular large industrial enterprises were involved in co-operation with these research centres.

Industrial and technology policy in the **1970s** was characterised by national and regional efforts towards the modernisation of industry, by promoting the development and application of strategic technologies across industry borders, e.g. the manufacturing and use of semiconductor technology and new materials. The technology policy of the late 1970s and **1980s** concentrated on the acceleration of technical change and industrial competitiveness. In addition to the generation and application of high tech, there was also support for the introduction and diffusion of new and improved products and processes, particularly in SMEs.

The policies of the federal state of North Rhine-Westphalia will be the main focus of analysis. North Rhine-Westphalia established its own technology policy by the end of the 1970s and developed it further into the **1990s**. While the federal state has a very

heterogeneous structure on the one hand, their initiatives are much more capable of being directed specifically towards particular regional problems. On the other hand regional technology and industry policy can co-ordinate financial support from outside the region. The weight of national and EU policies should not be underestimated given the sums that were provided by these for the implementation of the North Rhine-Westphalian technology policies such as the ZIM Initiative (see below). The transfer from the structural funds of the EU to the target 2 regions in North Rhine-Westphalia amounted to 500 mill DM per year during the early 1990s.

4.1.1.1 Theory based strategies

The industrial and technology policy in North Rhine-Westphalia mirrors the overall trends in political paradigms: In the 1960s and 1970s, policy makers especially in national governments believed that economic growth could be created or at least stimulated. This view was abandoned in favour of a supply side politics which among others aimed at stimulating technology transfer and strengthening SMEs (Heinze et al. 1998, 282f). However, the first phase of the economic crisis in the Ruhr area was responded by a centralised regional policy not acknowledging a real structural crisis but reacting to a temporary demand trend (Butzin 1993a).

When the shift was finally made from passive restructuring through adapting the traditional industries to changed market needs, towards active restructuring, there was a need to mobilise the potential in local industry. This had to be solved given a structural weakness of the Ruhr area: In comparison to economically more dynamic regions, firms in the Ruhr area realised fewer innovations and generally conducted less R&D. As outlined above, R&D promotion schemes funded mainly industry in regions with a more diversified industrial structure. The diffusion of new production technologies was comparatively slow in the Ruhr area and problems existed with the supply of information about markets or technologies and innovation financing.

In the 1980s the focus of technology policy in NRW was on the structural change and diversification of the sectoral specialisation of the region as well as on promoting innovation as a means to economic growth. The policy instruments applied aimed at facilitating the application and commercialisation of technological innovations.

Regionalisation and decentralisation of technology policy in North Rhine-Westphalia towards a more bottom-up approach was initiated by the "Ruhrkonferenz" in 1979. It was the first initiative that tried to discuss political objectives and options with regional stakeholders such as unions, companies and political groups.

The implications of network theory and the innovative milieu approach seem to be especially important for analysing and contributing to the solution of the structural

sclerosis of the Ruhr area (e.g. Grabher 1993; Butzin 1993a and 1993b). As described earlier, the success of the Ruhr economy was founded on the paradigm of mass production with the prerequisites of flexible specialisation being almost non-existent – such as a highly qualified local labour force, smaller units, strong co-operation between companies, collective learning processes, access to external knowledge through national and international partners and other industries and research institutes. Instead, the Ruhr area is characterised by a hierarchical and closed network which needs to be restructured. Furthermore, for a long time the traditional industries in the region hindered the entrance of companies from other sectors to the Ruhr area and the local labour market (Butzin 1993a).

The economic sclerosis of the Ruhr area has two dimensions which are related to the dominant production structure on the one hand, and to the mental model of the local actors on the other. First, against the background of the success stories of other European and North-American regions (e.g. Saxenian 1994; Pyke/Sengenberger 1992), flexible production is more able to adapt to structural changes and innovation. Prosperous regions are characterised by co-operative linkages between the actors in the region and across regions. If companies have to enter new markets with new products they link up with new production clusters. Therefore, the production structure dominated by coal mining and steel production of the Ruhr area can be seen as a problem which prevented flexible restructuring until the 1980s.

The second aspect is less tangible and refers to the regional identity and shared vision of the actors. The long dominance of the coal and steel complex, which was associated with a specific social texture, privileges and strong regional identity, almost excludes other development paths. This can help to explain the perpetuation of traditional industries and hesitant attempts at a profound restructuring in the early years of crisis. Modern technologies and a flexible production structure require a different kind of social and economic exchange relations. In order to constitute such a creative milieu by turning a stagnating local milieu into a creative and innovative environment, several factors seem to be important to (Butzin 1993b, 249ff): education and a qualified workforce, cultural and social aspects, business- or production related services, regional co-operation and co-ordination, international networking.

Successful transformation of production systems for instance highlight the importance of promoters of regional economic development, such as consultancy services, transfer agencies, regional development agencies, educational and training institutions (e.g. Heidenreich/Krauss 1998; Alcouffe/Kephaliacos 1998; Cooke 1998). Technology and industry policy in North Rhine-Westphalia therefore rather has a bottom-up approach. Public institutions responsible for regional technology and innovation policy are less

actors than moderators between different interest groups. In such a role personal contacts and advantages resulting from social proximity are important. This type of policy is more action-based with integrated feedback mechanisms. Actor-based feedback regional technology and innovation policy, as described here for North-Rhine Westphalia successfully integrates cultural and social factors, and is rather flexible.

4.1.1.2 Applied policy instruments

The applied policy instruments of the federal state North Rhine-Westphalia belong to several categories spanning from a selected institutional funding of regional R&D institutes on special purposes, to financial incentives for industrial innovations, to technology transfer infrastructure and education. Different initiatives of North Rhine-Westphalia are shown in the following table 5.

Table 5: Political initiatives to restructure the Ruhr area

Time period	Technology policy measures	Main aims and impacts
Industry and Technology policy		
Mid 1970s – 1984	Technology programme for coal mining and energy	<ul style="list-style-type: none"> • orientation towards traditional industries • no diversification of production structure
1978 – present	Technology Programme for the Economy (TPW)	<ul style="list-style-type: none"> • financial incentives focussed on SMEs • advisory services
1984 – present	North Rhine-Westphalia Initiative for Future Technologies	<ul style="list-style-type: none"> • promotion of innovations in modern technologies, especially environment • promotion of technology transfer • promotion of socially acceptable technologies • further development of the TPW of 1978
since 1987 – 1991	Initiative for the Future of the Coal and Steel Region (ZIM) Initiative for the Future of the Regions of NRW (ZIN)	<ul style="list-style-type: none"> • new approach • integration of different funding institutions: EU, national, NRW • bottom-up approach • action fields
Stimulating measures		
1968 – 1973	Development Programme Ruhr	<ul style="list-style-type: none"> • education, training • traffic infrastructure
1970 – 1975 1979 – 1984	North Rhine-Westphalia Programme Action Programme Ruhr	infrastructure: <ul style="list-style-type: none"> • foundation of HEIs • establishment of area development fund • support of training and qualification
1988 – 1999	International Housing Exhibition Emscherpark	<ul style="list-style-type: none"> • conversion of polluted areas • other
since 1995	Foundation initiative NRW	<ul style="list-style-type: none"> • improving industrial structure • acceleration of the technological and economic development

Technology infrastructure		
since 1920/1979	"Kommunalverband Ruhrgebiet"	<ul style="list-style-type: none"> • service and public relations function • co-operation among local authorities in the Ruhr area
since 1984	local economic policy	<ul style="list-style-type: none"> • fostering inward investment • support of SMEs • foundation of technology centres
since 1985	technology transfer network	<ul style="list-style-type: none"> • technology transfer office at the universities, chambers of commerce, trade unions • regional fund ("Strukturhilfefonds") • foundation of the tbr agency (counsel, intermediation, administration) • foundation of ZENIT (advice, joint development, marketing support, administration) • foundation of technology centres

Source: based on Hassink (1992); Nocken (1992); Heinze et al. (1996)

Since the end of the 1970s and beginning of the 1980s technology and industry policy has been seen as a key element of restructuring of the North Rhine-Westphalian industrial structure (Kilper 1992, 160). Therefore, the "Technology Programme for the Economy" (Höhnscheid 1980) marked the beginning of the regional technology policy, its elements were: financing of innovation activities, especially in SMEs, and the provision of information and consultancy. The funding and promotion of R&D projects included pilot production and market penetration. Some of these sub-programmes are still in operation today in the further developed Technology Programme (BMBF/BMWi 1999), although modified according to EU regulations (e.g. the support of production and market penetration is no longer allowed). Besides support of firms, institutional promotion of the establishment of new institutes and the re-orientation of existing organisations also continues to be supported. The programme aimed at changes in individual patterns of behaviour in order to improve the existing industrial structure.

Mainly regional policies are used to mobilise regional endogenous potentials. Therefore, policy tries to motivate firms located in North-Rhine Westphalia, which have so far not been innovative, to engage in appropriate activities, e.g. by influencing the interactions of formal and informal mechanisms of innovation-related activities. It was assumed that providing enterprises with information and knowledge would create a sufficient awareness of innovations among the firms' decision-makers. Public supported specific technology and innovation consultancy should clarify the risks associated with innovations for the firm and make it easier for them to deal with innovation (Meyer-Krahmer et al. 1984). Today these kind of consultancy services are still part of innovation supporting programmes in North Rhine-Westphalia (BMBF/BMWi 1999). These activities of the 1970s can be seen as the starting point for building up the innovation service networks which exist today.

From 1978 until the present, the Technology Programme of North Rhine-Westphalia provided financial support through subsidies to motivate enterprises to enlarge their already existing innovation activities. But this financial means is only used for a specific target, e.g. to finance research work in fields of specific needs of North-Rhine Westphalia (in the 1970s in machine construction, electronics, plastic and today in energy saving and mining) and which are not properly covered by federal German or EU-programmes.

The Technology Programme of 1978 was further developed and adapted to emerging needs, e.g. by the "NRW Initiative for Future Technologies", which was introduced in 1984. This initiative aimed at integrating the policies of different regional ministries, namely the bundling of technology, research and economic policy as well as environmental policies and socio-economic aspects. It consisted of four different sub-programmes (Kilper 1992, 162):

- The "Technology Programme for Future Technologies" was to promote innovations by the Ministry for Economic Affairs, SMEs and Technology in eight dedicated technology areas
- The Ministry for Labour, Health and Social affairs was responsible for the sub-programme "Socially Acceptable Technologies"
- The promotion of technology transfer to SMEs by the agency ZENIT (Zentrum für Innovation und Technik) under the auspices of the Ministry for Economic Affairs
- The promotion of dedicated technology fields through the Ministry of Science and Research.

Despite its innovative and ambitious character, the programme "NRW Initiative for future technologies" could only partly realise integrated action of different ministries, with at times even contradictory promotion philosophies and traditional clientele. After characterising the first technology policy initiatives in North Rhine-Westphalia, recent policy measures and the technological infrastructure are described in detail in chapter 4.2.

The following table gives an overview of the budget of the above described programmes.

Table 6: Overview of past industrial and technology programmes of North Rhine-Westphalia

Time period	Programme	Budget
1968-1973	Entwicklungsprogramm Ruhr	ca. 17 bill. DM
1970-1975	Nordrhein-Westfalen-Programm	ca. 31 bill. DM
1974-1984	Technologieprogramm Bergbau	ca. 0,6 bill. DM
1974-1984	Technologieprogramm Energie	ca. 1,6 bill. DM
seit 1978	Technologieprogramm Wirtschaft	1978-1984 ca. 0,35 bill. DM
1979-1989	Technologieprogramm Stahl	ca. 0,5 bill. DM
1980-1984	Aktionsprogramm Ruhr	ca. 7 bill. DM
1987	Zukunftsinitiative Montanregionen Zukunftsinitiative für Regionen NRW's Landesinvestitionsprogramm	
1992-1995	Handlungsrahmen Kohlegebiete	ca. 1 bill. DM
1994-1997	Gemeinschaftsaktion Industriestandort NRW	ca. 2 bill. DM

Source: Heinze et al. (1996)

4.1.1.3 Key institutions and actors

Due to the fiscal powers of the German federal states, one key actor is the government of North Rhine-Westphalia. While there may be political debate about the financial contributions of the national and federal state level (see e.g. Nocken 1992), the policy programmes designed by the federal state government (sometimes together with programmes of the EU) have had the most impact on the development of the Ruhr area and North Rhine-Westphalia as a whole. Within in the decentralised approach which the federal government has pursued since the early 1980s, networks of different actors on the regional and local level have emerged in the Ruhr Area. One example is the ZENIT agency which acts as an important node in the technology transfer network of North Rhine-Westphalia (see chapter 4.2.1.4). Due to the large size of the Ruhr areas and the range of different initiatives within the regional industrial and technology policy, not all key actors can be named here. For instance, cities with their local organisations for the promotion of economic and technological development as well as universities and co-operations between these actors play an important role.

This polycentric picture stems partly also from the administrative peculiarities of the Ruhr area which have already been mentioned: The Ruhr area is divided into three different administrative areas and the "Kommunalverband Ruhr" only has limited political power. There is therefore not one strong actor who can lobby with "one voice" on behalf of the area's interests, rather the policies of the federal government are formulated outside the Ruhr area. Furthermore, a certain competition between different

Ruhr cities and their key actors exists (Hassink 1992, 84), which can hinder co-operation and co-ordination between different networks and network partners.

4.2 Current development efforts

4.2.1 Current (regional) development strategies and policy efforts

4.2.1.1 Introduction

Since 1990 much attention has been shifted away from the restructuring of the Ruhr area towards the former German Democratic Republic, in terms of public financial means and private investment. Also, while North Rhine-Westphalia has for a long time been a recipient country of the federal transfer scheme, it now becomes a contributor. However, North Rhine-Westphalia continues its own policy approach towards restructuring of the region. It has developed a broad based and diversified research sector (MSWWF 1999) with different organisations which contribute to industrial R&D and innovation according to their specific capability and orientation. As providers of qualified human capital and as partners in R&D co-operation, the education and scientific infrastructure plays an important role, as will be explained in the following.

4.2.1.2 Education, qualification and R&D

Academic education and qualification

The federal state North Rhine-Westphalia has 52 higher education institutions (universities, technical universities, polytechnics) with 501,000 students enrolled in 1998/99 (MSWWF 1999). The rise in numbers of university students in the Ruhr area has already been shown in chapter 3.

This density of higher education opportunities has been achieved by an active expansion of the higher education system since the 1960s. During the 1950s there were four universities in North Rhine-Westphalia: Bonn, Cologne, Münster, Aachen, none of them located in the Ruhr area. In the 1960s ten universities were founded, in addition to eleven polytechnics. Among these were the universities in Bochum, Dortmund, Duisburg and Essen. The polytechnics evolved from former engineering schools, academies and other higher education schools.

While the foundation of the universities was also motivated by the need for highly qualified personnel, in comparison to other industrialised countries and the political ideology to open university education for all social classes, many hopes were also di-

rected towards a possible contribution of the universities to the restructuring of the Ruhr area.

Table 7: List of higher education institutes in NRW

before 1945	Universities of Bonn, Köln, Münster and Technical University Aachen
1961	Ruhr University Bochum
1962	University Dortmund
1965	University Düsseldorf
1967	University Bielefeld
1971	11 Polytechnics
1972	"Gesamtochschulen"/Universities Duisburg, Essen, Paderborn, Siegen and Wuppertal (mix between universities and polytechnics)
1974	Distance University Hagen

Source: NRW-Lexikon (1996)

Further education and training

Unlike the higher education which is the responsibility of the federal state NRW, regional training and qualification activities are mostly characterised by institutional diversity, which are partly financially supported by the Federal Labour Office (Bosch 1995, 128f; see also the chapter on labour market policies):

- Initial vocational training within the dual system.
- General further education offered by adult education centres, private providers and other institutions is financed to a large extent by participants themselves.
- Further vocational training is largely financed by companies. The Federal Labour Office provides subsidies, especially for the training of unskilled and semi-skilled workers or newly hired workers.
- Further training for the unemployed (or those threatened by unemployment) is financed by the Federal Labour Office and the EU. Private providers such as chambers of commerce and industry, trade union centres and firms provide this training.
- Vocational training for those not in employment without prior contributions to the Federal Labour Office is financed by those individuals.

Research and development

North Rhine-Westphalia has a dense R&D landscape which comprises:

- three **national research centres** (German Aerospace Research Establishment, Cologne, Forschungszentrum Jülich, GMD National Research Centre for Information Technology, St. Augustin). The national research centres (Großforschungseinrichtungen) perform R&D which cannot be carried out either by universities or by industry. This includes in particular activities with a long-term orientation which appear to have a high degree of risk, require relatively large research teams and incur high costs. The national research centres typically perform research which requires very large scale equipment. Co-operation with industry takes place in basic research by joint R&D projects with large enterprises or through mixed teams
- six institutes of the **Fraunhofer Society (FhG)**. Their task is to promote the practical application of scientific knowledge in high-tech fields through long-term application-oriented, applied research and pre-competitive R&D. Besides public funded projects, the FhG mainly performs contract research which is financed by industry. FhG regards itself as the "intermediary" organisation between science and industry, since their directors simultaneously hold university positions in the field of advanced technologies. Co-operation with industry takes place in applied research and development by joint R&D projects (pre-competitive R&D), mainly with larger enterprises or through contract research for medium sized firms in high tech fields. This contract R&D intends to complement the internal resources of the firm and contribute to the solution of specific problems. In this form of co-operation, the FhG works on limited tasks, on the basis of a problem definition provided by the enterprise. The results of this work are usually integrated into the firm's innovation activities by its own management. Co-operations of FhG with smaller firms and the regional serving of industry requires special activities and support.
- eleven research institutes of the Max-Planck-Society. The institutes of the **Max Planck Society** mainly perform basic research in selected new fields of natural and social sciences. They concentrate on new research topics of potential future importance for industry or the whole of society which have either not yet found an established place at university institutes, or - because of their interdisciplinary character or the resources they require - cannot find a place there. Co-operation with industry takes place in basic research by joint R&D projects with large enterprises or through mixed teams.
- several research institutes in the field of biotechnology have been founded and a new initiative started for the funding of research and application agencies (e.g., "Forschungs- und Verwertungsgesellschaft" at the Ruhr University Bochum) which aims at the facilitation of timely commercial application of innovations.

- additionally, a high number of independent research institutes, which are mostly located in universities, aim to co-ordinate the research done at universities and research activities occurring outside the higher education sector. As **universities** deal with complex research topics, co-operation with industry usually takes place by joint R&D projects (e.g. with large enterprises) or through affiliated institutes ("An"-Institute), in this case possibly also with smaller (regional) firms. Projects range from an agreed exchange of results to a combination of project activities done by mixed teams consisting of industrial and university researchers in a common laboratory. The affiliation with universities secures networking with basic research and access to the international scientific community; a practical orientation is ensured by industrial "carriers" of the institutes or organisational conditions such as mixed teams. The co-operation between affiliated university institutes and industry has been explicitly encouraged since the change of university regulation in the late 1980s. Since then the privately funded research at such institutes has increased significantly (e.g. Morlok 1992, 406f).
- **Polytechnics** perform education and experimental development for specific problems which is oriented towards the short and medium terms. The main emphasis of the work of polytechnics is not so much on research, but of the day-to-day entrepreneurial R&D business of SMEs. In doing so they specifically meet the needs of the smaller industrial enterprises. Co-operation with industry takes place mainly in smaller development projects for (regional) SMEs in their daily development efforts for realising (incremental) innovation for a wide range of conventional and sophisticated conventional technologies. Besides in small development projects, polytechnics are usually very experienced in the field of consultancy. Due to their being well known as qualified educational entities and for supplying services oriented towards SMEs (consulting, further training, contract development, expertise) their fields of activities are wide, especially within their regions.

Furthermore, North Rhine-Westphalia embarks on modern trends and best practices in innovation policy, e.g. by actively stimulating foundations of new businesses and supporting innovation-oriented networks: The "Gründungsoffensive NRW" (foundation initiative) was started by the federal state government as well as chambers of industry and commerce, local agencies for promoting the economy, technology centres and universities in 1995 (Land NRW 1996, 24).

4.2.1.3 Basic infrastructure

Besides institutions of higher education and practical training, other locational factors play an important role for structural change. An important precondition not only for the attraction of new firms into the region but also for the growth of regional firms are attractive business sites with an adequate infrastructure, which comprises for example:

traffic connections and services such as financial institutions willing to finance innovations, and economic promotion agencies.

The low quality of business sites hindered the diversification of the industrial structure and attraction of new industries to the region for a long time. In the 1960s, a shortage of free space and the contamination of soil contributed to little investment from other industries, since the coal and steel industries did not sell space due to the fear of competition for highly skilled personnel on the labour market (Butzin 1993b, 245). For example: while the direct investments from the region abroad amounted to 21.8 bill DM in 1980 and to 76.1 bill DM in 1994, the inflow of capital was much less dynamic with 17.6 bill DM in 1980 and 54.6 bill DM in 1994, however, a strong improvement can be observed (Braczyk/Cooke/Heidenreich 1998).

The "Grundstücksfonds" was founded as an important instrument of sustainable urban planning whose task was the conversion of old industrial sites (MSKS 1998). These are revitalised in order to provide attractive business sites for a diversified industrial and service structure, housing areas, cultural and recreation zones in the agglomeration area, conservation of cultural heritage of the region and also technology centres (see chapter 4.2.1.4). The activities of the area fund are supported by a variety of different programmes and funds mostly from the federal state of North Rhine-Westphalia and structural funds of the EU. In addition, funds were generated by the selling of space. In the past, private investors could often be attracted to the objects revitalised by the "Grundstücksfonds".

In the case of financing start-ups and innovations, technology policy used existing structures to a large extent. Within the finance sector especially Sparkassen, which are partly owned by the cities and districts and serve large numbers of smaller businesses and private customers locally or regionally, became very involved in innovation financing in the Ruhr area. They have good connections with regional actors (e.g. local administration, economic promotion agencies, chambers of industry commerce and of craft, industrial associations). At the beginning of the 1980s some of the Sparkassen started innovation financing schemes for small technology companies and new technology based firms, in parallel with the Technology Programme. On the one hand the banks' decision to grant a credit depends on the economic situation of companies or the founder of a new firm. Handling these activities is part of the core business of credit institutes. On the other hand a new product or a process to be developed have to be principally convincing and practicable. There must also be a market for a foreseeable period of time. Regional R&D institutes can provide technological expertise to banks in order to evaluate innovation projects. In many cases, a strong network between local actors integrating the technical expertise of universities, polytechnics and from qualified consultants and local banks could emerge.

4.2.1.4 Support for the regional technology and innovation infrastructure

Regional technology and innovation policy could also improve regional conditions for innovation by equipping the region with R&D institutions. North Rhine-Westphalia actively encouraged the establishment of R&D institutes in the area by providing favourable conditions especially for the foundation and early phases.

Another way of improving innovation conditions is to increase the opportunities for contacts and exchanges between R&D institutions and industry through technology transfer (e.g. through joint research, licensing, innovations consultancy by scientists, personal transfer and vocational training or creation of opportunities for industry to make use of scientific apparatus and equipment at low cost). The Ruhr-University Bochum was the first university in Germany that started such technology transfer activities as a pilot project already in the early 1970s (ISI 1977). **Technology transfer units** at universities, chambers of commerce and trade unions have been being actively established since 1976. Today this network covers all regions in North Rhine-Westphalia (see figure 112). In 1993, the federal government provided 72 positions and 1 mill DM for expenses per annum. An additional programme to finance individual projects was financed with 0.5 and 0.75 mill DM in 1991 and 1992 (MWF 1993, 40)

Figure 12: Technology transfer in North Rhine-Westphalia



Source: MWF (1993, 39)

Today opportunities for contact and co-operation with R&D institutions in North Rhine-Westphalia are offered by a whole network of advisory and information centres of autonomous industrial organisations, industrial associations, etc. The access to advice and information that is demand-oriented, specifically suited to regional target groups and adapted to their requirements is particularly important for innovative SMEs. This **international linking of R&D and innovation** is supported by the use of world wide information and know-how concerning new technology by specialised regional agencies and providing firms with access to national or international databases or innovation financing opportunities. Important for this international linking is also the making of knowledge and experiences, e.g. of regional basic research, available world-wide, at no or low cost to the user, even if this causes external costs and necessitates basic research for the region. Especially in high-tech oriented international ex-

change it is necessary for a country or a region to take part in this competition as a qualified international player of technology and to be accepted in communication within the scientific community.

As an example of such an organisation specialised in new technologies and innovation the "Zentrum für Innovation und Technik" (**ZENIT**) is discussed as an important element of an innovation oriented network node.

The ZENIT is an initiative of the federal state, it was implemented in the context of the NRW Initiative for future technologies in 1984. The centre plays an important role in co-ordinating technology policy efforts in North Rhine-Westphalia. Its tasks are:

- advising the Ministry for Economic Affairs and Technology
- implementation of federal and EU programmes
- stimulation of innovation in SMEs by counselling and information
- advising of SMEs and mediating between firms and research centres
- joint R&D projects and providing marketing and management support for SMEs
- providing financial and funding advice for SMEs and new technology-based firms
- providing qualification measures for industrial and service firms.

Most client companies of ZENIT are very small, i.e. with less than 100 employees, and companies from the traditional sectors underrepresented. The major share of income is provided by the state (at the beginning of the 1990s 20 percent; Hassink 1992, 95). ZENIT is an important node of the innovation network in North Rhine-Westphalia. ZENIT also operates as an agency on behalf of the EU.

Another possibility for supporting innovative SMEs and new firms are incubators. **Technology centres** can be seen as an integral part of the technology promotion of the federal state NRW. By 1996 52 technology centres had been established which have received more than 1 billion DM since 1984 (Elle et al. 1997, 17). In the early 1980s the first centres were established in Aachen, Dortmund and Duisburg in order to make the potential located in universities and R&D institutes broadly available (e.g. Michel 1991, 3f). Since then, the foundation of technology centres has also been extended to other university locations, industrial locations and rural areas. While the technology centres are mostly connected with the federal government during their start-up phase, the local actors who run the centres are highly autonomous in order to realise a flexible management style. These are mostly the local community, local banks and traditional enterprises. Most centres do not only provide space but a wide variety of services including IT-infrastructure and consultancy. In addition to the construction expenses most technology centres require – in relation to the services offered – between 2 and 8 percent of their operating expenses subsidised (Elle et al. 1997).

4.2.1.5 Labour market policies and vocational training

In Germany, labour market policies of the central government are usually implemented by the local authorities. Among the labour market policies relevant to North Rhine-Westphalia are the following (Land NRW 1992 and 1996); they incorporate measures of qualification, financing employment especially of long-term unemployed persons, and integration into the labour market, e.g. through self-employment:

- Employment creation measures under the 1969 law to promote employment: By 1992 48 job creation programmes in NRW have been founded by this programme.
- In accordance with the federal law on social welfare the NRW programme "Arbeit statt Sozialhilfe" created 2400 jobs (by 1992) with wages paid by the federal state.
- The federal government started a programme for employment aid for the long-term unemployed in June 1989.
- Re-training courses which are financed in co-operation with the EU are offered for disadvantaged long-term unemployed people (e.g. young people and women returners).

In addition, the federal state executes various own initiatives which are financed by its own budget (Davies 1995, 146; Land NRW 1992). Some of these have already been mentioned in the context of technology policy but also include labour market instruments:

- The special labour market programme of 1990 received funding from the EU Structural Funds under Objective 3 and 4 and from the federal state budget.
- The promotion of social measures aimed at structural change in the Objective 2 regions of NRW includes retraining for people threatened by unemployment (especially due to cuts in the coal and steel industry), unemployed and – as a special sub-programme "Qualifizierung für den Mittelstand" – training for employees in SMEs.
- The "Zukunftsinitiative Montanregion" and "Zukunftsinitiative für die Regionen NRW" (ZIM/ZIN, initiative for the future of the coal and steel regions and for the regions of NRW) also aim at upgrading training opportunities. ZIM financed equipment and facilities in vocational schools and in industrial training centres.

4.2.2 Key projects

In the following, two key projects will be presented: The ZIM/ZIN initiative and the International Housing Exhibition "Emscherpark". Both initiatives share important characteristics with the technology policy approach in North Rhine-Westphalia since the early 1990s. These include a decentralised planning mechanism in order to stimulate bottom-up project generation, bundling of financial resources from different ori-

gins and the attempt to realise co-operation between different actors such as usually independently acting ministries. Both aim not only at the restructuring of the industry through technology policy measures but also aim at transforming the wider environment for innovation and improving the "soft" locational factors of the Ruhr area.

The once again aggravating economic crisis of the coal and steel industry in the 1980s led to the foundation of the "**Zukunftsinitiative Montanregion**" (ZIM). Two years later, the aims of ZIM were extended to all regions in NRW in the "**Zukunftsinitiative für die Regionen Nordrhein-Westfalens**" (ZIN). The initiatives were not new public programmes but intended to frame existing structural policies of the federal state, the national level and the EU.

ZIM was implemented in 1987 for 4 years with an annual budget from the federal state of 293.3 million DM. The action fields of the programme comprised the promotion of innovation and technologies, support for future-oriented promotion of workers' qualification, improvement of infrastructure, improvement of the environmental and energy situation (Kilper 1992, 165).

The innovative character of ZIM was the decentralised approach. Unlike other programmes that are planned by ministries, the projects of ZIM were realised locally on the basis of a consensus between enterprises, trade unions, communities and local administration, chambers of industry, trade and crafts and other organisations. The underlying idea was to establish a social consensus about structural change. The projects were evaluated and decided upon by an interministerial committee of the federal state (Nocken 1992). Within the ZIM initiatives, about 1,200 project proposals were submitted of which about 260 received priority. However, almost 95 percent of these projects were carried out under the leading role of public actors, most of them being infrastructure projects. In 1989, the concept of ZIM was applied to all regions in NRW within the "Zukunftsinitiative der Regionen des Landes Nordrhein-Westfalen" (ZIN) which received 1.1 bill DM funding.

The core idea of the initiatives were the regional conferences in the 15 participating regions. These regional conferences aimed at formulating, on the basis of a regional strength and weakness profile, development strategies. The participants of the regional conferences could be chosen by the local interest groups themselves. The Government of North Rhine-Westphalia encouraged action strategies in the fields of:

- innovation and technology
- qualification of employees
- creation and securing of jobs
- extension and modernisation of infrastructure
- improvement of environment and energy situation.

The vote of the regional conferences served as recommendations for federal structural and technology policy.

One recent key project that aimed at the social and ecological rejuvenation of the old industrial area is the **International Housing Exhibition** ("Internationale Bauausstellung Emscherpark", IBA). The IBA was initiated by the federal state government and the 17 cities of the Ruhr area, it comprises 800 km² of the "Emscherregion" which seems to be one of the least favoured structured regions. The aim of the IBA was to incorporate a wide range of local development projects that aimed at (Land NRW 1996, 31f):

- improvement of the housing situation
- promotion of ecologically sustainable production
- creation of technology centres
- conversion and re-use of old industrial sites as part of the cultural heritage of the Ruhr area.

Thus the IBA included ecological, economic and social goals in the restructuring of the old industrial region. It was structured in seven main projects.

According to the regionalisation approach in NRW politics, the projects within the IBA were in the decentralised responsibility of the project consortia, mostly local communities and enterprises. The co-ordination was performed by the agency "IBA Emscherpark GmbH". While the federal government did not establish a dedicated promotion scheme, projects of the IBA have priority in other public programmes. In total, resources from 36 public promotion schemes could be bundled in order to finance 91 projects. Up to 1994 public promotion amounting to 1.8 bill DM was handed out, from a total sum of required public support of 2.5 bill DM, at the same time 0.8 bill DM of private capital had been mobilised (Gaedtke 1995). The IBA is considered to be a successful initiative as it could mobilise management experience and funding across different ministries and actors.

4.3 The role of the regional infrastructure

4.3.1 Regional research & development infrastructure

The research landscape and the role of the various actors in their collaboration with industry and their support of industrial innovation have been described in detail in chapter 4.2. The successes in building up the R&D infrastructure which contributed to the restructuring of the old industrial area have already been outlined. In the following

only some remarks and two examples of the functioning of the R&D infrastructure will be given.

The relatively well developed R&D infrastructure of the Ruhr area seems not related enough to industrial innovations. This difficulty in linking up the regional technological infrastructure – universities, polytechnics and R&D institutes – is especially visible in the structurally weakest sub-zone of the Ruhr area in which very little innovation-orientation in industry occurs: the Emscher-Lippe zone (Feldotto1997). Taking into account the excellence of the R&D institutions and universities, their impact seems rather low (Hassink 1992, 104). This is also confirmed by patent analysis (Grupp/Blind 1999).

Additional evidence is provided when looking at the share of R&D expenditure of gross domestic product and the distribution of expenses between private and public sectors: North Rhine-Westphalia as a whole lags behind many other German regions in terms of R&D expenditure as a percentage of GDP of the region. In terms of industry share of R&D, North Rhine-Westphalia is about the German average.

Table 8: R&D expenditure by actor

Regions	R&D expenditures as % of the Gross Domestic Product			Distribution of R&D expenditures by executive agents			
	Total	Public sector	HEIs	Private sector	Public sector	HEIs	Private sector
Germany	2.43	0.37	0.44	1.62	0,15	0,18	0,67
Saarland	0.94	0.15	0.53	0.25	0,16	0,56	0,27
Schleswig-Holstein	1.32	0.35	0.40	0.58	0,27	0,30	0,44
Mecklenburg-Vorpommern	1.36	0.55	0.61	0.20	0,40	0,45	0,15
Brandenburg	1.57	0.78	0.21	0.59	0,50	0,13	0,38
Sachsen-Anhalt	1.61	0.34	0.66	0.61	0,21	0,41	0,38
Niedersachsen	1.70	0.34	0.40	0.95	0,20	0,24	0,56
Hamburg	1.77	0.42	0.43	0.92	0,24	0,24	0,52
Tübingen	1.78	0.41	0.71	0.66	0,23	0,40	0,37
Nordrhein-Westfalen	1.90	0.29	0.38	1.23	0,15	0,20	0,65
Rheinland-Pfalz	1.94	0.13	0.36	1.46	0,07	0,19	0,75
Madrid	2.07	0.69	0.27	1.11	0,33	0,13	0,54
Hessen	2.16	0.15	0.31	1.69	0,07	0,14	0,78
Sachsen	2.30	0.60	0.82	0.88	0,26	0,36	0,38
Bremen	2.56	0.46	0.45	1.56	0,18	0,18	0,61
Bayern	2.86	0.26	0.35	2.25	0,09	0,12	0,79
Baden-Württemberg	3.80	0.48	0.44	2.88	0,13	0,12	0,76
Berlin	3.89	1.27	1.01	1.61	0,33	0,26	0,41

Source: Eurostat (1996); European Commission (1994)

The growth of R&D expenditure in the private sector in North Rhine-Westphalia between 1987 and 1993 is also far below the German average.

Table 9: Growth of R&D expenditures 1987-1993 (in percentages)

	Private sector	Public Sector	HEIs
Germany	23,97	53,80	65,94
Baden-Wuerttemberg	43,81	n.a.	46,77
Bayern	13,99	n.a.	50,40
Berlin	75,61	n.a.	89,51
Brandenburg	n.a.	n.a.	n.a.
Bremen	31,04	n.a.	136,11
Hamburg	-24,15	n.a.	37,81
Hessen	19,50	n.a.	38,91
Mecklenburg-Vorpommern	n.a.	n.a.	n.a.
Niedersachsen	4,66	n.a.	26,49
Nordrhein-Westfalen	6,62	n.a.	41,90
Rheinland-Pfalz	-2,38	n.a.	43,84
Saarland	45,21	n.a.	49,66
Sachsen	n.a.	n.a.	n.a.
Sachsen-Anhalt	n.a.	n.a.	n.a.
Schleswig-Holstein	19,50	n.a.	49,43
Tübingen	n.a.	n.a.	n.a.

Source: Eurostat (1996); European Commission (1994)

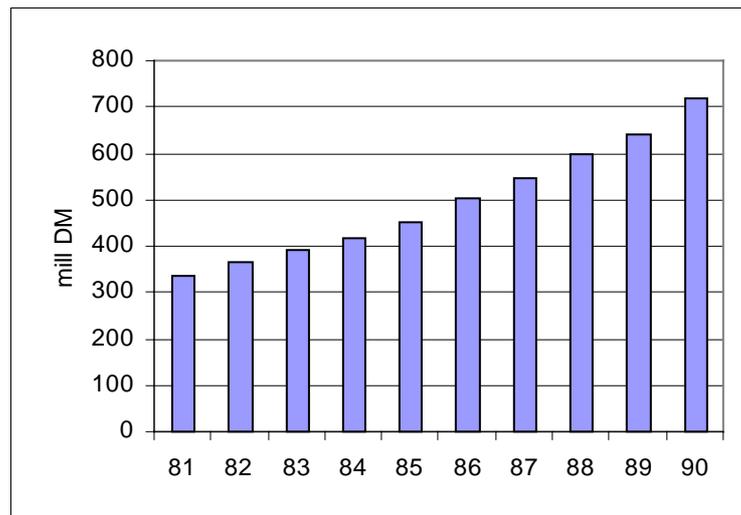
In contrast, the following example of one Fraunhofer Institute in the Ruhr area and a look at the private financing of R&D at higher education institutes shows how application-oriented research institutes can be oriented towards the needs of the local economy.

Example: FhG IMS Duisburg

The Fraunhofer Institute for Microelectronic Circuits and Systems (FhG IMS), based in Duisburg works on applications of microelectronics and silicon technologies in the fields of semiconductors, telecommunications, testing and measurement, control systems and automation, vehicle electronics, and media electronics. The working team of the FhG IMS is contract oriented towards conception, design of integrated circuits and micro-systems, towards prototype manufacturing and testing. FhG IMS expert basis consists of a permanent staff of over 120 employees and equipment. FhG IMS financing is by means of long term and counter-cyclical R&D projects for state contractors and by income from contract research with industry (especially from technology firms in Germany and from abroad). Since the institute concentrates on high technologies, FhG IMS as most of the FhG institutes tends to co-operate more with large enterprises. There is however also a transfer of results of the work of FhG IMS into practice and problem-solving for regional SMEs (especially by limited-run series of semiconductors manufactured "in-house" supported by the government of North Rhine-Westphalia). Working and financing of FhG IMS of this type is considered optimal. By combining public R&D-projects, contracts from larger companies on the one side and SMEs activities as public supported regional serving of industry on the other side, FhG IMS has a sufficiently large international and regional market. Regional services and strategic alliances are very appropriate for the microelectronic sector, especially as co-operation of this kind enables synergy's in the supply of expertise. FhG IMS is to be seen mainly as an important part of the long-term oriented technology development of North Rhine-Westphalia.

In addition, the positive role of the application-oriented R&D institutes, among them the affiliated university institutes can be seen from the rise of private funding of R&D in the higher education sector: From 1979 to 1990, the amount funded by third parties was raised from 277.3 mill DM to 718.5 mill DM, especially after the modification of the respective regulation in 1989 (MWF 1993, 26).

Figure 13: Development of private funding of research at universities



Source: MWF (1993, 26)

As the funds provided by the government in North Rhine-Westphalia for R&D at higher education institutes amounted to only 77.9 mill DM in 1990, this example also shows the substitution of public funds by private sources. Finally, despite certain successes, the discussion reveals that there is still much potential in the region which has not been mobilised yet.

4.3.2 Universities and polytechnics

In addition to their mission in R&D, the institutions of higher education contributed significantly to the restructuring of the Ruhr area. The provision of human capital training in modern technologies on the one hand was a necessary prerequisite for industrial diversification through endogenous potentials, but also ranks as an important locational factor for the attraction of extra-regional investors. For instance, two thirds of the students at universities in the Ruhr area are enrolled in natural sciences, engineering or economic sciences, which is higher than the German average of 50 percent (Gramke 1993, 21). Furthermore, universities assumed important roles in the regional technology transfer which was heavily subsidised by the federal state government.

Some critical remarks also have to be made: Although university education in technical areas provides a high number of students, the demand for their skills within the Ruhr area is much lower, with the consequences of a "brain drain" to other parts of Germany, e.g. Butzin cites the example of IT-students: While 11 percent of IT students in Germany study at universities in the Ruhr area, only 4 percent of them are employed in the region (Butzin 1993b, 249).

Looking at the whole of North Rhine-Westphalia, the picture is more positive: The higher education and research infrastructure provide a seedbed for spin-offs and the foundation of technology-oriented enterprises from academia. For instance, the Wuppertal region which borders the Ruhr area has won in a national competition among universities which are local players in supporting the development of an innovative milieu. Another study reveals that, following Baden-Wuerttemberg, North Rhine-Westphalia could attract most students from polytechnics which have founded their own business (Richert/Schiller 1994).

4.3.3 Innovation and technology transfer centres, business incubators

Technology centres provide high-quality business space at subsidised prices. This was especially important, as the lack of attractive business space with a sufficient infrastructure was a bottle-neck for regional development in the Ruhr area. In addition, technology centres provide a range of supporting services which should be especially valuable for start-up firms. However, these counselling functions which most centres offer are only requested by a small share of inhabitants as tenants' inquiries reveal (Elle et al. 1997). Over the course of time, even an over-provision of space was a consequence of regionalised structural policy.

The employment impact of the technology centres in North Rhine-Westphalia is very difficult to assess. Including the centre staff and the tenant companies 11,200 people were employed, plus 6,400 employees of companies that had already moved out of the technology centres. However, these employment figures cannot be directly attributed to the promotion of technology centres alone. It can be estimated that between 2,000 and 4,000 jobs have been created by the technology centre policy, whereas the major part of companies and employment would also have been realised somewhere in North-Rhine-Westphalia without the existing offer of technology centres (Elle et al. 1997). While these quantitative indicators and cost-benefit analyses are very difficult to evaluate, climatic effects of technology centres should be taken into account to some extent. It is felt that they contributed to a more entrepreneurial culture in the region.

As described in Chapter 4.2, North Rhine-Westphalia possesses a diversified technology transfer network. Since their introduction in the 1980s there have been various

positive and negative experiences leading to modifications of the structure. For instance, the "Technologieberatungsstelle Ruhr" which was a collaboration of Ruhr cities and consulted technology-based firms, had to be closed in the 1990s since their range of tasks was not demanded enough by the local fabric. An evaluation of technology transfer centres at universities reveals that their performance differs very much depending, among others, on their organisational integration into the faculties, and their personnel resources (Staudt et al. 1991, 20ff). As a major success factor, their integration in informal networks is crucial for the mediation between the scientific sector and SMEs. However, the overall picture is that firms in the Ruhr area have access to a wide variety of transfer and consulting agencies.

4.3.4 Regional educational and vocational training institutions

The regional practical education infrastructure is somewhat complementary to the function of the higher education institutes. Nevertheless, the availability of well trained workers is also an important locational factor. This refers not only to the initial training of workers but also to retraining in modern technologies.

Traditionally, the dual system of vocational training in Germany relies on two pillars: In addition to in-house training in firms, the apprentices receive more formal training in vocational schools. In terms of in-house training and supply of apprentice places, SMEs have become the main actors in training in North Rhine-Westphalia.

The training system of the Ruhr area was relatively focussed on the needs of traditional industries. In order to provide skilled workers for new industries, it had to incorporate new qualifications. Moreover, new technologies posed new challenges to the vocational training system. While the dual system and especially the training posts available in local industry caused some rigidity and adaptation problems, new training contents were established during the 1980s (Kitsche 1992).

In the course of structural change, retraining has become increasingly important. At the same time, the rise in numbers of students enrolled in vocational training institutes indicates the labour market problems: On the one hand the lack of adequate skills in non-traditional industries of the region becomes obvious and on the other hand, training programmes can absorb the unemployed for a short period. While overall student numbers doubled from 1980 to 1987, at the same time the percentage of unemployed thereof rose from 17 to 69 percent (Kitsche 1992, 376). Therefore, the dynamic development of the vocational training numbers is to a large extent financed by the labour offices.

The Ruhr area possesses a very diversified but not very consolidated training infrastructure. The structure of technical colleges and other institutions for adult education is very decentralised. As a consequence, it is almost impossible to gain a comprehensive overview of the existing different education programmes supplied by private and semi-public institutions. This makes an improved adaptation to the needs of the population difficult (Bosch 1995).

5 Conclusion and summary

Main achievements of the transformation of the old industrial area

The starting point for the restructuring of the Ruhr area as an old industrial area was not very promising. In comparison to the 1970s, by the end of the century the Ruhr area and North Rhine-Westphalia have been successful in achieving innovative and healthy conditions (see table 10). These are characterised by:

- a diversified industry structure, both in terms of size mix between large firms and SMEs, as well as in terms of a range of various industrial and service sectors,
- shift from a hierarchical co-operation pattern with closed networks towards more co-operation including horizontal links,
- dynamic development of business start-ups,
- introduction of innovative activities in previously non-innovating firms and expansion of innovative activities in existing firms,
- establishment of new technological fields (e.g. biotechnology, environment technology) in new, or within existing R&D institutions and firms,
- a diversified and excellent infrastructure supporting innovation and comprising educational, research and teaching organisations, as well as supporting services and financing possibilities,
- a more flexible administration, with competent actors on the local level being able to initiate co-operation among different actors out of policy, the local administration, industry and other stakeholders.
- from a socio-economic viewpoint, a positive attitude towards technology and acceptance of innovation and a good entrepreneurial spirit and vision of the future of the region, such as the slogan "blue sky over the Ruhr" marking the transition from an old coal and steel region.

The following table sketches the situation before and after the transformation of the old industrial area:

Table 10: Regional characteristics before and after transition

	Ruhr area before 1970	Ruhr area today
Industry structure	<ul style="list-style-type: none"> • dominant large enterprises, • mass production • few industrial sectors (coal & steel), • R&D only in large enterprises 	<ul style="list-style-type: none"> • mixture of large, small and medium sized firms • in-house R&D activities • diversified production and service structure
Co-operation	<ul style="list-style-type: none"> • vertical, hierarchical between large enterprises and SMEs 	<ul style="list-style-type: none"> • horizontal and vertical co-operations, networking
Human capital	<ul style="list-style-type: none"> • traditionally or semi-qualified, not flexible 	<ul style="list-style-type: none"> • highly qualified, more flexible
Higher education institutes and R&D infrastructure	<ul style="list-style-type: none"> • not available within the region 	<ul style="list-style-type: none"> • to a large extent available within the region • not fully inter-linked
Policy and Administration	<ul style="list-style-type: none"> • lobby of conglomerates, local and regional politicians and trade unions 	<ul style="list-style-type: none"> • decentralised approach • fostering SMEs and new technologies • mediation without huge financial commitment • mobilisation of private capital
Environment and location	<ul style="list-style-type: none"> • traditional attitudes, • environmental problems 	<ul style="list-style-type: none"> • environmental problems partly solved ("Blue sky above the Ruhr"), • monuments of industrial culture
Innovative orientation	<ul style="list-style-type: none"> • depressed • old paradigm 	<ul style="list-style-type: none"> • new regional spirit • first signs of creative milieu

Selected indicators

The analysis is founded on **quantitative** as well as **qualitative** indicators which have to be applied in a complementary way. The following table summarises the findings of selected quantitative indicators which have been presented during the study and convey a differentiated picture of the transformational successes and persisting structural problems of the Ruhr area. The list also shows the performance of specific indicators in the case of the Ruhr area and reveals the importance of interregional comparisons.

Table 11: Summary of selected quantitative indicators for the Ruhr area

Indicator	achievement	structural problem
Industry structure <ul style="list-style-type: none"> • employment by branches • employment in coal & steel • employment development in the service sector • composition of service sector • firm foundation rate • unemployment 	<ul style="list-style-type: none"> • diversified structure • motor of economic growth • above national average 	<ul style="list-style-type: none"> • 50% in traditional complex • slow transition • growth lagging behind national average • little share of production oriented services • high above national average with low flexibility
Human capital <ul style="list-style-type: none"> • migration • students development • students educated and employed in the region • qualification of workforce 	<ul style="list-style-type: none"> • like national average • like national average • improved 	<ul style="list-style-type: none"> • brain drain to other regions in some techn. disciplines
Research & development <ul style="list-style-type: none"> • R&D per GDP • R&D share by agents • growth of R&D • private funded R&D at HEIs 	<ul style="list-style-type: none"> • national average • increase 	<ul style="list-style-type: none"> • below national average • below average (West-G.) • far below average

Important qualitative indicators refer for instance to the co-operation pattern, to the overall vision of the region, to the excellence of the R&D infrastructure or to the support provided by the technology transfer network, to name only a few.

Some critical remarks

However, after the positive view on the achieved restructuring, some more critical remarks have to be made. Today the industrial structure of North Rhine-Westphalia is diversified, and yet a large part of the region's industry still depends on the traditional sectors. Furthermore, the restructuring has taken almost 30 years and maintaining the social peace has caused huge economic costs of which the burden was largely carried by the German tax system. The policy of conservation of traditional industries was only abandoned relatively late. Future developments will also show how much the newly emerging technologies and industries will flourish and be able to substitute the coal and steel complex. Countries in Central and Eastern Europe should be aware of indicators of economic decline which signal either a deep structural crisis or a temporary slack in demand.

While the higher education institutes and R&D infrastructure, which were established in the Ruhr area from the 1970s, played a very important role in stimulating the trans-

formation process by providing human capital and technological knowledge, the local industry cannot fully absorb the potential in the science sector. This is partly true for the students educated in the region but also for the interlinkage especially of SMEs with local R&D institutes. While some localities and new industrial clusters in the Ruhr area experienced dynamic development, this is not yet the case for the whole region and industry as a whole which are still in a "catch-up" process. In this, the role of the technology transfer infrastructure has to be highlighted. Although the network is sometimes very complex due to its policentricity, there is a very modern supply of a range of support services for innovation and business start-ups. The integration of the actors of the technological infrastructure into formal and informal networks is especially crucial.

Conducive sources for the restructuring of the Ruhr area were both endogenous resources (such as the emergence of the environmental cluster in NRW) and external resources, i.e. linking up with global networks, attracting investments from other countries and regions and channelling funds from extra-regional organisations into the region. In any case, local networks and global integration should complement each other, as the example of the Ruhr area clearly shows. Initially local agents did not allow investments from outside the region and diversification of the industrial structure. This attitude as well as the traditional "coal and steel"-mentality only changed slowly.

Policy approach and selected instruments

Technology and industry policy in North Rhine-Westphalia has contributed significantly to the positive development of the Ruhr area. Initially this was through the promotion of higher education and qualification, the fostering of new technologies (e.g. environment) and the active support of SMEs.

Since the early 1980s the policy approach has been characterised by decentralisation and co-ordination. Policy programmes were designed to stimulate bottom-up initiatives and initiative local networks across different types of actors from science, industry and administration, by for example providing discussion fora (see e.g. the Ruhr conference and subsequent events). The co-ordination was comprised of different aspects: formulating priority fields, initiating co-operation between different ministries of North Rhine-Westphalia and bundling public financial resources from the federal state, national and supra-national level and also private capital: For instance, EU funding was used for the establishment of R&D institutes, vocational training, the implementation of a modern qualification structure or for funding technology and incubator centres. This role of mediation of the federal government was also very practicable, since – in contrast to the huge sums initially invested – industrial and technology policy have recently only had relatively limited financial resources at their disposal.

As could be shown, regional industrial and technology policy plays a major role when the restructuring of an old industrial region is at stake. Instruments of regional technology policy can directly influence the innovative capability of firms within the area, e.g. through consulting, information, co-ordination of networks and further training. The aim of such measures is inducing of good economic performance through the exploitation of existing regional resources and complementing them by national or supra-national funds.

The mobilisation of endogenous resources and the stimulation of innovation activities in industry is a specific challenge in CEECs, and so there is a specific role for regional technology policy. However, as the Ruhr example shows, there are some preconditions: Local actors have to be competent and be able to assume active roles in the restructuring process. This is true for the local administration which has to be able to attract and manage e.g. EU-funds efficiently, and incorporate them into the regional technology policy concept, and also for private or semi-public actors who become active in local innovation networks and industry clusters.

References

- Alcouffe, Alain; Kephaliacos, Charilaos (1998): Regional innovation systems and global markets: the Midi-Pyrenees benchmark, in: Braczyk, Hans-Joachim, Cooke, Philip, Heidenreich, Martin (Eds.): *Regional Innovation Systems: The role of governance in a globalized world*, London UCL Press, pp. 345-378.
- Blind, Knut; Grupp, Hariolf (1999): Interdependencies between the Science and Technology Infrastructure and Innovation Activities in German Regions: Empirical Findings and Policy Consequences, in: *Research Policy*, Vol. 28, pp. 451-168
- Bosch, Gerhard (1995). Industrial restructuring and further training in North Rhine-Westphalia, in: Cooke, Philip (Ed.): *The Rise of the Rustbelt*, London: UCL Press, pp. 125-138.
- Braczyk, Hans-Joachim; Cooke, Philip; Heidenreich, Martin (1998) (Eds.): *Regional Innovation Systems: The role of governance in a globalized world*, London UCL Press.
- Braczyk, Hans-Joachim; Heidenreich, Martin (1998): Regional governance structures in a globalized world, in: Braczyk, Hans-Joachim; Cooke, Philip; Heidenreich, Martin (Eds.): *Regional Innovation Systems: The role of governance in a globalized world*, London UCL Press, pp. 414-440.

- Bräunling, Gerhard; Jaeckel, Gerhard; Pinter, Jürgen; Schöler, H.R.; Walter, Günter H. (1981): Darstellung, Bewertung und Perspektiven öffentlich geförderter Pilotvorhaben. Karlsruhe: FhG-ISI.
- Bundesministerium für Bildung und Forschung (BMBF); Bundesministerium für Wirtschaft und Technologie (BMWi) (1999): Innovationsförderung- Hilfen für Forschung und Entwicklung. Bonn.
- Butzin, Bernhard (1993a): Strukturkrise und Strukturwandel in "alten" Industrieregionen. Das Beispiel Ruhrgebiet, in: Geographie heute, Vol. 14, pp. 4-12.
- Butzin, Bernhard (1993b): Was macht das Ruhrgebiet alt? – Das Beispiel Ruhrgebiet, in: Berichte zur deutschen Landeskunde, Vol. 67, pp. 243-254.
- Cooke, Philip (1998): Introduction: origins of the concept, in: Braczyk, Hans-Joachim; Cooke, Philip; Heidenreich, Martin (Eds.): Regional Innovation Systems: The role of governance in a globalized world, London UCL Press, pp. 2-25.
- Davies, Sara (1995): Training policy and practice in Wales and North-Rhine-Westphalia, in: Cooke, Philip (Ed.): The Rise of the Rustbelt, London: UCL Press, pp. 139-161.
- Dege, Wilfried; Kerkemeyer, Sabine (1993): Der wirtschaftliche Wandel im Ruhrgebiet in den 1980er Jahren, in: Geographische Rundschau, Vol. 45, pp. 503-509.
- Elle, Hans-Dieter et al. (1997): Technologiezentren in Nordrhein-Westfalen. Entwicklungen, Leistungen, Perspektiven, Studie im Auftrag des Ministeriums für Wirtschaft und Mittelstand, Technologie und Verkehr des Landes Nordrhein-Westfalen, mimeo.
- European Commission (1994): Quinto informacion periodico sobre la situacion y la evaluacion socioeconomica de las regiones de la comunidad.
- Eurostat (1996): Research and Development: Annual statistics, Luxembourg.
- Feldotto, Petra (1997): Regionales Innovationsmanagement unter den Bedingungen einer regionalisierten Strukturpolitik: Das Beispiel der altindustrieller Regionen Nord-Pas-de-Calais und Emscher-Lippe, Berlin: Duncker & Humblodt.
- Fraunhofer-Institut für Systemtechnik und Innovationsforschung (FhG-ISI) (Ed.) (1979): Bericht des Modellversuchs: Entwicklung neuartiger Methoden zum Informationstransfer zwischen Hochschulen und Industrie an der Ruhr-Universität Bochum, Bochum, mimeo.
- Gaedtke, Michael (1995): Wie geht es weiter mit der IBA Emscher Park? Strukturwandel in der Emscherregion, Düsseldorf: Ministerium für Stadtentwicklung und Verkehr des Landes Nordrhein-Westfalen.

- Grabher, Gernot (1993): The weakness of strong ties: the lock-in of regional development in the Ruhr area, in: Grabher, Gernot (Ed.): The embedded firm: On the socioeconomics of industrial networks, London: Routledge, pp. 255-277.
- Gramke, Jürgen (1993): Strukturwandel im Ruhrgebiet, in: Hommel, Manfred (Ed.): Umbau alter Industrieregionen, Stuttgart: Franz Steiner Verlag, pp. 19 – 24.
- Hamm, R.; Wienert, H. (1989): Strukturelle Anpassungen altindustrieller Regionen im internationalen Vergleich, Essen: Rheinisch-Westfälisches Institut für Wirtschaftsforschung.
- Hassink, Robert (1992): Regional innovation policy: Case-studies from the Ruhr Area, Baden-Württemberg and the North East of England, Utrecht:
- Heidenreich, Martin; Krauss, Gerhard (1998): The Baden-Württemberg production and innovation regime, in: Braczyk, Hans-Joachim; Cooke, Philip; Heidenreich, Martin (Eds.): Regional Innovation Systems: The Role of governance in a globalized world, London UCL Press, pp. 214-244.
- Heinze, Rolf G. et al. (1996): Strukturpolitik zwischen Tradition und Innovation, Nordrhein-Westfalen im Wandel, Opladen: Leske + Budrich.
- Heinze, Rolf G.; Hilbert, Josef; Nordhause-Janz, Jürgen; Rehfeld, Dieter (1998): Industrial clusters and the governance of change: Lessons from North Rhine-Westfalia, in: Braczyk, Hans-Joachim; Cooke, Philip; Heidenreich, Martin (Eds.): Regional Innovation Systems: The role of governance in a globalized world, London UCL Press, pp. 263-283.
- Höhnscheid, W. (1980): Technologie-Programm Wirtschaft des Landes Nordrhein-Westfalen, in: Bundesministerium für Raumordnung, Bauwesen und Städtebau, 7/8. Bonn.
- Kamann, Dirk-Jan (1997): Policies for Dynamic Innovative Networks in Innovative Milieux, in: Ratti, Remigio; Bramanti, Alberto; Gordon, Richard (Eds.): The Dynamics of Innovative regions: The GREMI Approach, Aldershot: Ashgate, pp. 367-391.
- Kilper, Heiderose (1992): Technologien und ihre Folgen, in: Reh, Werner (Ed.): Jahrbuch der Politik und Wirtschaft in Nordrhein-Westfalen 1988–1990, Bonn: Bouvier, pp. 159-174.
- Kitsche, Adalbert (1992): Berufliche Bildung, in: Reh, Werner (Ed.): Jahrbuch der Politik und Wirtschaft in Nordrhein-Westfalen 1988–1990, Bonn: Bouvier, pp. 361- 379.
- Kommunalverband Ruhr (KVR) (1999): Zahlenspiegel Ruhrgebiet, Strukturdaten im Zeitvergleich, aktualisierte Diskettenaufgabe, Essen.
- Land NRW (1992): Landesentwicklungsbericht Nordrhein-Westfalen, Düsseldorf: Ministerium für Wirtschaft und Mittelstand, Technologie und Verkehr.

- Landesamt für Datenverarbeitung und Statistik Nordrhein-Westfalen (Ed.) (1999): Statistisches Jahrbuch Nordrhein-Westfalen, Düsseldorf: LDS.
- Metcalfe, J.S. (1994): Evolutionary Economics and Technology Policy, in: The Economic Journal, Vol. 104, pp. 929-944.
- Meyer-Kahmer, F.; Dittschar-Bischoff, R.; Gundrum, U.; Kuntze, U.; Gielow, G.; Krist, H.; Walter, G.H. (1884): Erfassung regionaler Innovationsdefizite. In: Bundesministerium für Raumordnung, Bauwesen und Städtebau, Heft 06.954, Bonn.
- Michel, Ewald (1991): Das Ruhrgebiet, Strukturwandel eines Altindustriengebiets, in: Geographie und Schule, Vol. 14, pp. 2-7.
- Ministerium für Stadtentwicklung, Kultur und Sport des Landes Nordrhein-Westfalen (MSKS) (1999): Grundstücksfonds Nordrhein-Westfalen 1998, Düsseldorf: WAZ.
- Ministerium für Wissenschaft und Forschung des Landes Nordrhein-Westfalen (1993): Forschung in Nordrhein-Westfalen, Düsseldorf: Neusser Druckerei und Verlag GmbH.
- Morlok, Martin (1992): Forschungspolitik, in: Reh, Werner (Ed.): Jahrbuch der Politik und Wirtschaft in Nordrhein-Westfalen 1988–1990, Bonn: Bouvier, pp. 403-417.
- Ministerium für Schule und Weiterbildung, Wissenschaft und Forschung des Landes Nordrhein-Westfalen (MSWWF): Forschung in NRW. <http://www.mswwf.nrw.de>.
- Nocken, Ulrich (1992): Wirtschaftspolitik, in: Reh, Werner (Ed.): Jahrbuch der Politik und Wirtschaft in Nordrhein-Westfalen 1988–1990: Bonn: Bouvier, pp. 107-135.
- NRW-Lexikon (1996): NRW-Lexikon. Politik, Gesellschaft, Wirtschaft, Recht, Kultur, Opladen: Leske + Budrich,
- Pöhls, Uwe (1992): Die Bevölkerungsentwicklung in Nordrhein-Westfalen, in: Reh, Werner (Ed.): Jahrbuch der Politik und Wirtschaft in Nordrhein-Westfalen 1988–1990, Bonn: Bouvier, pp. 38-47.
- Pyke, Frank; Sengenberger, Werner (Eds.): Industrial districts and local economic regeneration, International Institute for Labour Studies, Genf
- Rehfeld, Dieter (1995): Disintegration and reintegration of production clusters in the Ruhr area, in: Cooke, Philip (1995): The rise of the Rustbelt, London: UCL Press, pp. 85-102.
- Richert, Jörg; Schiller, Rüdiger (1994): Fachhochschulabsolventen als Existenzgründer. Ergebnisse einer Sonderauswertung von Daten der Deutschen Ausgleichsbank, in: Reihe Bildung, Wissenschaft, Aktuell, 1/94, Bonn: Bundesministerium für Bildung und Wissenschaft.

- Sachverständigenrat (SVR) (1988): Wirtschaftliche Erneuerung altindustrieller Problemregionen: Das Beispiel Ruhrgebiet, in: Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung, Arbeitsplätze im Wettbewerb, Stuttgart: Kohlhammer, pp. 183-210.
- Saxenian, AnnaLee (1994): Regional advantage: culture and competition in Silicon Valley and Route 128, Harvard University Press, Cambridge Mass.
- Schlieper, Andreas (1986): Hundertfünfzig Jahre Ruhrgebiet: Ein Kapitel deutscher Wirtschaftsgeschichte, Düsseldorf: Schwann.
- Schrader, Manfred (1998): Ruhrgebiet, in: Kulke, Elmar (Ed.): Wirtschaftsgeographie Deutschlands, Gotha: Klett-Perthes, pp. 435-463.
- Staudt, Erich; Bock, Jürgen; Mühlemeyer, Peter (1991): Die Rolle der Technologietransferstellen zwischen dem Wissenschaftssystem und der mittelständischen Industrie – Makler oder Kompetenzzentren? – Empirische Ergebnisse zur Situation in Nordrhein-Westfalen, Berichte aus der angewandten Innovationsforschung No 98; Bochum: IAI.
- Walter, G.H. (1994): Technology Policy in a Regional, National and European Context; MOEL Working Paper 15e, Karlsruhe: FhG-ISI.

The series "Working Papers Firms and Region" presents research work of the department "Innovation Services and Regional Development" of Fraunhofer Institute for Systems and Innovation Research (ISI), Karlsruhe, Germany. The former "Arbeitspapiere Regionalforschung", published between 1995 and 1999, was merged in this new series.

No.	Authors	Title
R2/2000	Ulrike Bross Günter H. Walter	Socio-economic Analysis of North Rhine-Westphalia Joint Research Project INCO-COPERNICUS
R1/2000	Knut Koschatzky	The regionalisation of innovation policy in Germany – Theoretical foundations and recent experience
R4/1999	Knut Koschatzky Ulrike Bross	Struktur und Dynamik von regionalen Innovationsnetzwerken unter Transformationsbedingungen – das Beispiel Slowenien
R3/1999	Emmanuel Muller	There is no territorial fatality! (or how innovation interactions between KIBS and SMEs may modify the development patterns of peripheral regions)
R2/1999	Knut Koschatzky Andrea Zenker	The Regional Embeddedness of Small Manufacturing and Service Firms: Regional Networking as Knowledge Source for Innovation?
R1/1999*	Ulrike Bross Knut Koschatzky Peter Stanovnik	Development and Innovation Potential in the Slovene Manufacturing Industry First analysis of an industrial innovation survey * Already published as "Arbeitspapier Regionalforschung" No. 16

Address to order:
Fraunhofer Institute for Systems
and Innovation Research
Library
Breslauer Strasse 48
D-76139 Karlsruhe
Tel. +49 / 721 / 6809-217 / -219
Fax: +49 / 721 / 689152
e-mail: gh@isi.fhg.de