Industry and Innovation,
Vol. 14, No. 1, 69–94, February 2007

Routledge
Taylor & Francis Group

Research Paper

Cluster-Based Technology Policy—The German Experience

DIRK DOHSE

Kiel Institute for World Economics, Kiel, Germany

ABSTRACT The German Federal Government has undertaken a series of particularly interesting policy experiments in the field of technology policy in recent years, a major policy innovation being the explicit recognition of regional clustering aspects in federal support programmes. The paper provides a categorization and assessment of these policy experiments and tries to shed some new light on two fundamental policy questions that are important beyond the German context: (i) can clusters be built by national government policy action? and (ii) is regionalization of technology policy a suitable means of achieving goals at the national level? We find that utilizing the regional level to boost national innovation and competitiveness can—under certain conditions explicated in the paper—indeed be seen as a promising means of achieving national goals. More specifically, we find that InnoRegio type programmes might be particularly useful in regions with distinctive structural problems such as the Central and Eastern European countries, whereas BioRegio type models might be a suitable means of policy-making at the level of the European Union.

KEY WORDS: Industrial clusters, knowledge spillovers, technology policy

1. Introduction

> *Policymakers care about industrial clusters and their geographical location, since clusters are associated with rents. Membership of clusters and inter-firm networks is strongly believed to enhance the productivity, and competitive performance of firms*. (Forslid and Midelfart Knarvik, 2002: 2)

There are many indications that, increasingly, growth and innovation seem to emerge from innovative complexes of firms and organizations. It is argued that it is primarily within these geographically concentrated networks or "clusters", that new knowledge is created and that

Correspondence Address: Dirk Dohse, Kiel Institute for World Economics, Duesternbrooker Weg 120, Kiel 24105, Germany. Email: dirk.dohse@ifw.uni-kiel.de

1366-2716 Print/1469-8390 Online/07/010069–26
DOI: 10.1080/13662710601130848

regional value-added and employment growth are realized. Accordingly, clusters of innovative activity are conceived of having an important impact not only on regional but also on national competitiveness: it is stated that innovative clusters constitute the "regional foundations of national competitiveness" (Council on Competitiveness, 2005) and that they are the underlying "drivers of national innovation systems" (OECD, 2001). At the centre of scientific and political interest are sectors which are expected to be engines of growth in the knowledge-based economy, such as information technology, biotechnology, environmental technology and multimedia. It is discussed whether the externalities inherent in these cluster-intensive industries are strong enough to bring economies on a higher growth path and what institutions are needed to capture the growth opportunities that these industries provide.

The growing interest in clusters reflects the increasing pressure that firms and locations face to compete on innovation rather than on productivity alone. Clusters are important in this respect, since they allow firms to be more innovative (and productive) than they could be in isolation and because they reduce entry barriers for technology-based start-ups relative to other locations (Ketels, 2004). Of particular importance is that functioning clusters provide a high density of information flows, not simply vertically between consumers and suppliers but also horizontally between firms in the same industry and across industries. Young and small firms, especially in knowledge-intensive sectors, depend heavily on shared knowledge and social capital, that is, "… they benefit from intellectual, technological and social 'spillovers' based on network interactions with other entrepreneurs, other scientists, financiers and people in the same business and with comparable mindsets to themselves" (Cooke, 2001: 280).

Against this background, it is not at all surprising that governments in several industrialized countries increasingly consider the cluster dimension in their technology support programmes. The focus of the current paper is on national, cluster-based technology policy in Germany as German technology policy has undertaken a series of particularly interesting policy experiments in recent years.[1, 2] The aim of the paper is to provide, on the one hand, a categorization and assessment of these policy experiments and to try, on the other hand, to shed some new light on two fundamental and closely related policy questions: (i) can clusters be built by national government policy action? and (ii) is regionalization of technology policy a suitable means of achieving goals at the national level?

The paper is organized as follows: in Section 2 we briefly discuss the shift from traditional technology policy to cluster-based technology policy in Germany. Section 3 compares the two prototype models of cluster-based technology policy in Germany (the BioRegio contest and the InnoRegio contest) and discusses recent policy initiatives derived from these two prototypes. In Section 4 we assess the strengths and weaknesses of the new cluster-based approaches in German technology policy, whereas Section 5 provides some more general reflections on cluster building and national advantage that appear to be

[1] This is, of course, not to deny that there have been important developments in national cluster policies in other countries as well. Within Europe the Netherlands, Denmark, the UK, Ireland, Finland and Sweden have been particularly active in using the cluster approach to organize parts of their economic policy.

[2] Cluster policies at the state ("Länder") level are older than the federal policies. See Section 2 for a more detailed discussion.

important beyond the German context. In the concluding Section 6 it is asked what policy makers in other European countries might learn from the German experiences.

2. From Traditional Technology Policy to Cluster-Based Technology Policy

Traditionally, the reference units of German technology policy were single firms, technologies or sectors. Starting with the support of national research centres (“Großforschungseinrichtungen”) and of large-scale projects (e.g. in the fields of nuclear power or space exploration) in the 1950s and early 1960s, German technology policy became increasingly “diffusion-oriented”[3] in the 1970s and 1980s (Fier and Harhoff, 2002). The mid-1980s and early 1990s brought a shift in the technology policy agenda towards consideration of small and medium-sized enterprises (SMEs) in project funding, encouraging research cooperation between firms and state-financed research institutes (“Verbundforschung”), and the support of innovative networks—albeit without a clear-cut spatial dimension (ibid.).

In the mid-1990s the Federal Research Ministry (BMBF, for short) was formulating a fundamental reorientation of technology policy which had its public manifesto in the famous Federal Research Report of 1996. This reorientation was, on the one hand, prompted by the institutional requirements of new technologies (biotech, in particular) that were incompatible with the existing technology policy framework and, on the other hand, a reaction to Germany’s poor economic performance in the mid-1990s (Lehrer and Asakawa, 2004). Important policy reorientations included the use of lead projects as an element of technology promotion, initiatives to found and promote new technology-based firms, support of spin-offs from research institutes, support of SMEs in the new German Länder, improved patent promotion and technology transfer, support of networking activities and the provision of venture capital (BMBF, 1996b: 28–34).

Most remarkably, however, in the mid-1990s the German Federal Government discovered the *region* as a new reference unit for technology policy. Policy instruments such as the BioRegio contest, the City Contest Multimedia or the Competition of Nanotechnology Competence Centers have drawn a lot of attention nationally as well as internationally. In contrast to these early instruments that were restricted to single technologies, the much discussed InnoRegio contest encompasses different fields of technology but is geographically restricted to the new German Länder. The new policy focus in Germany was explicitly acknowledged by the EU in its European Trend Chart on Innovation:

> The most significant change in innovation policy making is probably the explicit recognition of (regional) clustering aspects in support programmes. Various new programmes address these issues … Common to all these approaches is the integration of the regional dimension based on regional competencies in the knowledge generation process (existing public and private R&D facilities), supportive public administrations, institutions for financing innovation (e.g. venture capital funds) and lead customers (e.g. chemical industry in the case of biotechnology). (European Commission, 2000: 25)

[3] This shift was so radical that Ergas (1987) called Germany a showcase for diffusion-oriented (as compared to mission-oriented) technology policy.

It is, however, noteworthy, that cluster policies are nothing completely new in Germany. Some German states (Länder) performed cluster policies long before the federal government recognized the region as a resource of comparative advantage. The most prominent cases in point are Baden-Württemberg, North Rhine-Wesphalia and Bavaria.

Baden-Württemberg was the first German state to develop its own technology programme in 1976. In subsequent years, Baden-Württemberg's technology policy measures, on which Lothar Späth, prime minister from 1978 until 1990 had large impact, were developed in fields in which organizational and spatial proximity are essential, that is: support of SMEs, technology transfer, business start-up support, technology centres and clusters (Cooke and Morgan, 1990; Hassink, 1996, 2002; Fuchs and Wassermann, 2005; Koschatzky, 2005). In *North Rhine-Westphalia* there has been an active cluster policy from the 1990s onward, and the former Federal Minister of Economic Affairs, Clement, has been the main initiator of these policies (Hassink, 1993; Rehfeld, 1999). In *Bavaria*, the "strengthening of the strong"—meaning strong locations as well as strong technologies—has become an explicit policy priority since Prime Minister Edmund Stoiber took office in 1993, although one may argue that Bavarian state policy pushed and favoured the Munich high-tech agglomeration with its outstanding competence in microelectronics and the life sciences long before 1993 (Sternberg and Tamasy, 1999; Berger, 2005). In fact, the federal government might have learned from these states how to boost innovative clusters.[4]

Cluster-based technology policy in the context of this paper is understood as a national technology policy making use of the regional level in order to pursue national goals. Cluster-based technology policy in Germany in the above-mentioned sense focuses on three targets: upgrading of regional high-tech clusters, stimulation of interregional competition for technology and better functioning of regional innovation systems (Dohse, 2000a).

As the aim of the paper is to provide a general assessment of the new cluster-based technology policy in Germany rather than to discuss each single policy instrument belonging to this category in detail, the discussion in the following section is focused on the two prototype models of the new cluster-based technology policy, namely, the BioRegio contest and the InnoRegio contest and their descendants.

3. Prototype Models and Followers

3.1. The Prototypes: BioRegio and InnoRegio

BioRegio. In the early 1990s it became obvious to German policy makers and to the informed public that Germany was suffering from a late start in the emerging biotech industry.[5] Hence the German government considered it necessary to make a particular effort to strengthen Germany's position in this technology area which is seen as a key technology and a key driver of economic growth in knowledge-based economies. The BioRegio contest was designed by the federal government as a competition at regional level in which consortia formed from public and private sector organizations would develop a concept for biotech research and commercialization on a regional basis. All participants in

[4] I am grateful to an anonymous referee for hinting at this important point.

[5] Cooke (2001: 267) argues that with respect to commercialization of biotech the UK lags 10 years behind the USA, whereas Germany's progress is about 10 years behind the UK.

the contest had to give a presentation of their respective strengths in biotech as well as proposals for future development of biotechnology in the region. An independent jury was installed by the Federal Research Ministry to find the three regions that could most convincingly demonstrate that they had the critical mass of competence, the plan and the willingness to upgrade their biotech cluster (see Table 1 for a complete list of decision criteria).

The number and the internal structure of the regions participating in the contest were not predetermined by the BMBF, nor were the institutions taking the lead in the formation of the BioRegios. In some regions the local or state governments coordinated the regions' activities, in other cases it was industry or research institutions themselves. Seventeen rather heterogeneous BioRegios formed to participate in the contest (Figure 1). Some of them were single cities (and their hinterland) such as Freiburg (3), Jena (6) or Regensburg (12 in Figure 1). Others were networks of neighbouring cities such as Braunschweig–Göttingen–Hannover (9) or Heidelberg–Mannheim–Ludwigshafen (15) or they covered whole federal states such as Berlin-Brandenburg (1).

The three regions selected by the jury as winner regions were Munich (8), Rhineland[6] (13) and the Rhine–Neckar Triangle[7] (15). The East German region of Jena received a ''special vote'' for its ''especially positive new-orientation'' in the field of biotechnology after re-unification. Public funds amounting to €76.7 million were reserved for the three winners in the BioRegio contest, which served the federal government as best practice examples in the following years. Moreover, the winning regions received priority in the appropriation of funds from the ''Biotechnology 2000'' programme of the Federal Research Ministry for a time span of 5 years.

Despite its relatively small size BioRegio had an important symbolic and practical impact on the German biotech innovation system (see Dohse, 2000b for an in-depth analysis). ''More than any other federal initiative it has produced rapid, positive results and galvanized entrepreneurship in respect of new firm formation, also giving a significant boost to Germany's lagging venture capital industry'' (Cooke, 2002: 171). This is also reflected by

Table 1. Criteria by which the BioRegio model regions were chosen

C1:	Number and scale of existing companies oriented towards biotechnology in the region
C2:	Number, profile and productivity of biotech research facilities and universities in the region
C3:	Interaction (networking) of different branches of biotech research in the region
C4:	Supporting service facilities (patent office, information networks, consulting)
C5:	Strategies to convert biotechnology know-how into new products, processes and services
C6:	A regional concept to help the start-up of biotechnology-based companies
C7:	Provision of resources through banks and public equity to finance biotechnology companies
C8:	Cooperation among regional biotech research institutes and clinical hospitals in the region
C9:	Local authorities' approval practice with regard to new biotech facilities and field experiments

Source: BMBF (1996a).

[6] Including the cities of Cologne, Aachen, Düsseldorf and Wuppertal.

[7] Including Heidelberg, Mannheim and Ludwigshafen.

No. in map	Name of BioRegio	Inhabitants (million)		Continued	
1	BioTOP-Initiative Berlin-Brandenburg	6.013	10	Bioinitiative Nord	2.172
2	Region Bremen	0.549	11	Region Nordwest-Niedersachsen	0.214
3	BioRegio Freiburg	0.199	12	BioRegio Regensburg	0.125
4	BioRegio Greifswald-Rostock	0.288	13	**BioRegio Rheinland**[a]	2.165
5	BioRegio Halle-Leipzig	0.752	14	BioRegio Rhein-Main	1.239
6	*BioRegio Jena*[b]	0.101	15	**BioRegio Rhein-Neckar-Dreieck**[a]	0.616
7	BioMIT Mittelhessen	0.149	16	BioRegio Stuttgart/Neckar-Alb	0.585
8	**Initiativkreis Biotechnologie München**[a]	1.236	17	BioTechnologie Ulm	0.115
9	BioRegioN	0.901		All BioRegios	17.419

[a]Winning region.
[b]Special vote.

Figure 1. Participants in the BioRegio contest

the fact that "Germany can now claim to be Europe's most densely populated biotech kindergarten" (Ernst & Young, 2001: 5).

InnoRegio. While the major aim of BioRegio was to initiate a catch-up process in a generic high-tech industry the main objective of InnoRegio is to close—or at least to reduce—the *regional* innovation and development gap between eastern and western Germany. Indeed, one may argue that InnoRegio with its budget of €256 million is an important building block in the federal government's strategy of "rebuilding the East".

InnoRegios are, according to a definition by the Federal Research Ministry, regional units, smaller than states (Bundesländer) in which people and institutions from private enterprises, science, education, policy, administration and private organizations cooperate in order to generate technical, economic and social innovations (BMBF, 1999: 6).

There were 444 rather heterogeneous projects that participated in the first, so-called "qualifying phase" of the InnoRegio contest that lasted from April till October 1999. The applicants had to present their regional innovation profile, to outline the expected revenue that the InnoRegio funding would generate in their respective region and to explain their strategy of network-building and intraregional cooperation in later stages of the contest. From these more than 400 applications an independent jury selected 25 approaches. Selection criteria were, according to the Federal Research Ministry, the originality of the approaches, the sustainability of intraregional cooperation and the expected revenue of funding for the respective region (BMBF, 1999). It seems, however, that regional proportionality aspects have also played a major role in the jury's decision as the percentage of winner regions from a state is commensurate with the percentage of applications from that state[8] (Table 2).

The winning projects got the privilege to participate in the second phase (the so-called development phase) of the contest. Each of them received up to €154,000 for the development of a realization concept which had to be presented until summer 2000. These realization concepts were again assessed by the jury on the basis of the criteria in Table 3.

Table 2. Regional distribution of InnoRegio applicants and InnoRegio winners

	Applicants		Winners	
State (Bundesland)	Abs. number	Percentage	Abs. number	Percentage
Berlin	35	8	1	4
Brandenburg	102	23	5	20
Mecklenburg-Vorpommern	60	14	4	16
Sachsen	115	26	7	28
Sachsen-Anhalt	81	18	5	20
Thüringen	47	11	3	12

Source: BMBF (1999), own calculations.

[8] The city of Berlin is the only exception.

Table 3. Decision criteria in the second phase of InnoRegio

C1:	Novelty and originality of the approaches
C2:	Impact on the region's competitiveness and employment situation
C3:	Dynamic (long run) potential of the projects
C4:	Expected regional return of the projects
C5:	Sustainability of the development induced by the projects
C6:	Plausibility and maturity of the presented concepts
C7:	Quality (intensity) of cooperation
C8:	Regional embeddedness of the actors
C9:	Financial contribution of the region itself
C10:	Applicability of the approaches to other regions

Source: BMBF (1999: 15).

The successful concepts receive generous funding (up to €256 million) in the third, so-called realization phase of the contest that lasts until 2006.

Common features and differences. At first glance, BioRegio and InnoRegio might appear rather similar: both aim at stimulating the clustering of innovative activities and inducing a technology push, not only in those regions that receive funding but in the country as a whole. Both address the regional level in order to pursue national goals. The national goal behind the BioRegio contest is making Germany the number 1 in European biotechnology whereas in the case of InnoRegio it is rebuilding the German East. Both instruments are designed as an invitation to competition between regions and employ independent juries as referees to find the winners, and both pursue a strategy of improving the scope and quality of cooperation within regional innovation systems.

However, a closer look reveals substantial differences (Table 4): while BioRegio starts from the premise that biotechnology is a key technology of the 21st century and the necessity of federal funding is derived from the expectation of substantial positive externalities of biotechnology, InnoRegio is not focused on a specific technology but funds a wide variety of projects ranging from modern information technologies and innovative educational projects to specific forms of sustainable tourism.

Table 4. Differences between BioRegio and InnoRegio

BioRegio	InnoRegio
Restricted to biotechnology	Not restricted to a single technology
Not restricted to particular regions	Restricted to eastern Germany
Strengthening of the strong, dynamic regions	Focusing also on problem regions
Growth objective	Growth and convergence objective
Participants are (networks of) cities	Participants are single projects
Small number of participating regions (17 applications)	Large number of projects participated (440 applications)
''Hardware'' criteria dominated	''Software'' criteria dominated

The regional focus of InnoRegio is restricted to eastern Germany,[9] whereas no regions were excluded *ex ante* (there was no ''closed shop'') in the case of the BioRegio contest. The participants in the BioRegio contest are whole cities or networks of cities whereas the participants in the InnoRegio contest are in fact no regions at all but rather single projects or institutions within these regions. This might explain why there was a large number of participants in the InnoRegio contest compared to a relatively small number of BioRegio participants. The decisive criteria in the BioRegio decision were ''hardware criteria'' (existing firms and research facilities located in the region), whereas ''soft factors'' (such as development concepts for the future, originality of the approaches and networking strategies) gained more prominence in the InnoRegio decision.

The major difference between the two contests is, however, their different philosophy concerning the actual goals of technology policy. The objective of BioRegio is increasing Germany's international competitiveness in a generic technology, that is, BioRegio pursues a clear-cut national growth objective. In contrast, InnoRegio tries to pursue two goals in one, namely, regional income convergence and national growth, and it is hard to make out which is the dominant goal.

3.2. The Followers

The prototype models BioRegio and InnoRegio were succeeded by a number of programmes with rather different aims, focus and conceptual design. These programmes can broadly be classified as members of the ''BioRegio family'', members of the ''InnoRegio family'' and ''non-family members'' (Table 5).[10]

Within the ''BioRegio family'', the BioRegio contest was succeeded and complemented by the programmes BioFuture, BioChance and BioProfile.

Table 5. The most prominent programmes of cluster-based technology policy in Germany at a glance

BioRegio family	InnoRegio family (''Entrepreneurial Regions'')	Non-family members[a]
– BioRegio	– InnoRegio	
	Innovative Regional Growth Poles	– Learning Regions
– BioFuture[b]	– Interregional Alliances[b]	– NEMO
– BioChance[b]	– Centres for Innovative Competency	– Cooperation Networks and Cluster Management
– BioProfile	– InnoProfiles	

[a]The list of non-family members is not complete. Only the most important programmes are considered.

[b]Only indirect regional impact (see footnote 10).

[9] We use the term ''eastern Germany'' as a synonym for the new German Länder throughout the paper.

[10] It should be noted, however, that the BioRegio family members *BioFuture* and *BioChance* don't have an explicit regional focus. Their regional impact is a more indirect one, as they were designed to complement BioRegio and the impact of the submitted projects on their respective BioRegios was a criterion (although not the most important one) in the BMBFs funding decisions. A similar argument holds for the InnoRegio family member *Interregional Alliances*.

BioFuture is a programme designed to either enhance scientific careers or business start-ups in biotechnology. The initiative supports independent teams of young scientists with €1.5 million each for a 5-year period. The complementary *BioChance* programme provides support for high-risk projects in applied research carried out by young biotech firms, preferably in cooperation with universities and/or research institutes. Its aim is to strengthen research in biotechnology and to promote the applications of the results of such research. For this purpose, grants are disbursed to successful applicants to subsidize the costs of research, which should be pre-competitive yet aiming to lead to the development of new commercial products (European Commission, 2001: 10).

The *BioProfile* contest has been designed to allow regions to define a specialization within the overall biotechnology area in which they have a regional competitive advantage. This approach is open to smaller regions that do not have the high level research capability that was required for success in BioRegio. The winners of the *BioProfile* initiative are the clusters around Berlin, Hannover and Stuttgart. The Federal Ministry of Education and Research has earmarked a total of €50 million for 5 years, which is shared among the three winning clusters.

The ''InnoRegio family''[11]—apart from the InnoRegio contest itself—consists of the programmes Interregional Alliances, Centers for Innovative Competency, InnoProfiles and Innovative Regional Growth Poles (Table 5).

Interregional Alliances (German title: *Interregionale Allianzen für die Märkte von morgen*) provides start-up finance up to a limit of €85,000 for the implementation of interregional innovation networks, whereas *Centers for Innovative Competency* (*Zentren für Innovationskompetenz*) is designed to upgrade excellent research departments at universities or research institutes in the new Länder into internationally renowned research centres.

The new programme *InnoProfiles* especially supports cooperation between junior research groups and such businesses that represent regional core competences and have the potential to contribute significantly to their region's economic development. Having started in June 2005, the programme is set out to support at least 10 projects annually over the next 4 years. Until 2012, the BMBF will allocate €150 million to this programme.

Innovative Regional Growth Poles (*Innovative Regionale Wachstumskerne*) is—from a conceptual point of view—the most sophisticated follow-up programme. Although it is claimed by the BMBF that it is a member of the InnoRegio family it is argued here that *Innovative Regional Growth Poles* (IRGP, for short) combines elements of both prototype models and might therefore be classified as a descendant of the BioRegio contest as well as an InnoRegio offspring (see illustration in Table 5).

Like the InnoRegio contest, IRGP is restricted to eastern Germany, does not focus on a single technology and supports intraregional cooperation projects. However, unlike InnoRegio—and in resemblance to BioRegio—this initiative is strictly growth oriented and attaches great importance to the economic potential of the promoted networks. The

[11] Just recently, the BMBF has bundled the four programmes of the ''InnoRegio family'' under the umbrella of a new innovation initiative for the new German Länder called ''Entrepreneurial Regions'' (the German name is ''Unternehmen Region''). A total budget of more than €500 million has been set aside for these programmes for the period 1999–2007.

presentation of regional development projects as concrete as business plans is required in order to get funding from this €112 million programme.

The application procedure is similar to that of InnoRegio: in a first step project outlines have to be prepared, which are discussed and assessed by the BMBF. Those project ideas that are positively assessed get support for the development of detailed realization concepts. The final funding decision is made on the basis of these realization concepts.

In marked contrast to InnoRegio, the BMBF's decisions in all stages of IRGP are primarily based on hardware criteria. These include: (i) a clear thematic focus of the innovation alliances, (ii) the existence of a critical mass of competences (human capital, qualified labour, R&D results, available capital, infrastructure and so forth), (iii) a discernible market potential, (iv) a sufficient entrepreneurial and strategic capacity of the management and (v) financial resources (equity) independent of public funding.

It is noteworthy, however, that cluster-based technology policy in Germany is well established now and is no longer restricted on the two prototypes and their descendants: in the meantime, a number of other cluster-based measures have been developed that neither belong to the BioRegio nor to the InnoRegio family tree (Table 5).

A striking example is the BMBF programme *Learning Regions* that started in 2000 and will run until 2006. It promotes the building of regional networks of education institutions in order to introduce innovative measures for training and education. In April 2001, the first 54 projects were selected for public funding from 250 proposals. Out of a second tender, another 20 regional networks were established in 2002.

Furthermore, a second player has entered the stage of federal cluster-based technology policy in Germany: the Federal Ministry of Economics and Technology (BMWi)[12] has in a way begun to imitate the successful measures developed by the Federal Ministry of Research and Education (BMBF) and designed a number of cluster-based technology policy measures, including the programmes NEMO and Cooperation Networks and Cluster Management (Table 5).

The BMWi programme *Network Management East* (NEMO) that started in 2002 supports regional networks of small and medium-sized firms and research institutes in the new German Länder. NEMO is complementary to the older BMWi network programmes *InnoNet* and *PRO INNO* that support pre-competitive and high-risk (InnoNet) as well as close to the market (PRO INNO) cooperation projects between SMEs and research institutes.[13]

The new (starting in 2005) programme *Cooperation Networks and Cluster Management* which is embedded in the Joint (Bund/Länder) Task ''Improvement of the Regional Economic Structure'' supports cooperation between enterprises and other regional actors in order to help the regions advance their endogenous potential and strengthen their competitiveness with up to €500,000 per project (BMWi, 2005).

In 2004 the Federal Ministry of Research and Education (BMBF) and the Federal Ministry of Economics and Technology (BMWi)[14] announced they would attune and bundle their technology support programmes in a joint ''High-Tech Master Plan for Innovation and

[12] From 2002 to 2005: Federal Ministry of Economic Affairs and Labor (BMWA).

[13] The network programmes InnoNet and PRO INNO are not listed in Table 5 as they have no explicit regional focus.

[14] At that time: Federal Ministry of Economic Affairs and Labor (BMWA).

Future Technologies in the SME Sector" and made clear that cluster-based approaches will continue to play a prominent role in German technology policy.

4. Assets and Drawbacks of National Cluster-Based Technology Policy in Germany

In this section we address assets and drawbacks of national cluster-based technology policy in Germany. Although the discussion is mainly on a theoretical level we also bring in some available empirical evidence from evaluation studies.[15]

4.1. The Assets

The rationale behind cluster-based technology policy is original and intriguing: these policies explicitly consider the existing spatial structure of a country and try to exploit the propensity of knowledge-intensive industries to cluster in order to raise national technological competitiveness (Dohse, 2000b; Sternberg, 2003). This strategy is based on the perception that the resource which above all distinguishes modern, highly developed economies from less developed economies and upon which competitive advantage can be based is knowledge, such that competitiveness can be boosted by the development of knowledge as a *strategic resource* (Temple, 1998). And clusters, with their high density of information flows, their social capital and their access to intellectual, technical and social spillovers appear to provide a particularly fertile soil for the growth of the strategic resource knowledge.[16] Clusters provide a specific form of market organization that helps firms to become more knowledgeable and to compensate for demand and supply fluctuations (enhance resource efficiency), in particular when industry conditions are characterized by high uncertainty or ambiguity (Maskell and Lorenzen, 2004).

A distinct feature of the new cluster-based technology policy measures in Germany is that the new approaches are taking regions seriously. The role of the regions is not a passive one, they are not mere recipients of public funding but active players in the innovation process. To be successful in the competition for public funding the regions have to bundle and activate their innovative resources, that is, the policy measures directly aim at stimulating and galvanizing the endogenous growth potential existing in the regions. Thus, when initiatives submit their proposals they have already made an important first step towards establishing a regional network and self-organizing their future division of

[15] It has to be noted, however, that because most of the programmes are still in operation the available empirical evidence is rather limited as yet (Eickelpasch and Fritsch, 2005).

[16] Although there is ample case study evidence on the role of clusters as drivers of growth and innovation, mainstream economists have often criticized the lack of more rigorous theoretical work and more systematic empirical analyses on these issues. In recent years, however, the case study evidence has been supplemented by rigorous theoretical work and empirical studies based on larger samples of firms and regions. In a recent paper by Norman and Venables (2001) it is shown that competition among national governments for clusters might be efficiency-enhancing in a two sector, many country world when one sector (the one that tends to cluster) is subject to increasing returns to scale at the national level. Baptista (2000) finds that the speed of intraregional diffusion of new technology increases with the number of adopters already located in the respective region which may be seen as a hint that innovations diffuse faster within a geographical cluster. And Audretsch and Dohse (2004) are able to show that the location in agglomerations with a high knowledge potential has a positive impact on the post-entry performance of young high-tech firms.

innovative labour (Eickelpasch and Fritsch, 2005). A survey performed by the DIW Berlin among members of those InnoRegio initiatives that were selected for funding in the final stage of the contest substantiated a considerable mobilizing effect concerning the self-organization of innovative networks (Eickelpasch *et al*., 2004).[17] Moreover, another DIW survey among the rejected applicants of the InnoRegio contest showed that for each initiative funded in the InnoRegio programme there were at least three rejected initiatives that were realized in spite of their rejection in the InnoRegio programme (DIW, 2005). In view of this ''mobilization surplus'' one may argue that the overall mobilization of innovative potential resulting from InnoRegio has considerably exceeded the amount of activity directly funded by the programme (Eickelpasch and Fritsch, 2005: 1280).[18]

Another argument for taking regions seriously might be derived from the fact that technological change is path dependent and national governments lose influence and can no longer shelter their respective regions from increasing competitive pressure from abroad. Against this background, giving the regions a competitive edge in an emerging technology may be seen as an attractive strategy of providence for the future.

The recent innovations in German technology policy may also be seen as an attempt to build up sustainable *regional innovation systems*. Regional innovation systems are conceptualized as systems of collective order based on mutual understanding, trust and reciprocity among the members of the regional innovation community (Cooke, 1998: 16). The regions themselves are viewed as places of collective technological learning and technological competence is seen as a regionally developed and rooted asset (Braczyk and Heidenreich, 1998: 416). The new policies fit quite well into the *regional innovation system* concept as they share the assumption that the regional environment is crucial for the innovation process and aim at fostering the establishment of a collective order of trust and reciprocity within the regions that may help overcome obstacles to innovation.

In fact, the BioRegio (less so the InnoRegio) contest also comes quite close to another theoretical concept, that of Functional, Overlapping, Competing Jurisdictions (FOCJ), suggested by Frey and Eichenberger (1995). The BioRegios formed spontaneously—although on the basis of already existing structures—and are in principle *functional* (single purpose) regions. They *compete* with each other for public funding, mobile inputs, ideas and—in the longer run—market shares. Furthermore, they may be seen as *overlapping* as they need not (although they may) be identical with the usual administrative regions, and their composition may change with regard to the field of technology they try to promote or the kind of public good they offer (Dohse, 2000b). Functional, overlapping, competing jurisdictions have various advantages (Frey and Eichenberger, 1995: 218):

- they are not determined and imposed from outside and above but emerge in response to the ''geography of problems'';
- as functional regions they have the virtue of minimizing interregional spillovers, internalizing intraregional (knowledge) spillovers and of exploiting economies of scale;

[17] Eickelpasch *et al*. (2004) report that only 5 per cent of the respondents had cooperative relationships with all or many partners before the contest, whereas nearly one-fifth of them did not cooperate with their InnoRegio partners before and the large majority (68 per cent) had cooperative relationships with only some of their InnoRegio partners before.

[18] Similarly, Kulicke *et al*. found that a major advantage of PRO INNO is the mobilization of innovative potential and the enhancement of the participants' ability to cooperate with and learn from others (Kulicke *et al*., 2005).

- they stimulate the competition between regions which is a competition between governments and institutions.

To sum up, the theoretical case for a cluster-based technology policy of the kind performed by the German Federal Government appears to be quite strong. In practice, however, there remain a number of problems.

4.2. The Drawbacks

Some of these problems are quite general in nature and apply to all kinds of cluster-based technology policy, whereas others are specific to the respective prototype. We begin with a discussion of the more general problems.

A very general (and difficult to solve) problem of cluster-based technology policy is the discrimination of innovative enterprises that are located outside the target regions of the respective programmes. Moreover, it still is unsettled whether the regional clustering of innovative activities in a specific technology area really produces substantial positive externalities. To a significant extent, this depends on the position of the corresponding industry in the industrial life cycle. The formation of clusters seems to be suitable for stimulating the growth of industries and technologies that are in an early stage of their life cycle (like biotechnology, microprocessing or nanotechnology), but it seems less appropriate for mature industries and technologies (Dohse, 2000a).

Another possible drawback is the existence of goal conflicts between the regional technology policies pursued by the regions themselves (i.e. the ''Bundesländer'' in Germany) and the federal government's policies. As already discussed in more detail in Section 2, some large and technologically strong Länder (in particular Baden-Württemberg, North Rhine-Westphalia and Bavaria) performed cluster policies long before the federal government recognized the region as a resource of comparative advantage in the mid-1990s. In the meantime, cluster policies have become so popular among German policy makers that in recent years all 16 Bundesländer have initiated cluster-based policy programmes (Krumbein and Ziegler, 2005: 19). Even less favoured states with a weak technological basis and strict budget restrictions try to keep up with the leading regions in a competition for technology, and it is evident that such an un-coordinated policy action runs the risk of inefficient double spending and a waste of taxpayers' money since ''… too many regions are attempting to become technology cores without even the glimmer of a possibility of doing so'' (Storper, 1995: 302). Moreover, incentives that dissipate the regions' natural advantages may act to the detriment of innovation and technological change as resources are allocated to locations where they are less productive (Feldman and Martin, 2005: 1237). Thus, the question of innovation policy coordination between Germany's federal and Länder governments comes to the fore. Some authors (e.g. Reinhard, 1999) argue that there exists in fact no significant coordination between federation and Länder in the field of innovation policies, such that double spending and waste of resources appear very likely. A recent study by Wilson and Souitaris comes to more sophisticated results, however. The authors identify three broad areas of interaction between federation and Länder in innovation policy. These are, in the order of declining formality: the innovation infrastructure, promotional programmes and individual projects. In recent years one can observe a shift in focus from formal and binding interaction mechanisms towards informal and voluntary ones (Wilson

and Souitaris, 2002: 1129ff.). Nevertheless, the system of voluntary collaboration between the different layers of government is perceived to work well by representatives of both sides. Furthermore, the increasing use of competitions such as BioRegio or InnoRegio is seen as an efficient mode to disburse federal money that serves the interests of both, the federation and the Länder (ibid.).

A further disadvantage of the new programmes that applies to both prototypes is that they take more time than conventional programmes.[19] This was criticized by BioRegio as well as by InnoRegio participants, especially by those who planned to realize high-tech projects and were afraid of losing first-mover advantages (Dohse, 2000b; Eickelpasch *et al.*, 2002).

Apart from the above-mentioned more general problems of cluster-based technology policy there are also problems specific to the respective prototype. The determination of the adequate level of selectivity in funding is a case in point: a clear-cut technological (and regional) focus as in the BioRegio contest implies a ''picking of winners'' and a ''presumption of knowledge'', whereas a broadly scattered funding of small projects—as in the InnoRegio contest—might possibly have no effect at all, because the necessary ''critical levels'' are not reached. The BioRegio contest may be seen as an instrument for picking winners in two respects: picking a winning technology (biotech) and picking winning regions.[20] The picking of a winning technology is problematic because the underlying assumption that this technology will create substantial positive externalities in the future is unprovable *ex ante* which raises the obligatory question why one should think that bureaucrats are cleverer than the market (Hayek, 1975; Krugman, 1994; von Tunzelmann, 1995).[21] A similar argument holds for the picking of winning regions. Cluster-based technology policy approaches may be costly (apart from their direct costs in the form of taxpayers' money) as they foster the development of some selected regions and suppress the development of other regions, at least in relative terms (Dohse, 2000b).

While the BioRegio contest obviously pursues a growth objective, the InnoRegio contest pursues two objectives at once: overall economic growth and regional convergence. On the one hand, it aims at strengthening the innovative potential of Germany as a whole, on the other hand, it intends to start a catch-up process of lagging regions (eastern Germany vis-à-vis western Germany, East German regions with special structural problems vis-à-vis more prosperous regions). Achieving both objectives with one single instrument is hardly possible, because there is a clear trade-off between these two objectives: the growth or efficiency objective requires investment of taxpayers' money in those regions in which they yield the highest social marginal return. This is usually the case in regions that can already boast a certain amount of research infrastructure and technological competence. Thus, the growth objective frequently requires a ''strengthening of the strong'', as was the

[19] This is due to these programmes' multilevel selection procedure as well as to the higher organizational effort for the administration.

[20] One may also use the less familiar term ''backing winners'' here, since the selection of winning regions is not a fully blind bet but contains a strong element of knowing the good form of contestants before starting the contest.

[21] It should be noted, however, that von Tunzelmann (1995) argues that a more comprehensive strategy of ''making winners'' is preferable to just picking prospective winners and that Stiglitz doubts whether the whole discussion is framed in the right way as the ''… objective of the government is not to pick winners, but to identify externality-generating innovations'' and in this respect governments ''… have had a history of notable successes'' (Stiglitz, 1999: 22).

case in the BioRegio contest. By contrast, regional convergence demands for the support of regions with structural problems which is problematic from an overall economic efficiency point of view. As is well documented in the literature, cluster building from a ground zero position is much more likely to fail than cluster building promoted from a strong science and financial base (Cooke, 2002: 171). By pursuing two objectives at once the InnoRegio contest violates a policy principle known as ''Tinbergen's law'' according to which the number of policy goals must not exceed the number of policy instruments available (Tinbergen, 1952, 1956; Jankowski and Wlezien, 1993; Ahrens and Lippert, 1994).

4.3. Combining the Prototypes' Strengths—A Guarantee for Success?

As both prototype models have their specific merits and problems it is well comprehensible that the BMBF has tried to combine the strengths of both prototypes, BioRegio and InnoRegio, in the new initiative ''Innovative Regional Growth Poles'', as discussed in Section 3. We consider this as evidence that a process of learning by doing and stepwise optimization is going on in the BMBF.[22] Nevertheless, even with regard to the most advanced initiative ''Innovative Regional Growth Poles'' there remain some doubts:

- The restriction of the programme to eastern Germany is not compatible with overall economic efficiency.
- The central premise underlying the new programme is that intraregional networking (or cooperation) between East German firms is the bottleneck in the development of ''innovative growth poles'' in eastern Germany. One might ask whether it is really necessary to financially support such cooperation if it is in the firms' own interest.
- Furthermore, one might ask if the integration of partners from more distant locations (e.g. from western Germany or from abroad)[23] into these networks is more stimulating than the narrow focus on intraregional cooperation.[24]
- Recent research on the East German economy shows that those regions in the new Länder considered to be ''growth poles'' by the German *Council of Economic Advisors* (Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung) have performed poorly in the 1990s and have not produced considerable growth spillovers to neighbouring regions (DIW *et al.*, 2002, chapter 2).[25]

---

[22] In telephone interviews with BMBF and PTJ (BMBF-Projektträger Jülich) officials it was confirmed that the experiences with both prototypes, BioRegio and InnoRegio, were considered in the design of IRGP. The clear-cut focus on hardware criteria was laid in order to avoid ''teething troubles'' experienced with InnoRegio (e.g. undue long time span for the elaboration of project ideas into concrete projects, unclear or shifting thematic focus of some initiatives) and to enhance the economic efficiency of the programme.

[23] The integration of firms or research institutes from West Germany is possible but it is not financially supported by the BMBF.

[24] Studies based on the European Regional Innovation Survey (e.g. Sternberg, 2002) show that intensive intraregional as well as interregional linkages foster firm growth. It is striking, however, that Saxony—the only East German region in that sample—is characterized by a high share of intraregional linkages (as compared to interregional or international linkages) which could be interpreted as a weakness of Saxony's regional innovation system (Sternberg, 2002: 148). Thus, if Saxony is representative for eastern Germany as a whole interregional and international linkages might be the bottleneck factor rather than intraregional linkages.

[25] This is, however, no principal objection as this may change in the longer run and need not apply to the new ''growth poles'' at which IRGP targets.

- Last but not least, the IRGP programme is financed with money from the German UMTS licence auction. As is well known the suppliers of cellular phone networks had to pay an immense amount (€51 billion) for these licences. Even independent observers say that the price was much too high and is likely to become a substantial handicap for the growth of the German telecommunications sector. Thus, one might argue that small-scale technological transformation of selected regions in eastern Germany is bought dearly by hampering the large-scale transformation of the country towards the information society.

So, while IRGP is arguably the most advanced of the new policy programmes it is clearly too early to assess whether it does indeed outclass its predecessors. Complementary research has only come to preliminary results as yet: a recent survey by the Malik Management Centre St Gallen suggests that those IRGP initiatives that linked their technology base with specific clients' needs from the very start performed best. Moreover, the study finds some evidence that the 18 initiatives supported by the BMBF over the past years have contributed to raising the regions' skill profiles (BMBF, 2005). As these appear to be rather soft and preliminary results, further research on the relative performance of IRGP (as compared to BioRegio and InnoRegio) is definitely needed in order to advance the future design of cluster-based technology policy in Germany.

5. More General Reflections on Cluster Building and National Advantage

In the previous section we have assessed strengths and weaknesses of the new cluster-based approaches in German technology policy. In this section we try to shed some new light on two more general policy questions that appear to be highly relevant beyond the German context: (i) can clusters be built by national government policy action? and (ii) is regionalization of technology policy a suitable means of achieving goals at the national level?

5.1. Can Clusters be Built?

Regional or local governments often play an important role in the promotion, self-organization and upgrading of existing clusters, removing local bottlenecks (e.g. in the physical and institutional infrastructure) and administrative obstacles to innovation. Central government, by contrast, is usually held responsible for setting macro-economic conditions and a regulatory framework favourable to innovation and growth.

The German Federal Government has gone one step further and plays a more active role than most other central governments in Europe by explicitly trying to exploit the country's polycentric spatial structure for competitiveness policy purposes. Its strategy is to initiate an interregional competition for public funding in order to spur the regions to bundle and fully develop their endogenous technological potential, which, in turn, is expected to help forward the technological competitiveness of the country as a whole. This raises the central question, *whether, by which means and under which circumstances national governments can create internationally competitive clusters within their territories*.

A clear-cut answer is complicated by the fact that the large and growing literature on clusters and localized learning has been accused of being "fuzzy" and incapable of providing policy prescriptions (Lorenzen, 2001). However, there are a number of recent

attempts to explicate policy options from this literature, particularly in the journals *European Planning Studies* (e.g. Hassink, 1997), *European Urban and Regional Studies* (e.g. Hassink, 1996) and *Regional Studies* (e.g. Ashcroft *et al*., 1995), as well as book publications by Rosenfeld (1995), Koschatzky (1997a, b), Steiner (1998) and Archibugi *et al*. (1999).[26] One may argue that—notwithstanding the relative poverty of policy advice derivable from this literature—a number of arguments and results are so common in the above-named contributions that they do in fact provide a basis for sketching out policy means as well as more general policy principles (Lorenzen, 2001).

Policy means derivable from this literature focus on strengthening the ability to learn in all parts of the economy, which encompasses the ability to create new knowledge as well as the ability to absorb knowledge produced elsewhere (Lundvall, 1999). Following the classification scheme proposed by Lorenzen (2001), these policy means can be subdivided into means for promoting firm level learning, means for promoting interactive learning and means for promoting knowledge centres and links to the outside (see also Table 6).

Even more important, there appears to be quite some consistency in the literature with respect to more general policy principles: first, as already argued in Section 4, *there is an obvious need for a localized policy* as national competitiveness depends to an increasing degree upon learning processes which take place at the regional or local level (Amin and Thrift, 1994; Maskell *et al*., 1998; Lorenzen, 2001; Asheim *et al*., 2003).

Second, *there are narrow limits to policy imitation*. Hospers and Beugelsdijk (2002) have convincingly argued that the opportunities for lesson-drawing in regional cluster policies are limited due to the uniqueness of regional structures and regional cultures. Their theoretical argument is supported by the fact that experiences with implementing clones of policies which were successful elsewhere have been rather discouraging. Given the uniqueness of each single cluster, it is pivotal to take the characteristics of the existing system of innovation into account when introducing new elements and institutions (Lundvall, 1999).

Third—and perhaps most important—*policy measures must conform to market processes* (Maskell *et al*., 1998), as successful clusters are business driven and cannot

Table 6. Policy means discussed in the localized learning literature

Means for promoting firm level learning	Means for promoting interactive learning	Means for promoting knowledge centres and links to the outside
– Education and training	– Nurturing more learning agents	– Enhancing the quality of local universities and research institutes
– Support for organizational learning	– Promoting cooperation, communication and trust	– Providing an excellent technology transfer infrastructure
– Support for spin-offs	– Promoting cluster structures	– Attracting MNCs and utilizing large firms

MNCs=multinational corporations.
Source: Lorenzen (2001).

[26] Moreover, a useful compilation of policies towards regional clustering can be found in OECD (1999).

be created by public policy "from scratch". This implies that policy makers should recognize firms as learning and experimenting enterprises, leave room for experimentation and variety at the regional level and facilitate learning (in particular complex and socially embedded—i.e. systemic—learning), as well as unlearning (i.e. the shift in firms' routines and technologies) (Lorenzen, 2001).

The theoretical argument for cluster-based policies has been explicated elsewhere (see, e.g. Porter, 1990; Lorenzen, 2001; Enright, 2003 and the literature quoted therein or Storper, 1995. See also Section 4 of this paper). In this context it is just necessary to mention that the strongest rationale for cluster development policies—as well as for other policy interventions into the market process—is market failure.[27] Proper cluster development policies should therefore spend due effort to identify and address the specific market failures they are designed to overcome (Enright, 2003).

Supplementary to the above-named and widely accepted principles, the analysis of the German case in the previous sections of this paper suggests three further lessons for federal governments trying to grow internationally competitive clusters within their territory.

Cluster-based technology policy should take care to identify and build upon existing strengths of the regions; *"strengthening of the strong" is more promising than subsidizing the weakest regions*. Such a policy may increase regional disparities, although this needn't always be problematic: if the strategy of upgrading national champions to internationally significant growth regions is successful, it is likely that this will also benefit peripheral and technologically backward regions.

Cluster-based technology policy should—in a spatial sense—be as open as possible, that is, the regions participating in a competition for government funding should form spontaneously and no regions should be excluded from this competition (i.e. there should be no "closed shops").

Cluster-based technology policy should focus on young, knowledge-intensive sectors or industries in an early phase of their life cycle that strongly rely on (and produce) knowledge spillovers and can thus be expected to be the primary beneficiaries of such policies.[28]

We conclude that national governments can (and in many cases do) support and galvanize the development of internationally competitive clusters within their territory. To minimize the risk of failure—that is, the risk of wasting taxpayers' money—inherent in such cluster-support policies, national governments should carefully consider the policy principles discussed in this section. Most important, policy measures must conform to market processes and cluster promotion should be understood as an experimental and highly complex matter, requiring a high degree of openness, creativity and willingness to learn on the part of all parties involved.

---

[27] Classical forms of market failure include externalities (e.g. knowledge spillovers) or underprovision of public goods (e.g. in the area of education and training). Enright adds impacted information (when information useful to firms is not available or only available at prohibitive costs), managerial myopia (when information available is not used due to a lack of understanding) and coordination failure (when information is available and understood but not used because actors are unable to organize themselves to act in concert) to this list (Enright, 2003: 120).

[28] Considering the results of recent research by Lehrer (2005) one may add that cluster-based technology policy is better suited for "science-driven" high-tech industries (such as biotech) than for "market-pioneering" high-tech (such as computers) since "science-driven" sectors allow multiple local clusters to coexist whereas "market-pioneering" sectors often tend to locate in one (or a few) hegemonic clusters.

5.2. Does Cluster-Based Technology Policy Help Forward National Competitiveness?

In their editorial introduction to the *Research Policy* special issue on "Regionalization of Innovation Policy" Fritsch and Stephan conclude that an important unresolved research question that deserves further investigation "… is the contribution of regionalized innovation policy to the achievement of goals at the national level" (Fritsch and Stephan, 2005: 1126). We argue that at least in federal systems characterized by strong players at the sub-national level the utilization of the cluster dimension and the decentralization of innovation policy can be seen as promising means of improving national innovative performance and competitiveness. The German approach to cluster-based technology policy is a very good case in point as it has a number of distinctive features that are conducive to the achievement of national goals: although the new policy instruments dealt with in this paper clearly represent a regionalization of federal activity and give considerable latitude on the nature and composition of the regional networks as the primary reference units of policy, they nonetheless remain federal activity and keep the strategic responsibility at the federal level. This arrangement allows a combination of the advantages of classical "bottom up" and classical "top down" approaches. The direct communication and the strong motivation of cluster members at the local level tend to induce faster outcomes and enhance the efficiency of innovation-related cooperation (Fromhold-Eisebith and Eisebith, 2005), whereas the national perspective helps avoid an overly parochial and fragmented approach and warrants that poor performance is noticed and addressed (Wilson and Souitaris, 2002). One may therefore argue that the new policy instruments have a considerably higher impact—not only at the regional but also and in particular at the national level—than conventional programmes of comparable budget size (Dohse, 2003; Eickelpasch and Fritsch, 2005).

Some observers (e.g. Wachendorfer-Schmidt, 2000; Jeffery, 2002) have noticed that the German system is currently shifting from cooperative federalism to *competitive federalism*, and new policy instruments such as BioRegio or InnoRegio do exactly reflect this policy shift: they promote intraregional cooperation, interregional competition and national coordination in the technology policy arena. The stimulation of *interregional competition* (or competition between clusters) is a particularly interesting and important element of the German model of cluster-based technology policy. As is well known from the literature, however, competition among countries or regions is not equivalent to product market competition and thus doesn't have the same efficiency properties (Krugman, 1994), which raises the question whether the promotion of interregional (inter-cluster, respectively) competition by the federation is justified at all. The answer depends, of course, on the chosen definition of *interregional competition*. A possible meaning of interregional competition is that the immobile factors of production that are bound to a specific region compete for complementary mobile factors in order to raise their marginal product and thus their income. Immobile factors of production are land, part of the labour force,[29] regional amenities and so forth whereas capital, skilled labour and—perhaps most important—technological knowledge are to a certain degree mobile.[30] Competition between regions in

[29] This is particularly true for unskilled labour, although one should not name unskilled labour as an immobile factor of production per se.

[30] There are, of course, substantial differences in the degree of mobility of different kinds of knowledge. Codified knowledge is highly mobile whereas tacit knowledge sticks (at least temporarily) to particular individuals and regions.

the above-mentioned sense can serve as a stimulus to modernize and innovate institutionally (Dohse, 2000b), and thus to avoid institutional sclerosis of the kind described by Olson (1982).[31] Such competition may be seen as an experimental mode for the discovery of superior institutional arrangements and it may help the regions to recognize and fully develop their ''comparative institutional advantage'', a notion introduced by Hall and Soskice (2001). It is important to note that competition may not only stimulate the discovery of superior institutional arrangements but also contribute to their faster diffusion (Eickelpasch and Fritsch, 2005).

The stimulation of interregional competition by the federation may thus be seen as an important catalyst for the institutional restructuring of the whole country with positive impact on national innovativeness and competitiveness. This applies even more as there are indications that the Länder—which increasingly gain importance in the German technology policy arena—appreciate the new competition-based initiatives by the federal government: the Länder governments like and support the new policy approach ''since it is bottom up, allows activity to match local circumstances and gives them latitude to support as they deem most appropriate'' (senior official in Brandenburg Economics Ministry, quoted in Wilson and Souitaris, 2002: 1132).

While a deliberate mixture of cooperative and competitive elements may well be beneficial for the achievement of national goals another element is—in the author's view—equally important: the modest role of the federation that gives the regional units the freedom to experiment and to learn from experience.[32] The federal government makes no attempt to impose one-size-fits-all solutions on locally delegated activity, but instead formulates rather general goals and performance measures: ''… how the local players achieve this goal, who they collaborate with, and precisely which performance measures to use is up to them'' (Wilson and Souitaris, 2002: 1138). This fits quite well with the notion of *experimental federalism* introduced by Sabel (1996). The freedom to experiment, to learn from mistakes and to stepwise improve one's policy is a necessary condition for competition to work as a discovery procedure as explicated above.

Moreover, a federal policy that stimulates experimentation and variety at the regional level may help the regions to recognize their respective strengths and build up unique place-specific assets that cannot be easily replicated elsewhere. Feldman and Martin have argued that an activity system[33] which is unique, not easily replicated and sustainable is the key to constructing what they call ''*jurisdictional advantage*'' (Feldman and Martin, 2005). We argue that a policy that helps the regions to construct ''jurisdictional advantage'' is also conducive to what may be called ''*national advantage*'' as a country's competitiveness and welfare critically depend on the strength and international competitiveness of its regions.

---

[31] One may add that even the belief by policy makers that their countries or regions compete is ''… an important factor in explaining institutional change'' (Lehrer and Asakawa, 2004: 921).

[32] The adequacy of such a policy depends, of course, on the political administrative system of a country and its economic development level. In Germany, due to its federal political system, local actors are well endowed and empowered to develop strong bids, whereas in countries with centralized political systems this might not be the case. In such countries, in particular when they are in an early economic development stage, directive cluster-based policies might be rather efficient.

[33] The term ''activity system'' is borrowed from corporate strategy and is defined as ''… a coherent web of activities'' (Feldman and Martin, 2005: 1239).

To sum up, we conclude that the German Federal Government's approach of utilizing the regional level to boost innovation and competitiveness can indeed be seen as a promising means of achieving policy goals at the national level.

6. A Model for Other European Countries?

Are the German experiences with cluster-based technology policy of any value for policy makers in other European countries? In our view, they are.

Taking into account that there are narrow limits to policy imitation (as argued in Section 5.1), it may nevertheless be useful for policy makers in other European countries to carefully analyse the German experiments with cluster-based technology policy and to use them as a source of inspiration in designing their own policies: ''The foreign economy may act as a mirror, which enables policymakers to take a fresh look at current domestic practices and institutions, to reappraise their strong points and to think of ways to improve their imperfections'' (CPB, 1997: 2).

A strong point about the German approach is that the federal government plays a rather decent and unboastful role. Its (quite realistic) self-conception is that of a catalyst and facilitator of innovation processes rather than that of an omniscient planner. The new policy measures leave room for experimentation and variety at the regional level, take the systemic and embedded nature of learning into account, focus on long-term, dynamic aspects of cluster development and are open to accept a wide variety of outcomes (regional development paths) as long as the actual outcome is in line with the overarching objective of increasing technological competitiveness. Moreover, there are different types of programme that take different regional structures into account.

InnoRegio type programmes might be particularly useful in regions with distinctive structural problems such as the Central and Eastern European countries (CEECs) (new EU member states) that belonged to the former communist bloc. As was argued in Section 4, a major advantage of InnoRegio type models is the mobilization of innovative potential and the enhancement of the participants' ability to cooperate with and learn from others. As shown in Section 3, the requirements concerning what we called ''the already existing hardware of a region'' are lower in the InnoRegio type programmes than in the BioRegio type programmes. Taken together, these findings suggest that policy makers in the CEECs, facing the challenges of structural change on a technical and economic level as well as social modernization, might profit from having a closer look at InnoRegio type programmes.

By contrast, BioRegio type models seem to be more appropriate for technologically and economically advanced countries striving for technological leadership or at least catch up with the top performers. Moreover, BioRegio type models require—even more than InnoRegio type programmes—that the country has strong players at the sub-national level endowed and empowered to develop strong bids and a dispersed regional innovation structure, that is, enough regions that have the potential to become internationally competitive clusters in the longer run. There are, admittedly, only few countries in Europe (apart from Germany) that fulfil these requirements (see Table 7). Nevertheless, BioRegio type models might be a suitable means of policy-making at the level of the European Union.

Table 7. Regional R&D[a] concentration in selected European countries and the USA

More than half of a country's R&D employment is located in the following regions (metropolitan areas) …

Germany 1997		**France 1995**		**UK 1995**		**Italy 1995**		**Spain 1995**		**Austria 1993**	
Munich	12%	Paris (Ile de France)	48%	London (South East)	41%	Milano (Lombardia)	33%	Madrid	32%	Vienna	52%
Stuttgart	12%	Rhone-Alpes (Lyon)	11%	East Anglia	11%	Turin (Piemonte)	24%	Barcelona (Cataluna)	29%		
Hessen-Süd	9%					Roma (Lazio)	10%				
Rhine-Neckar	6%										
Berlin	4%										
Dusseldorf	4%										
Braunschweig	3%										
Cologne	3%										
	53%		59%		52%		67%		61%		52%
Denmark 1995		**Sweden 1995**		**Finland 1995**		**Norway 1995**		**Netherlands 96**		**USA**	
Copenhagen	63%	Stockholm	34%	Helsinki	47%	Oslo	37%	West-Netherlands	39%	New Jersey/Essex	9%
		Gothenburg (Västsverige)	25%	Etelä-Suomi	32%	Ostlandet Sudre	17%	South-Netherlands	37%	Boston	8%
										Los Angeles	7%
										Philadelphia	6%
										Chicago	5%
										Detroit	4%
										New York	4%
										San Jose	3%
										Washington, DC	3%
	63%		59%		79%		54%		76%	About	50%

[a]Only private sector R&D.

Source: Gehrke and Legler (2001: 36).

Acknowledgement

The author is grateful to two anonymous referees for helpful comments. The usual disclaimer applies.

References

Ahrens, H. and Lippert, C. (1994) Tinbergen-Regel und Agrarpolitik, in: K. Hagedorn, F. Isermeyer, D. Rost & A. Weber (Eds), *Gesellschaftliche Forderungen an die Landwirtschaft. Schriften der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaues e. V.*, pp. 151–160 (Münster: Landwirtschaftsverlag Münster-Hiltrup).

Amin, A. and Thrift, N. (1994) *Globalisation, Institutions and Regional Development in Europe* (London: Oxford University Press).

Archibugi, D., *et al.* (Eds) (1999) *Innovation Policy in a Global Economy* (Cambridge: Cambridge University Press).

Ashcroft, B., *et al.* (1995) UK innovation policy: a critique, *Regional Studies*, 29(3), pp. 307–311.

Asheim, B., Isaksen, A., Nauwelaers, C. and Tödtling, F. (Eds) (2003) *Regional Innovation Policy for Small–Medium Enterprises* (Cheltenham: Edward Elgar).

Audretsch, D. B. and Dohse, D. (2004) *The Impact of Location on Firm Growth*, CEPR Discussion Paper 4332 (London).

Baptista, R. (2000) Do innovations diffuse faster within geographical clusters?, *International Journal of Industrial Organization*, 18(3), pp. 515–535.

Berger, C. (2005) Technologie- und Innovationspolitik in Bayern, in: W. Krumbein & A. Ziegler (Eds), *Perspektiven der Technologie- und Innovationsförderung in Deutschland*, pp. 26–50 (Marburg: Schüren-Verlag).

BMBF (Bundesministerium für Bildung und Forschung) (1996a) BioRegio-Wettbewerb—Entscheidung im November. Pressemitteilung vom 25. Oktober. Bonn.

BMBF (1996b) Bundesbericht Forschung 1996. Bonn.

BMBF (1999) Ausschreibungsbroschüre: Innovative Impulse für die Region. Berlin.

BMBF (2005) Die Strategie entscheidet—Mit Weitsicht zum Wachstumskern, in: BMBF (Ed.), *Unternehmen Region 3/2005*, Berlin.

BMWi (Bundesministerium für Wirtschaft und Technologie) (2005) Neues GA-Förderangebot ''Kooperationsnetzwerke und Clustermanagement''. Pressemitteilung vom 14. Januar. Berlin.

Braczyk, H.-J. and Heidenreich, M. (1998) Regional governance structures in a globalized world, in: H.-J. Braczyk, P. N. Cooke & M. Heidenreich (Eds), *Regional Innovation Systems*, pp. 414–440 (London: UCL Press).

Cooke, P. (1998) Introduction: origins of the concept, in: H.-J. Braczyk, P. N. Cooke & M. Heidenreich (Eds), *Regional Innovation Systems*, pp. 2–25 (London: UCL Press).

Cooke, P. (2001) New economy innovation systems: biotechnology in Europe and the USA, *Industry and Innovation*, 8, pp. 267–289.

Cooke, P. (2002) *Knowledge Economies. Clusters, Learning and Cooperative Advantage* (London and New York: Routledge).

Cooke, P. and Morgan, K. (1990) Learning through networking: regional innovation and the lessons of Baden-Württemberg, Report No. 5, Regional Industrial Research, Cardiff.

Council on Competitiveness (2005) *Regional Innovation Guide*, Electronic Resource http://www.compete.org/nri/regional_innovation_-guide.asp (accessed 16 February 2005).

CPB (Netherlands Bureau for Economic Policy Analysis) (1997) *Challenging Neighbours: Rethinking German and Dutch Institutions* (Berlin: Springer).

DIW (Deutsches Institut für Wirtschaftsforschung) (2005) Results of complementary research to the InnoRegio-program. Berlin (mimeo).

DIW (Deutsches Institut für Wirtschaftsforschung), IAB (Institut für Arbeitsmarkt- und Berufsforschung der Bundesagentur für Arbeit), IfW (Institut für Weltwirtschaft), IWH (Institut für Wirtschaftsforschung Halle) & ZEW (Zentrum für Europäische Wirtschaftsforschung) (2002) Fortschrittsbericht wirtschaftswissenschaftlicher Institute über die wirtschaftliche Entwicklung in Ostdeutschland. IWH Sonderheft 3/2002. Halle.

Dohse, D. (2000a) Regionen als Innovationsmotoren—zur Neuorientierung in der deutschen Technologiepolitik, *Kieler Diskussionsbeiträge 366* (Kiel: Institut für Weltwirtschaft).

Dohse, D. (2000b) Technology policy and the regions: the case of the BioRegio contest, *Research Policy*, 29, pp. 1111–1133.

Dohse, D. (2003) Taking regions seriously: recent innovations in German technology policy, in: J. Bröcker, D. Dohse & R. Soltwedel (Eds), *Innovation Clusters and Interregional Competition*, pp. 372–394 (Berlin and Heidelberg: Springer).

Eickelpasch, A. and Fritsch, M. (2005) Contests for cooperation—a new approach in German innovation policy, *Research Policy*, 34(8), pp. 1269–1282.

Eickelpasch, A., Kauffeld, M. and Pfeiffer, I. (2002) The InnoRegio-program: implementing the promotion and developing the networks, *Economic Bulletin*, 39, pp. 281–289.

Eickelpasch, A., Pfeiffer, I. and Pfirrmann, O. (2004) Zur Evaluierung der Förderung regionaler Innovationsnetzwerke—Ansatz und Erfahrungen am Beispiel des InnoRegio-Programms, *Zeitschrift für Evaluation*, 3, pp. 181–198.

Enright, M. J. (2003) Regional clusters: what we know and what we should know, in: J. Bröcker, D. Dohse & R. Soltwedel (Eds), *Innovation Clusters and Interregional Competition*, pp. 99–129 (Berlin and Heidelberg: Springer).

Ergas, H. (1987) Does technology policy matter?, *CEPS Papers No. 29* (Brussels).

Ernst & Young (2001) *European Life Sciences 2001: "Integration". The Eighth Annual Ernst & Young Report on the European Biotechnology Industry* (Stuttgart).

European Commission (var. issues) *European Trend Chart on Innovation. Country Report: Germany* (Brussels).

Feldman, M. and Martin, R. (2005) Constructing jurisdictional advantage, *Research Policy*, 34(8), pp. 1235–1249.

Fier, A. and Harhoff, D. (2002) Die Evolution der bundesdeutschen Forschungs- und Technologiepolitik: Rückblick und Bestandsaufnahme, *Perspektiven der Wirtschaftspolitik*, 3(3), pp. 279–301.

Forslid, R. and Midelfart Knarvik, K.-H. (2002) Globalization, industrial policy and clusters, *CEPR Discussion Paper 3129* (London).

Frey, B. S. and Eichenberger, R. (1995) Competition among jurisdictions: the idea of FOCJ, in: L. Gerken (Ed.), *Competition among Institutions*, pp. 209–229 (Basingstoke: Macmillan).

Fritsch, M. and Stephan, A. (2005) Regionalization of innovation policy? Introduction to the Special Issue, *Research Policy*, 34(8), pp. 1123–1127.

Fromhold-Eisebith, M. and Eisebith, G. (2005) How to institutionalize innovative clusters? Comparing explicit top-down and implicit bottom-up approaches, *Research Policy*, 34(8), pp. 1250–1268.

Fuchs, G. and Wassermann, S. (2005) Path-dependency in Baden-Württemberg: lock-in or breakthrough?, in: G. Fuchs & P. Shapira (Eds), *Rethinking Regional Innovation and Change*, pp. 223–248 (Berlin and Heidelberg: Springer).

Gehrke, B. and Legler, H. (2001) *Innovationspotenziale deutscher Regionen im europäischen Vergleich* (Berlin: Duncker & Humblot).

Hall, P. and Soskice, D. (Eds) (2001) *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage* (Oxford: Oxford University Press).

Hassink, R. (1993) Regional innovation policies compared, *Urban Studies*, 30(6), pp. 1009–1024.

Hassink, R. (1996) Regional technology policies in the old and new Länder of Germany: case-studies from Baden-Württemberg and Thuringia, *European Urban and Regional Studies*, 3(4), pp. 287–303.

Hassink, R. (Ed.) (1997) Globalisation, regional and local knowledge transfer, *European Planning Studies*, 5(3), pp. Special Issue.

Hassink, R. (2002) Regional innovation support systems: recent trends in Germany and East Asia, *European Planning Studies*, 10(2), pp. 153–164.

Hayek, F. A. von. (1975) The pretence of knowledge, *The Swedish Journal of Economics*, 77, pp. 433–442.

Hospers, G.-J. and Beugelsdijk, S. (2002) Regional cluster policies: learning by comparing?, *Kyklos*, 55, pp. 381–402.

Jankowski, R. and Wlezien, C. (1993) Substitutability and the politics of macroeconomic policy, *Journal of Politics*, 55, pp. 1060–1080.

Jeffery, C. (2002) German federalism from cooperation to competition, in: M. Umbach (Ed.), *German Federalism: Past, Present and Future* (Basingstoke: Palgrave).

Ketels, C. (2004) European clusters, in: L. Hagbarth (Ed.), *Structural Change in Europe 3, Innovative City and Business Regions* (Bollschweil: Hagbarth).

Koschatzky, K. (Ed.) (1997a) *Technology-Based Firms in the Innovation Process: Management, Financing, and Regional Networks* (Heidelberg: Physica).

Koschatzky, K. (1997b) Innovative regional development concepts and technology-based firms, in: K. Koschatzky (Ed.), *Technology-Based Firms in the Innovation Process: Management, Financing, and Regional Networks*, pp. 177–201 (Heidelberg: Physica).

Koschatzky, K. (2005) The regionalization of innovation policy: new options for regional change?, in: G. Fuchs & P. Shapira (Eds), *Rethinking Regional Innovation and Change*, pp. 291–312 (Berlin and Heidelberg: Springer).

Krugman, P. (1994) Competitiveness: a dangerous obsession, *Foreign Affairs*, 73(2), pp. 28–44.

Krumbein, W. and Ziegler, A. (2005) Technologie- und Innovationspolitik der Bundesländer: Aktuelle Lage, Entwicklungslinien und Probleme, in: W. Krumbein & A. Ziegler (Eds), *Perspektiven der Technologie- und Innovationsförderung in Deutschland*, pp. 7–25 (Marburg: Schüren-Verlag).

Kulicke, M., Bührer, S. and Lo, V. (2005) *Untersuchung der Wirksamkeit von PRO INNO—Programm Innovationskompetenz mittelständischer Unternehmen* (Stuttgart: Fraunhofer IRB Verlag).

Lehrer, M. (2005) Science-driven vs. market-pioneering high tech: comparative German technology sectors in the late 19th and late 20th centuries, *Industrial and Corporate Change*, 14(2), pp. 251–278.

Lehrer, M. and Asakawa, K. (2004) Rethinking the public sector: idiosyncrasies of biotechnology commercialization as motors of national R&D reform in Germany and Japan, *Research Policy*, 33, pp. 921–938.

Lorenzen, M. (2001) Localized learning and policy: academic advice on enhancing regional competitiveness through learning, *European Planning Studies*, 9(2), pp. 163–185.

Lundvall, B.-A. (1999) Technology policy in the learning economy, in: D. Archibugi, *et al*. (Eds), Innovation Policy in a Global Economy (Cambridge: Cambridge University Press).

Maskell, P. and Lorenzen, M. (2004) The cluster as market organisation, *Urban Studies*, 41(5/6), pp. 991–1009.

Maskell, P., *et al.* (1998) *Competitiveness, Localised Learning and Regional Development: Specialisation and Prosperity in Small Open Economies* (London: Routledge).

Norman, V. and Venables, A. (2001) Industrial clusters: equilibrium, welfare and policy, *CEPR Discussion Paper No. 3004* (London).

OECD (Organization for Economic Cooperation and Development) (1999) *Boosting Innovation: The Cluster Approach* (Paris).

OECD (2001) *Innovative Clusters: Drivers of National Innovation Systems* (Paris).

Olson, M. (1982) *The Rise and the Decline of Nations. Economic Growth, Stagflation and Social Rigidities* (New Haven, CT and London: Yale University Press).

Porter, M. E. (1990) *The Competitive Advantage of Nations* (New York: The Free Press).

Rehfeld, D. (1999) *Produktionscluster: Konzeption, Analysen und Strategien für eine Neuorientierung der regionalen Strukturpolitik* (München: Hampp).

Reinhard, M. (1999) *The Co-evolution of Policies at the National, Regional and European Level—Country Report: Germany* (München: Ifo Institut für Wirtschaftsforschung).

Rosenfeld, S. A. (1995) *Industrial Strength Strategies: Regional Business Clusters and Public Policy* (Washington, DC: The Aspen Institute).

Sabel, C. F. (1996) A measure of federalism: assessing manufacturing technology centres, *Research Policy*, 25(2), pp. 291–307.

Steiner, M. (Ed.) (1998) *Clusters and Regional Specialisation: On Geography, Technology, and Networks* (London: Pion).

Sternberg, R. (2002) The regional impact of innovation networks, in: L. Schätzl & J. Revilla Diez (Eds), *Technological Change and Regional Development in Europe*, pp. 135–155 (Berlin, Heidelberg and New York: Springer).

Sternberg, R. (2003) New firms, regional development and the cluster approach—what can technology policies achieve?, in: J. Bröcker, D. Dohse & R. Soltwedel (Eds), *Innovation Clusters and Interregional Competition*, pp. 347–371 (Berlin, Heidelberg and New York: Springer).

Sternberg, R. and Tamasy, C. (1999) Munich as Germany's No. 1 high tech region: empirical evidence, theoretical explanations and the role of small firm/large firm relationships, *Regional Studies*, 33(4), pp. 367–377.

Stiglitz, J. (1999) Public policy for a knowledge economy. Electronic Resource http://www.worldbank.org/html/extdr/extme/knowledge-economy.pdf.

Storper, M. (1995) Competitiveness policy options: the technology–regions connection, *Growth and Change*, 26, pp. 285–308.

Temple, P. (1998) Clusters and competitiveness: a policy perspective, in: G. M. P. Swann, M. Prevezer & D. Stout (Eds), *The Dynamics of Industrial Clustering*, pp. 257–298 (Oxford: Oxford University Press).

Tinbergen, J. (1952) *On the Theory of Economic Policy* (Amsterdam: North-Holland).

Tinbergen, J. (1956) *Economic Policy: Principles and Design* (Amsterdam: North-Holland).

Tunzelmann, G. N. von (1995) Government policy and the long-run dynamics of competitiveness, *Structural Change and Economic Dynamics*, 6(1), pp. 1–21.

Wachendorfer-Schmidt, U. (2000) Regional policy in Germany. The European Union as the "Great Healer"?, in: D. Braun (Ed.), *Public Policy and Federalism* (Aldershot: Ashgate).

Wilson, D. and Souitaris, V. (2002) Do Germany's federal and land governments (still) co-ordinate their innovation policies?, *Research Policy*, 31(7), pp. 1123–1140.