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Technology policy and the regions — the case of the BioRegio contest

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Abstract

Only recently, it has been argued that technology policy should give more attention to the regions as they could play a key role in the process of technological change. The German Federal Government has tried to do so by initiating a contest in which Germany's leading Biotech regions competed for a given amount of public funding. This paper reports on the aims, the conceptual design and the results of the BioRegio contest (BRC) and tries to place it into a broader theoretical context. It is shown that the new policy instrument cannot solve the fundamental information problem associated with government intervention into the process of technological change, but that it goes into the right direction by taking the regions seriously and giving prominence to the well-functioning interplay of the various elements of regional innovation systems.

Keywords: Technology policy; Regions; Competitiveness; Economic geography; Biotechnology

1. Introduction

What has technology policy to do with the regions? Two links come immediately into mind: On the one hand, it is well known that technology is a pivotal factor in explaining regional growth (and employment) differences (see, for example, Fagerberg et al., 1997). On the other hand, some authors have argued that a successful national technology policy should give more attention to the regions as they could be key actors in the process of technological change (e.g., Storper, 1995a,b; Scott, 1996; Cooke et al., 1997). They recommend, in other words, to exploit the 'technology-regions connection' for competitiveness policy purposes.

The German Federal Government has tried to do so by initiating a contest in which Germany's leading Biotech regions competed for a given amount of public funding. The BioRegio contest (BRC) is not a carbon-copy of the ideas proposed in the theoretical literature (and it was probably not intended to be one) but we argue that the philosophy behind it comes quite close to some theoretical concepts that are currently discussed. We report on the aims, the conceptual design and the results of the contest, reveal some of the practical problems facing policy makers who try to make sense of the 'technology-regions connection', and try to place the BRC into a somewhat broader theoretical context, asking in which respects it may set new yardsticks and in which respects it might go wrong. The theoretical

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analysis is complemented by a survey among German biotech firms.

2. The BRC — a new instrument of technology policy

2.1. Background and aims of the contest

Compared to other countries, especially the US and the UK, biotechnology had a slow start in risk averse Germany, [1] although Germany traditionally has a strong and competitive chemical industry. Falling behind in a so-called 'generic' high-tech industry was a matter of serious concern for German policymakers in the early 1990s. Therefore, the BRC was designed to work as the motor of the catch up process, stimulating biotech firm start ups, the growth of existing companies and the provision of venture capital. It was planned in the early 1990s, started in 1995 and the winning regions were presented in late 1996. It is currently in its second phase (lasting 5 years) in which the winning regions get preferential access to federal funding to realize their biotech investment plans. The ambitious long run aim of the contest is to make Germany the number 1 in European biotechnology by the turn of the century (Bundesministerium für Bildung und Forschung, 1997).

2.2. The rules

The rules of the contest are rather simple: All regions wishing to participate had to give a presentation of their respective strengths in biotech from the lab bench to the market as well as proposals for future development of biotechnology in the region. An independent jury consisting of scientists, industry and trade union representatives was installed by the Federal Research Ministry. Its job was to find the three best organised regions with the most promising development concepts on the basis of the criteria outlined in Table 1. [2]

2.3. The participants

The number and the internal structure of the regions participating in the contest was not predetermined by the Federal Research Ministry, 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. In all regions' enterprises, research institutes and government officials cooperated very closely.

All in all, 17 BioRegios formed to participate in the contest, although the number of potential participants could have been higher. [3] Plate I shows how heterogeneous the participants in the contest are: Some of them are single cities (and their hinterland) such as Freiburg (3), Jena (6) or Regensburg (No. 12 in Plate I). Others are networks of neighbouring cities such as Braunschweig–Göttingen–Hannover (9) or Heidelberg–Mannheim–Ludwigshafen (15) or they cover whole federal states such as Berlin–Brandenburg (1). The most populous region (Berlin–Brandenburg) has more than 6 million inhabitants, compared to just a little more than one hundred thousand in the smallest BioRegio (Jena).

Most of these regions are situated in the industrial cores of Germany (e.g., the BioRegio Rhein/Main with Wiesbaden, Frankfurt, Darmstadt and Mainz and the BioRegio Rhein–Neckar–Dreieck with Heidelberg, Mannheim and Ludwigshafen). Only a few (e.g., Greifswald–Rostock or Wilhelmshaven–Oldenburg) are peripheral regions in the northeastern and northwestern parts of Germany.

2.4. Winning regions

The three regions selected by the jury were Munich (8), Rhineland (13), including the cities of

[1] Foreigners observe a penchant among German businessmen and bankers for caution, inflexibility and reluctance to make corporate decisions without broad consensus (see, e.g., Nash, 1994). Furthermore, reluctance in German society against gene-manipulated products (especially against gene-manipulated food) is much stronger than in the Anglo-American societies (Schitag, Ernst & Young, 1998).

[2] The criteria were given by the Federal Research Ministry; their usefulness will be discussed later (Section 4).

[3] BMBF (Bundesministerium für Bildung und Forschung) officials expected up to 30 regions to participate.

Table 1
Criteria by which the 'model regions' were picked out

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: Bundesministerium für Bildung und Forschung (1996).

Cologne, Aachen, Düsseldorf and Wuppertal, and the Rhine–Neckar Triangle (15) with Heidelberg, Mannheim and Ludwigshafen. It was pointed out that these regions all have a comprehensive scientific basis in modern biotech research, substantial enterpreneurial activity in the field of biotechnology and a promising regional development concept for biotech industry. The East German region of Jena received a 'special vote' for its 'especially positive new-orientation' in the field of biotechnology after re-unification.

Being chosen as a 'model region' has two advantages: On the one hand, public funds amounting to 150 million DM are reserved for the three winners in the BRC. On the other hand, the winning regions receive priority in the appropriation of funds from the ''Biotechnology 2000''-program of the Federal Research Ministry for a time span of five years. The latter advantage seems to be the more important one since the total amount of public biotech funding in Germany (about DM 1.5 billion from 1997 to 2001) is about 10 times higher than the direct BioRegio award and the jury's judgement on the regions capability and concepts is of crucial importance for the spatial distribution of funds from the larger budget. [4] Table 2 shows how much money was invested in biotech projects in the 17 BioRegios between January 1997 and November 1998. The numbers show the total project volume; the government funding share is between 40% and 50%.

[4] Considering institutional funding and the financing of research institutes, the total amount of government funding for biotechnology is even higher (approximately DM 1 billion in 1998).

2.5. Status of the contest within the whole of tech pol in Germany

The BRC may be seen as an institutional innovation in German technology policy, combining three different features:

(a) it aims at catching up in a 'strategic' [5] high-tech industry

(b) it addresses the regions as relevant players in this process and

(c) it stimulates interregional competition for technology.

Features (b) and (c) have not played a major role in German tech pol before the BRC started. By contrast, feature (a) is not really new since there

[5] According to Freeman and Soete (1997, Chap. 14.3) the term 'strategic' has three different dimensions: (i) *Strategic in a technological sense* means that access to certain products and technologies contains a perspective for strategic advantage and for future technological success. High tech is 'strategic' in the sense that it is essential raw material or intermediate technological input in capital and final consumer products and there are strong cumulative and increasing returns features involved in the development of such technologies. (ii) *Strategic in a trade sense* means that countries or firms can assure a competitive advantage due to early access to new high-tech products. (iii) The third definition (*strategic in an industry sense*) is the broadest one: An industry is strategic because of its widespread infiltration of the whole economy through the large amount of vertical linkages. Although biotechnology as yet has not infiltrated the whole economy it surely has the potential to do so in the future. When speaking of 'strategic' we therefore have a broad definition (strategic in a trade and industrial sense) in mind. For an empirical approach to identify 'strategic technologies' in Germany, see Meyer-Krahmer and Grupp (1993).

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	BioRegion Halle-Leipzig	0,752	14	BioRegio Rhein-Main	1,239
6	*BioRegion Jena*[b]	0,101	15	**BioRegion Rhein-Neckar-Dreieck**[a]	0,616
7	BioMIT Mittelhessen	0,149	16	BioRegion 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

Plate 1. Participants in the BioRegio contest.

have been some earlier programmes which aimed at catching up in high-tech industries such as nuclear power, electronics or space and aviation (Nelson, 1993).

Table 2
Biotech investment in the 17 BioRegios (January 1997–November 1998)

Name of BioRegio	Project volume		No. in Plate I
	Million DM	DM per inhabitant	
BioRegio Rheinland[a]	93.064	42.99	13
BioRegion Rhein–Neckar–Dreieck[a]	82.172	133.40	15
Initiativkreis Biotechnologie München[a]	49.064	39.70	8
BioTOP-Initiative Berlin–Brandenburg	29.206	4.86	1
BioRegio Jena[b]	28.162	278.83	6
BioRegio Rhein–Main	24.549	19.81	14
BioRegioN	18.468	20.50	9
Bioinitiative Nord	14.905	6.86	10
Region Bremen	11.341	20.66	2
BioRegion Stuttgart/Neckar–Alb	10.586	18.10	16
BioTechnologie Ulm	3.668	31.90	17
BioRegion Halle–Leipzig	3.653	4.86	5
BioRegio Greifswald–Rostock	3.551	12.33	4
BioRegio Regensburg	2.946	23.57	12
Region Nordwestliches Niedersachsen	2.434	11.37	11
BioMIT Mittelhessen	1.777	11.93	7
BioRegio Freiburg	1.614	8.11	3

Data source: BMBF.
[a]Winning region.
[b]Special vote.

Many observers have noted that the German innovation system displays a clear bias in favour of existing industries and incremental rather than radical innovation. Therefore, Germany may be characterized as ''a paradigmatic case of deepening'' (Ergas, 1987). By contrast, the innovation systems of countries like the US, the UK or France are characterized by ''shifting'' (towards new technologies) rather than ''deepening'' of existing technologies (ibid). German technology policy has for a long time made little effort to overcome this bias: Outside the heavily subsidized aircraft, nuclear power and space industries, the government so far largely abstained from sector specific policies targeting at 'generic' high-tech industries, which has led some observers to criticize that ''R&D support in Germany appears to be structurally conservative rather than structurally formative'' (Koopmann et al., 1997, p. 76). The BRC breaks with this tradition as illustrated in Fig. 1.

It is noteworthy that the BRC had a pilot function for government policy towards other fields of technology. Similar contests have been initiated in multimedia and the so-called 'nano-technologies', although the regions do not play such a prominent role in these contests as in the BRC. [6]

2.6. The German biotech industry before and after (the first phase of) the contest

Estimates of the size and development of the German biotech industry depend heavily on the underlying definitions. According to an often used definition, biotechnology is the manipulation of living organisms, or parts thereof, for the production of goods or services (Shan and Hamilton, 1991; Shan et al., 1994; Bartholomew, 1997). However, since this is a process rather than a product definition, it remains open which companies and which products are exactly implied, i.e., further specification is required to obtain a basis for empirical analysis. The perhaps

[6] Currently, a new instrument called 'InnoRegio contest' is in the phase of conceptualization. This instrument is not restricted to a specific technology but its geographic focus is on east Germany only. For more details, see Bundesministerium für Bildung und Forschung (1999); for a background study, see Koschatzky and Zenker (1999).

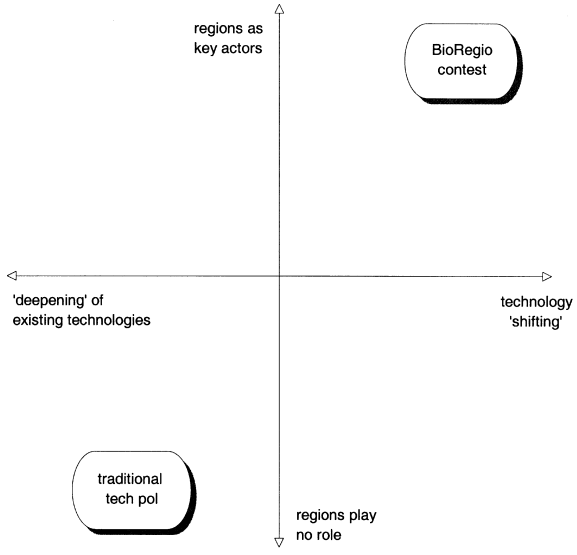


Fig. 1. The BRC and traditional technology policy in Germany contrasted.

most widespread specification for empirical purposes is the one used by Ernst & Young consultants focusing on entrepreneurial biotech. According to their definition — which has been adopted by the BMBF, the German Association of Biotech Industries (DIB) and many other organizations in their press releases and official statements — the entrepreneurial biotech sector ''... embraces all companies which use modern biological, rather than conventional, techniques to develop commercial products for human or animal healthcare, agricultural productivity, food processing, and the environmental services sector'' (Ernst & Young, 1998b, p. 2).

Having specified what products or services are 'biotech', one has to develop criteria to decide what makes up a 'biotech company'. In the first German biotech report by Schitag, Ernst & Young (1998) [7], three categories of biotech companies are distinguished.

(I) Core Entrepreneurial Life Sciences Companies (ELISCOs) are small or medium-sized firms (less than 500 employees) which have the commercialization of biotech as their main objective and which are characterized by substantial research effort and high innovativeness (as measured by patent applications). [8]

(II) Extended core ELISCOs are small or medium-sized firms (less than 500 employees) which develop products or services using methods of modern biotechnology but do not fit the stricter criteria for 'core ELISCOs'. [9]

(III) Category three consists of large life sciences [10] companies with more than 500 employees which are not exclusively focused on biotech but earn substantial revenues (> DM 10 million) with biotech products or services and have their headquarters in Germany.

Considering all three categories, the number of biotech companies in 1997 amounted to 465 (173 core ELISCOs, 269 extended core ELISCOs and 23 large category III firms) compared to less than 100 firms [11] before 1995, the year when the BRC started (Schitag, Ernst & Young, 1998). In international comparative analyses, it is usual, however, to define biotech companies in a narrow sense, i.e., to restrict to the core ELISCOs as the genuine biotech companies. [12] Their number increased from 75 in 1995 (the year when the BRC started) to 222 in 1998 which is the highest increase in all European countries, such that Germany — according to this criterion — has passed France (142 core ELISCOs) and almost caught up with the UK (268 core ELISCOs in 1998) (Schitag, Ernst & Young, 1998; Ernst & Young, 1999). [13] The vast majority of start ups is concentrated in the 17 BioRegios (Ernst & Young, 1999; Appendix A).

[7] Schitag, Ernst & Young is the German affiliate of Ernst & Young International.

[8] See Schitag, Ernst & Young (1998, p. 11) for more details.

[9] 'Extended core ELISCOs' are often firms which have diversified into biotechnology.

[10] The life sciences include a wide variety of disciplines such as health care (therapeutics and diagnostics), environmental and agbiotech, food processing and biochemistry.

[11] The exact number is not available.

[12] The 'core ELISCOs' (category I) correspond to the prototype ('dedicated') biotech companies in the US and the UK, whereas categories II and III play a less important role in these countries. Therefore, the US and the European Ernst & Young biotech reports only consider the 'core ELISCOs'.

[13] Just considering the 'core ELISCOs' may, however, understate the size of the German biotech sector relative to other countries, since it is a peculiarity of the German biotech industry that it comprises not only start-up firms but also many established firms which diversified into biotechnology (Bross et al., 1998).

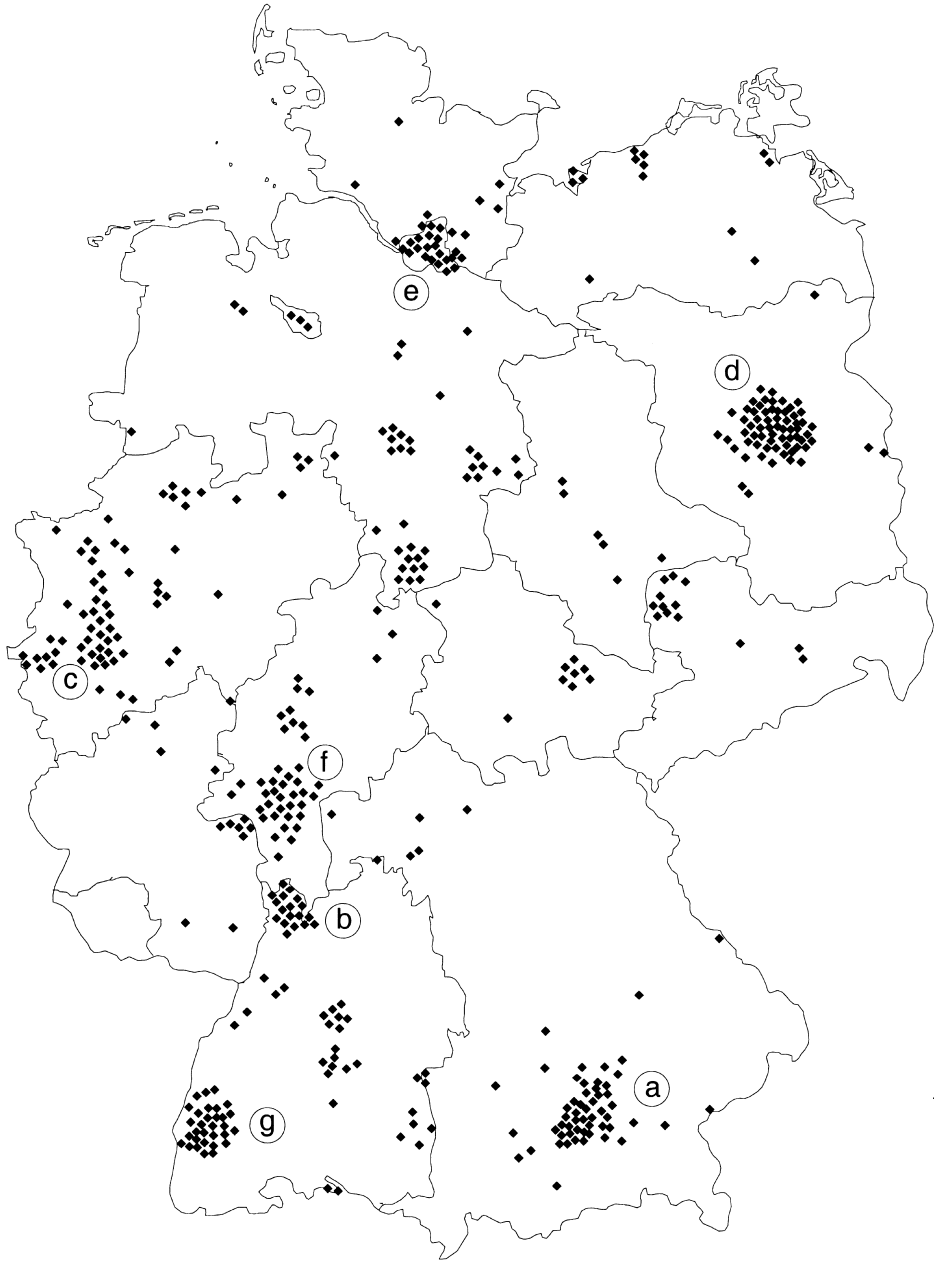


Plate 2. Biotech cluster in Germany. Data Source: Schitag, Ernst & Young, 1998.

Biotech investment [14] has also grown rapidly in recent years: Investment into the German biotech industry increased from DM 75 million in 1996 to DM 165 million in 1997 and approximately DM 425 million in 1998 (Schitag, Ernst & Young, 1998). [15]

[14] German biotech firms invest between 15% and 17% in R&D. With these figures biotech ranks top of all industry sectors (Reiß and Hüsing, 1992, p. 13).

[15] For a more detailed analysis of biotech financing and funding in Germany, see Reiß and Koschatzky (1997).

By contrast, the (direct) labour market effects one can currently observe are positive, but not overwhelming: According to the BMBF, each new biotech firm creates eight additional jobs on average, which is only slightly more than in other industries. [16,17]

A closer look at the current biotech map of Germany (Plate II) shows that a quite impressive biotech sector is emerging and that there is a strong tendency towards clustering. Up to now, seven larger biotech clusters have developed in Germany: The three winning regions Munich (a), Rhine–Neckar Triangle (b) and Rhineland (c); the Berlin area (d), the Hamburg area (e), the Frankfurt–Wiesbaden area (f) and the Freiburg area (g), which is part of the trinational 'BioValley upper rhine'. [18]

The identification of the clusters was accomplished through careful mapping of each production establishment. Note that only small and medium-sized enterprises are considered; Plate II does not consider larger enterprises and centers of scientific excellence such that the importance of some clusters (e.g., Berlin) may be overestimated and that of others (especially the Rhine–Neckar Triangle) may be underestimated by this mapping.

The tendency towards clustering is not a peculiarity of Germany but it is a typical feature of Biotech industry worldwide as is evidenced in the empirical work by Zucker et al. (1998), by Prevezer (1997) and by the various reports of Ernst & Young (1998a; b; 1999) on this topic. What is remarkable about the German biotech scene, however, is that the industry's inherent tendency towards spatial concentration is consciously and deliberately encouraged by government policies such as the BRC.

The dynamic development of the German biotech sector during the last years that shines through in the above numbers (and in the background statistics given in Appendix A) is a necessary but not a sufficient condition for a positive assessment of the new policy instrument. In Section 5, we go one step further, presenting the results of a survey among German biotech firms (participants in the BRC and non-participants), trying to shed some more light on the strengths and weaknesses of such a region-oriented technology policy instrument from the perspective of the actors that perform innovative activities and apply for government funding.

Before doing so, we now turn to some *theoretical* deliberations, asking in which respects the BRC sets new yardsticks (Section 3) and what might go wrong with the new instrument (Section 4).

3. Why the BRC might go into the right direction [19]

3.1. The regions as key actors in the process of technological change

The BRC is an experimental approach addressing the regions as key actors in the process of knowledge creation and diffusion. In interviews with BMBF officials, it came out that the concept is primarily based on *practical* deliberations (such as bringing together the relevant players and furthering private public partnership) as well as on the *empirical* observation that biotech firms tend to cluster. We argue that there are also good theoretical arguments for technology policy to take the regions seriously.

As is well known, technological change is path dependent because it involves interdependencies between choices made over time. Among these interdependent choices is the choice of location of innovative activities. Revision of locational choices is costly which gives technological change a spatial dimen-

[16] In other industries, the corresponding number is six additional jobs on average.

[17] The indirect and long-run impacts may nevertheless be substantial. See Section 4.3 for a discussion.

[18] The upper rhine region consists of the Freiburg area in Germany, the Alsace in France and the Basel area in Switzerland.

[19] It is beyond the scope of this paper to provide a complete survey of theoretical approaches from which one may derive arguments in favour of a region-oriented technology policy. Approaches not discussed here in extenso include the older network approaches (Håkansson, 1987), the industrial districts approach (Russo, 1985; Maillat, 1996) and the concept of innovative milieux (Aydalot, 1986; Camagni, 1991), all of which have provided important inputs for our understanding of regional innovation and for the concept of regional innovation systems that will be discussed later in this section. A critical discussion of the above named approaches can be found elsewhere (Koschatzky, 1998, 1999; Maillat, 1998).

sion. A technology policy that neglects this spatial dimension misses addressing an important determinant (and constraint) of technological change and is therefore likely to fail.

A slightly different line of argumentation is the following: In the age of progressive globalization, certain factors of production become essentially ubiquitous. The factors that give producers a competitive advantage are not those which are ubiquitously available but those which are bound to a specific location. Storper (1995b) speaks of 'untraded interdependencies' that characterize a region. These 'untraded interdependencies' are not static and irreversible but endogenous to political action such as the BRC.

A third line of argumentation views the regions as governance levels best suited to internalize spillovers. According to Storper (1995a), there are three possible target groups for technology policy initiatives: groups of firms in *sectors*, groups of firms in *technological spaces* and *regional groups of firms*. Traditional technology policy concentrates on the sectoral or technological level whereas the regional level is excluded. It is well known, however, that sector or technology specific policies have often failed in the past for various reasons. A major problem of sector specific policies is that intrasectoral spillovers seem to be of less importance than intersectoral spillovers (see Glaeser et al., 1992 for empirical evidence), i.e., spillovers seem to be bound to a specific technology rather than to a specific sector of the economy. The problem with technology spaces, on the other hand, ''... is getting the firms in these spaces, especially when they are potential and not actual spaces, to interact sufficiently and in the right direction'' (Storper, 1995a, p. 299). An approach like the BRC that addresses the regions as relevant players in the process of technology creation and diffusion may be a quite clever alternative since there is empirical evidence that most spillovers occur at the regional (or even at the local) level (Jaffe et al., 1993). Therefore, the region may be the governance level best suited to foster technological progress.

We conclude that the BRC, in taking the regions seriously, sets new yardsticks not only for technology policy but also for traditional regional policy: the regions are the key actors, the real protagonists in the BRC whereas in traditional regional policy their role is essentially passive as they are merely recipients of assistance from national or supranational (EU) structural funds.

3.2. Intraregional cooperation and interregional competition

The BRC promotes spatial clustering, rewards intraregional cooperation and stimulates interregional competition for technology. This strategy may also be justified on theoretical grounds.

The standard reference when discussing business clusters is Porter (1990). Porter (1990) primarily discusses clusters in terms of upstream and downstream links and only secondarily in terms of regional clusters. However, in a series of recent papers which have ''The Competitive Advantage of Nations'' as their point of reference (Porter, 1998; Porter and Sölvell, 1998) the regional dimension of the cluster concept comes to the fore. It is shown that regional clusters are characterized by strategic interdependence, rapid information flows and a unique mix of competition and cooperation that can have substantial impact on firm-strategies (Enright, 1998). Porter goes one step further, arguing that close interactions between the firms within a cluster are the key to much of the clusters success in the competition for technology. [20] A central aspect in this context — which is often overlooked by traditional technology policy but explicitly considered by the BRC — is that the close relationships within a functioning cluster improve motivation and measurement within the regional innovation community: ''Peer pressure, pride and the desire to look good in the community spur executives to outdo one another'' (Porter, 1998, p. 83).

The BRC may also be seen as an attempt to build up sustainable 'regional innovation systems' (at least for one specific field of technology), a notion that was suggested just recently by Cooke et al. (1997) and Braczyk et al. (1998). The regional innovation system concept has its roots in the literature on

[20] Interaction here means cooperative practices in a narrow sense as well as exerting pressure on suppliers or sub-contracting firms to innovate in order to improve one's own competitiveness.

national innovation systems (e.g., Lundvall, 1992; Nelson, 1993; Patel and Pavitt, 1994) and in regional science. Regional innovation systems complement more established systems of innovation which operate at the national level ''... by seeking, as appropriate and with local sensitivity, to integrate the whole industrial fabric within a given regionally administered space'' (Braczyk et al., 1998, p. vii). 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, p. 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, p. 416). The BRC fits quite well into the *regional innovation system* concept as it shares the assumption that the regional environment is crucial for the innovation process and aims at fostering the establishment of a collective order of trust and reciprocity within the regions that may help overcome obstacles to innovation. [21]

In fact, the BRC 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. FOCJs have various advantages (Frey and Eichenberger, 1995, p. 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,
- they stimulate the competition between regions which is a competition between governments and institutions.

While the first two advantages are self-explanatory, the last point calls for some more elaboration: Why should the competition between regions be a good thing?

It is quite obvious that competition among regions (as well as the competition among nations) is not analogous to product market competition and does not have the same efficiency properties. A corporation that is uncompetitive and does not manage to improve its performance will — at least in the longer run — cease to exist, whereas regions (or countries) that are uncompetitive do not go out of business. Therefore, Krugman (1994) has argued that competitiveness applied to nations (and thus regions) is ''a meaningless concept''. To most scholars, however, it seems farfetched to assert that because regions (or countries) are not simply larger versions of firms, the concept of competitiveness loses its meaning (Hufbauer and Stephenson, 1995, p. 45). But what do the terms 'competition' and 'competitiveness' really mean when applied to regions?

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, unskilled labour, regional amenities and so forth whereas capital, skilled labor and — perhaps most important — technological knowledge are to a certain degree mobile. [22] Such a kind of interregional competition (sometimes referred to as 'locational competition') may have positive as well as negative effects (see Wildasin, 1995 for an overview). As Krugman has reminded us, the

[21] One should notice, however, that the regional innovation systems that these authors have in mind are not restricted to a single technology.

[22] 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.

obsession with competitiveness may lead to unhealthy policies such as bidding wars and protectionism. On the other hand, interregional competition (in the sense of a competition among governments, representing the immobile factors) may help to break up Olson-type institutional sclerosis, to re-shape the regional production system and to contest the cartel of the 'classe politique'.

As the BioRegios neither have the competence to introduce protectionist measures nor the money to engage in excessive bidding wars their main parameter in the competition process is their institutional structure, or, to be more precise, their innovation support infrastructure. The BRC may therefore be seen as an approach fostering *institutional competition*. [23] Economic historians and evolutionary economists have stressed the usefulness of such institutional competition in the past (von Hayek, 1960; Jones, 1981; Baumol and Baumol, 1992). Frey and Eichenberger (1995: 225) sum up the evidence by stating that ''Europe owes its rise as a dominant economic and intellectual centre to the competition among governmental units''. The lessons that North draws from economic history go into the same vein: the critical question with changes in technology or external competitive conditions is ''... how flexible is the political organizational structure to changing the institutional framework to improve the competitive position of the economy'' (North, 1995, p. 36). But do national and sub-national governments and institutions still matter in a globalized world? It is sometimes argued that R&D activities become increasingly footloose, thereby weakening the links between technology development and national and regional circumstances. However, recent research has shown that a major feature of high-tech competition is that the global competitiveness of firms depends on local and national conditions over which national (and regional) governments and institutions have significant influence (Pavitt and Patel, 1996). Against this background a competition among regions struggling to design the most favourable environment for innovation (Storpers 'untraded interdependencies') seems to be a good thing on balance.

[23] According to De Vet (1993), it is the institutional capacity to attract and animate competitive advantage that gives regions a strong conceptual and real identity.

4. Why the BRC might go into the wrong direction

4.1. What about lagging regions and second best performers?

The philosophy behind the BRC is strengthening the strong, dynamic regions and thereby improving the competitiveness of the country as a whole. Such a policy action may well lead to greater territorial disparities, not just in high-tech employment but also in the development of human capital and in labour income (Suarez-Villa and Fischer, 1995, p. 38). Obviously, there is a clear trade off between such a kind of technology policy and regional development policy which aims at strengthening the less favoured regions. The responsible federal and state ministries should cooperate in order to prevent that technology policy and regional policy programmes counteract each other, for it makes little economic sense if the Federal Research Ministry (BMBF) tries to bundle biotech competencies whereas some state ministries pay subsidies to biotech enterprises for leaving the centers and locating in lagging or peripheral regions.

Furthermore, the BRC discriminates against innovative firms located outside the 17 Bioregios participating in the contest. This is especially a problem for firms in lagging and peripheral regions (see Section 5 for more details), but some industrial centers (such as Karlsruhe) are also concerned.

In view of these problems, one may ask what the alternatives are. An obvious alternative would be the subsidization of lagging regions. The problem with such an approach is, however, that the critical mass of technological competence is often not reached such that taxpayers' money is wasted — a classical dilemma of innovation-oriented regional development policy. Another alternative would be to subsidize the *second best performers* who could get to the top with these subsidies. This may help to create a greater number of leading regions, which in turn may stimulate interregional competition not just for pub-

lic funding but for the development of new ideas, new products and higher income.

4.2. The right criteria?

Finding the right criteria to evaluate and compare the regions' performance in an emerging high-tech industry is a difficult and thankless task. It is even more difficult to weight these criteria against each other as the weighting scheme predetermines winners and loosers.

The criteria used by the jury and presented in Table 1 may be comprised in three broad categories:

(a) The *already existing hardware*, i.e., the stock of firms and research facilities located in the region. Criteria c1 and c2 fall in this category.

(b) The *political, financial and service environment* for biotech development in the region (criteria c4, c6, c7 and c9).

(c) The *software*, encompassing the interaction between researchers of different branches and institutions (criteria c3, c8) as well as the strategies to convert know-how into new products (c5). Note that the categories b and escpecially c come rather close to Storpers notion of 'untraded interdependencies'.

In principle, the criteria chosen seem to be useful and plausible, although one could imagine further helpful criteria such as patent activity on the hardware or business climate on the software side. More problematic is the weighting of the criteria: The implicit weighting scheme used by the jury was not made explicit, although it seems that the *already existing hardware* was the decisive criterion, such that outsiders (regions at the periphery) had little chances from the beginning. The result of the contest is, therefore, not very surprising. The three winning regions (Munich, Rhineland and the Rhine–Neckar Triangle) are all located in the industrial cores of Germany and accommodate some of the worlds leading life sciences and chemical enterprises. The Rhine–Neckar Triangle has BASF, Boehringer Mannheim and E. Merck nearby. BioRegio Rhineland is home to the multinational Bayer. The Munich BioRegio also includes Boehringer Mannheim and has within its boundaries many of Germany's new entrepreneurial biotech companies (Ernst & Young, 1998b, p. 70). The dominance of the 'existing hardware' is also evidenced by the fact that the winning regions are locations of the so-called gene centres, which had received federal funding for several years. [24]

It is understandable that the jury gave the highest weight to 'hard criteria' as they have the advantage of being objectively measurable and comparable. It is in contradiction, however, to theories such as Storper's that emphasize the importance of 'untraded interdepencies' as the sources of technological change and regional advantage.

4.3. Picking winners and distorting the spatial structure of the economy

The BRC may be seen as an instrument for picking winners in two respects: picking a winning technology (biotech) and picking winning regions. [25]

4.3.1. Picking a winning technology

In the public debate in most industrialized countries, there seems to be little doubt that there is a beneficial role for the public sector to play in subsidizing new technologies. There are some 'key' or 'generic' technologies — so the reasoning goes — that are critical to a nation's future competitiveness. These technologies — so it is further argued — are unlikely to be developed without assistance and are likely to cause gaps in a country's technology supply chain, such that there is a need for government intervention. As a result, we observe that in many OECD countries governments devote substantial financial support to the development and deployment of so-called *generic technologies*. [26]

Economic theory throws some doubt on this popular line of argumentation. On economic efficiency grounds, it can be argued, a national technology policy can be justified if (and only if) private agents do not make the socially optimal decisions, i.e., if

[24] I am grateful to an anonymous referee who hinted at this point.

[25] 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.

[26] In the case of biotechnology, some observers speak of a real 'crusade'.

there is some kind of market failure calling for government intervention. Endogenous growth theory [27] identifies two main reasons for market failure, one focusing on positive externalities of private R&D spending, the other one on negative ones. *Positive externalities* cause a tendency towards private underinvestment in R&D since the social returns of R&D spending cannot be appropriated by private investors. Government intervention raising the level of research effort in the respective industry may then be beneficial. *Negative externalities* cause a tendency towards overinvestment in R&D due to inefficient parallel research. This points to a positive role of the government as an agent that bundles and focuses research efforts to ensure a maximum social rate of return and a minimum deadweight loss: A benevolent and omniscient central government could enhance efficiency by bundling research efforts and leading the regions activities into a direction that is optimal from an overall economic point of view.

However, even if bureaucrats were benevolent the problem remains that they are not omniscient: The underlying assumption that biotechnology will create substantial positive externalities in the future is unprovable ex ante which raises the obligatory question why one should think that bureaucrats are more clever than the market (von Hayek, 1975).

4.3.2. Picking winning regions

A similar argument holds for the picking of winning regions. The BRC may be costly (apart from its direct costs in the form of taxpayers' money) as it fosters the development of some selected regions and suppresses the development of other regions, at least in relative terms. Furthermore, picking the winners may be not only problematic from an efficiency point of view but also from distributional considerations: Why should factors employed in high-tech sectors and high-tech regions be the beneficiaries of subsidies at the expense of the rest of the population? As the high-tech employed are typically well endowed with human capital and the average income level in high-tech regions is considerably higher than elsewhere one may reformulate the above question as: Why should the poor subsidize the rich? (Hillman, 1995, p. 22).

The directly measurable impact of high-tech industries on macroeconomic growth and job creation is in many cases rather small (OECD, 1998), therefore not lending much support to the argument for government investment in high-tech sectors. One should, however, be aware that an exclusive focus on direct economic effects may grasp too short: Freeman and Soete (1997, p. 427) point out that there are many innovations which have widespread effects on society but whose measurable (macro-) economic effects are small or indirect, and Pavitt (1996) argues that it is highly unlikely that private firms would have financed the early research on environmental or public health problems (such as BSE or cancer and smoking). [28] Apart from the social effects which are not adequately reflected in macroeconomic indicators, these indicators do not grasp the indirect economic impacts which arguably are of greater importance than the direct effects. As is well known, new technologies create and destroy jobs. More fundamentally, they transform the structures of economies (from industrial economies to knowledge-based economies) and their ability to grow and to create jobs (OECD, 1998). Their impact on macroeconomic growth and employment is the result of the complex interplay of innovation with product and labour market conditions and with the regulatory environment. ''While R&D intensive innovative firms have a better than average jobs record, the bulk of the impact of technology on employment and wages is indirect, and occurs in sectors other than those in which the new technology was originally developed'' (OECD, 1998, p. 55). [29] One may add that the labour market impact of new technology is only insufficiently described by changes in employment and wages, since new technologies also change the

[27] Proponents of endogenous growth theory are — inter alia — Romer (1986; 1990; 1994), Lucas (1988), Grossman and Helpman (1990; 1991) and Aghion and Howitt (1992).

[28] See also Yoxen and Hyde (1986) for an in-depth analysis of the impact of biotechnology on living and working conditions.

[29] There is empirical evidence on the importance of embodied technology (the buying and assimilating of technologically sophisticated machinery and equipment) on total factor productivity (TFP) growth in the OECD area (OECD, 1996).

Table 3
(Self-)Assessment of the technological competitiveness of German biotech industry

	All firms			Non-participants			Participants that do not receive funding			Participants that receive funding		
Answers	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
Existence of a technology gap in the mid 1990s	0.79	0.21	0.00	1.00	0.00	0.00	0.69	0.31	0.00	0.75	0.25	0.00
- in basic research	0.16	0.28	0.56	0.38	0.25	0.38	0.08	0.17	0.75	0.08	0.42	0.50
- in applied research	0.45	0.48	0.06	0.50	0.50	0.00	0.38	0.46	0.15	0.50	0.50	0.00
- in transforming results into new products/ commercialisation	0.85	0.15	0.00	1.00	0.00	0.00	0.69	0.31	0.00	0.92	0.08	0.00
Has the situation improved since then?	0.36	0.55	0.09	0.13	0.75	0.13	0.31	0.54	0.15	0.58	0.42	0.00

a = Definitely true, b = partly true, c = not true.

whole production process, working conditions and the demand for specific skills. [30]

Therefore, considering the complex and interwoven social and indirect economic effects of new technologies such as biotechnology, the case for technology policy is in fact stronger than a first glance at the directly measurable economic impacts may suggest. Nevertheless, since taxpayers' money is involved and technology policy in general (and an experimental instrument such as the BRC in particular) is fraught with uncertainty, it is only fair to ask if the experiment has been overall successful and what could (or should) in case be improved. A modest step in this direction is presented in the Section 5.

5. The actors' perspective

5.1. Aims and scope of the investigation

In this section, we report on the results of an enterprise survey performed via e-mail in June 1999, that complements the theoretical deliberations in Sections 3 and 4. We had access to the e-mail addresses of 100 German biotech firms from all 17 BioRegios and from outside the areas covered by the BRC. We asked these firms to answer a questionnaire concerning their assessment of the BioRegio instrument. A translated version of the questionnaire can be found in Appendix B.

The aim of the investigation was not to perform a final and all-comprehensive evaluation of the specific BioRegio instrument (see Kuhlmann and Meyer-Krahmer, 1995, pp. 8–10, or Kuhlmann and Holland, 1995, pp. 16–22, for the core elements of a complete evaluation concept), but rather to shed some light on the more basic question if (and to what extent) it makes sense to include the regional level into national technology policy making. Therefore, we gave prominence to what Kuhlmann and Meyer-Krahmer (1995, p. 9) call the 'strategic efficiency' of the instrument (i.e., checking whether the assumptions on which the BioRegio instrument is based are appropriate in their perception of problems and causes) rather than checking its 'operative efficiency' (the concrete implementation and administration) in depth.

We tried to keep the questionnaire as short as possible and renounced on asking questions concerning confidential or firm-specific matters in order to secure an acceptable return. Thirty-three questionnaires (33%) were returned to us. Twenty-five (75.8%) of the responding firms participated actively in the BRC and 12 of them received (or still receive) funding from the BioRegio programme. The remaining eight companies (24.2% of all respondents) are located outside the BioRegios and have neither participated nor received funding. These are referred to as 'non-participants' in the remainder of this section.

[30] See Dunne et al. (1997) for further analysis of the impact of technologies on jobs and the European Commission (1994) for estimates of the employment potential of biotechnology.

Table 4
Obstacles to biotech innovation in Germany

	All firms			Non-participants			Participants that do not receive funding			Participants that receive funding		
Answers	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
Insufficient technology transfer between firms and universities	0.50	0.44	0.06	0.38	0.50	0.13	0.42	0.58	0.00	0.67	0.25	0.08
Lack of communication/co-operation between reg. key actors	0.36	0.55	0.09	0.50	0.38	0.13	0.31	0.62	0.08	0.33	0.58	0.08
Over-regulation	0.36	0.48	0.15	0.25	0.75	0.00	0.46	0.38	0.15	0.33	0.42	0.25
Lacking acceptance of biotech in the public	0.27	0.55	0.18	0.25	0.50	0.25	0.23	0.46	0.31	0.33	0.67	0.00
Risk averseness of German entrepreneurs	0.27	0.48	0.24	0.38	0.38	0.25	0.15	0.46	0.38	0.33	0.58	0.08
Lack of venture capital	0.24	0.42	0.33	0.25	0.63	0.13	0.15	0.46	0.38	0.33	0.25	0.42
Lack of research cooperation between firms	0.19	0.63	0.19	0.38	0.50	0.13	0.17	0.58	0.25	0.08	0.75	0.17
Lack of public funding	0.15	0.42	0.42	0.13	0.50	0.38	0.23	0.38	0.38	0.08	0.42	0.50
Lack of highly qualified researchers	0.06	0.21	0.73	0.13	0.25	0.63	0.00	0.15	0.85	0.08	0.25	0.67

a = Definitely true, b = partly true, c = not true.

5.2. Main results

The BioRegio instrument is widely known and quite well accepted by the German biotech community, although — not surprisingly — the assessment varies between those who receive funding from the programme and those who do not. The assumption underlying the BRC that there was a technology gap between Germany and the leading biotech nations (the US and the UK) when the BRC started in the mid 1990s was shared by all 33 respondents; 79% of the responding firms found this to be definitely true, 21% answered that this was partly true (Table 3). Such a gap was identified primarily in applied research and commercialisation, less so in basic research. [31] A vast majority of firms believe that the competitive stance of the German biotech industry has — at least in part — improved since then.

The firms' assessment concerning the most important obstacles to biotech innovation in Germany (Table 4) lends support to the thesis that the problems addressed by the BRC (insufficient technology transfer between firms and universities, lacking communication and cooperation among the regional key actors, [32] lacking acceptance of biotech in the public) are of paramount importance, although the important problem of over-regulation is only partly (as far as the regional level is concerned) and indirectly addressed by the BRC. By contrast, lack of public funding and lack of venture capital seem to be of less importance and only a minority of firms views lack of highly qualified researchers as an effective obstacle to biotech innovation in Germany. Comparing our results with an earlier survey among small and medium-sized biotech firms (FhG ISI, 1995) indicates that problems of venture capital and finance (ranking high in the ISI study) have become less acute in recent years, which is in accordance with the trends reported elsewhere (Schitag, Ernst &

[31] Although the general assessment in all three sub-groups goes into the same direction the 'non-participants' seem to be most critical about the competitiveness of the German biotech industry.

[32] It is interesting that the lack of communication and cooperation within the region is especially emphasized by the non-participants from outside the BioRegios (Table 4). This may indicate that these firms have a locational disadvantage further increased by the BRC.

Table 5
Advantages of the BRC

Answers	All firms			Non-participants			Participants that do not receive funding			Participants that receive funding		
	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
The BRC furthers …												
communication and cooperation among regional key actors	0.70	0.24	0.06	0.50	0.25	0.25	0.85	0.15	0.00	0.67	0.33	0.00
evolution of an innovation prone regional environment	0.58	0.39	0.03	0.38	0.50	0.13	0.62	0.38	0.00	0.67	0.33	0.00
research cooperation within the BioRegios	0.48	0.45	0.06	0.38	0.50	0.13	0.54	0.46	0.00	0.50	0.42	0.08
interregional competition for technology	0.33	0.48	0.18	0.25	0.63	0.13	0.38	0.38	0.23	0.33	0.50	0.17
break up of innovation-hampering political and administrative structures	0.21	0.52	0.27	0.38	0.38	0.25	0.08	0.69	0.23	0.25	0.42	0.33
faster diffusion of knowledge within the regions	0.21	0.48	0.30	0.13	0.50	0.38	0.31	0.46	0.23	0.17	0.50	0.33
intraregional competition	0.03	0.55	0.42	0.00	0.63	0.38	0.00	0.46	0.54	0.08	0.58	0.33

a = Definitely true, b = partly true, c = not true.

Young, 1998; Ernst & Young, 1999). Further obstacles named by the respondents include unfavourable corporate tax legislation in Germany (especially concerning 'stock option' models for the participation of employees), lack of economic and marketing skills of university researchers and a hostile environment to innovation and firm start-ups.

The most important *advantages* of the BioRegio instrument appear to be the enhancement of communication and cooperation among the regional key actors, the establishment of an innovation prone regional environment, the furthering of research cooperation within the BioRegios and the stimulation of interregional competition for technology [33] (Table 5). Those respondents who named further advantages emphasized the 'change of consciousness' brought about by the BRC: The regional actors have become aware of their region's potential, the social acceptance of biotech within the regions has improved and the BRC itself may be seen as a world wide marketing success for German biotech industry.

[33] Two respondents doubted that interregional competition for technology is really an advantage.

The most important *shortcoming* of the BRC — according to the actors' view — is that it misses to reduce regulation at the national level (Table 6).

A vast majority of firms (75%) views the BRC as a successful instrument that should be continued, and that has helped forward the international competitiveness of German biotech industry (Table 7). It is interesting that even those firms which do not receive funding (participants and non-participants) view the BRC as a success story: 70% of them (almost 90% of the non-participants from outside the BioRegios) say that the BRC has been successful and should be continued with and an even higher percentage (90%) say that the BRC has reached its objective to help forward the competitiveness of German biotech industry. Eighty-four percent of all responding firms agree that the BRC has contributed to an improved provision of venture capital; a somewhat smaller percentage also agrees that it has contributed to a considerable job creation.

Notwithstanding the overall positive assessment, the investigation also sheds light on some *problematic* aspects of the BRC. It is widely held among biotech firms that the 'picking of winning regions' may do injury to innovative firms located outside the

Table 6
Problems of the BRC

	All firms			Non-participants			Participants that do not receive funding			Participants that receive funding		
Answers	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
BRC does not reduce regulation at the national level	0.50	0.37	0.13	0.63	0.38	0.00	0.55	0.27	0.18	0.36	0.45	0.18
Neglect of less favored regions at the periphery	0.39	0.39	0.23	0.57	0.43	0.00	0.50	0.25	0.25	0.17	0.50	0.33
BRC leads to free rider effects	0.38	0.50	0.13	0.50	0.38	0.13	0.50	0.50	0.00	0.17	0.58	0.25
Injury to innovative firms located at peripheral regions	0.34	0.47	0.19	0.25	0.75	0.00	0.50	0.33	0.17	0.25	0.42	0.33
Winning regions were known in advance	0.27	0.33	0.40	0.29	0.29	0.43	0.33	0.50	0.17	0.18	0.18	0.64
Most recent developments in the regions not considered	0.24	0.42	0.33	0.38	0.50	0.13	0.38	0.38	0.23	0.00	0.42	0.58
Criteria for selection of winning regions not appropriate	0.21	0.55	0.24	0.25	0.75	0.00	0.38	0.46	0.15	0.00	0.50	0.50
Efficiency-deterring intervention into the market process	0.12	0.24	0.64	0.25	0.13	0.63	0.15	0.38	0.46	0.00	0.17	0.83

a = Definitely true, b = partly true, c = not true.

winner regions or even outside any of the 17 BioRegios, and that the new instrument neglects the less favored regions at the periphery (Table 6). [34] The criteria for the selection of winning regions are seen quite critically (especially by the 'non-participants' from outside the BioRegios) and 60% of all respondents (36% of those who receive funding) have the impression that the winner regions were known before the contest started. 88% of the responding firms (even 75% of those who receive funding) agree that the BRC leads — at least partly — to free rider effects and still 36% of all respondents (a clearly higher percentage of those who do not receive funding) are critical about the efficiency of such form of government intervention into the market process.

A majority of all respondents believes that the BioRegio funding does not reach the most innovative biotech firms (Table 7); however, this result varies strongly between the sub-groups: from those firms that receive funding from the BioRegio-programme 72.7% answered that the BioRegio funding reaches the most innovative firms whereas of those firms that do not receive funding, [35] it is just 23.5%. [36]

Interregional competition for scarce public funding is viewed as a means of enhancing the efficiency of technology policy by a majority of firms, although this result is not robust: Among those who were successful in attracting funding it is 75% that agree, among those who do not receive funding it is only 47%.

Some respondents made suggestions about what should be changed (or could be improved) with the

[34] All respondents from outside the BioRegios (non-participants) found this to be at least partly true.

[35] Non-participants and participants that do not get funding.

[36] A possible explanation is that there is a 'perception bias', i.e., each firm-representative views his or her firm (his or her region) as particularly innovative. Therefore, recipients of funding agree that the BRC reaches the most innovative firms; non-recipients disagree.

Table 7
General assessment of the BRC

	All firms		Non-participants		Participants that do not receive funding		Participants that receive funding	
	Yes	No	Yes	No	Yes	No	Yes	No
Is the BRC a successful policy instrument that should be continued with?	0.75	0.25	0.88	0.13	0.58	0.42	0.83	0.17
Has the BRC made Germany more competitive in the field of biotechnology?	0.91	0.09	0.75	0.25	1.00	0.00	0.92	0.08
Has the BRC contributed to creating new jobs to a considerable degree?	0.72	0.28	0.63	0.38	0.67	0.33	0.83	0.17
Has the BRC contributed to an improved provision of venture capital?	0.84	0.16	0.75	0.25	1.00	0.00	0.75	0.25
Does the BRC funding reach the most innovative biotech firms in Germany?	0.43	0.57	0.17	0.83	0.27	0.73	0.73	0.27
Is interregional competition for funding a suitable means of increasing the efficiency of government support for technology?	0.58	0.42	0.43	0.57	0.50	0.50	0.75	0.25

BioRegio instrument. Three firms claimed that the BRC should be succeeded (or complemented) by an integrated *national* concept for the support of biotech innovation. Others suggested to give up the restriction on regions or to make sure that each innovative firm can be associated with a Bioregio in order to prevent discrimination. Two respondents stressed that government should strengthen the bargaining position of start up firms vis-à-vis the big pharmaceutical companies by supporting early stage product development concepts and by better protecting the intellectual property of inventors. Finally, it was suggested to better consider recent trends in the BioRegios (i.e., to shuffle the cards new each year) and to give more weight to a region's development potential than to the already existing structures.

6. Conclusions

The BRC is an innovative policy instrument which has drawn a lot of attention nationally as well as internationally, trying to exploit the 'technology-regions connection' for competitiveness policy purposes. It cannot solve the fundamental information problem associated with government intervention into the process of technological change, but that could not be expected at all. On the other hand, it opens new perspectives for a more effective technology policy by taking the regions seriously and giving prominence to the well-functioning interplay of the various elements of regional innovation systems.

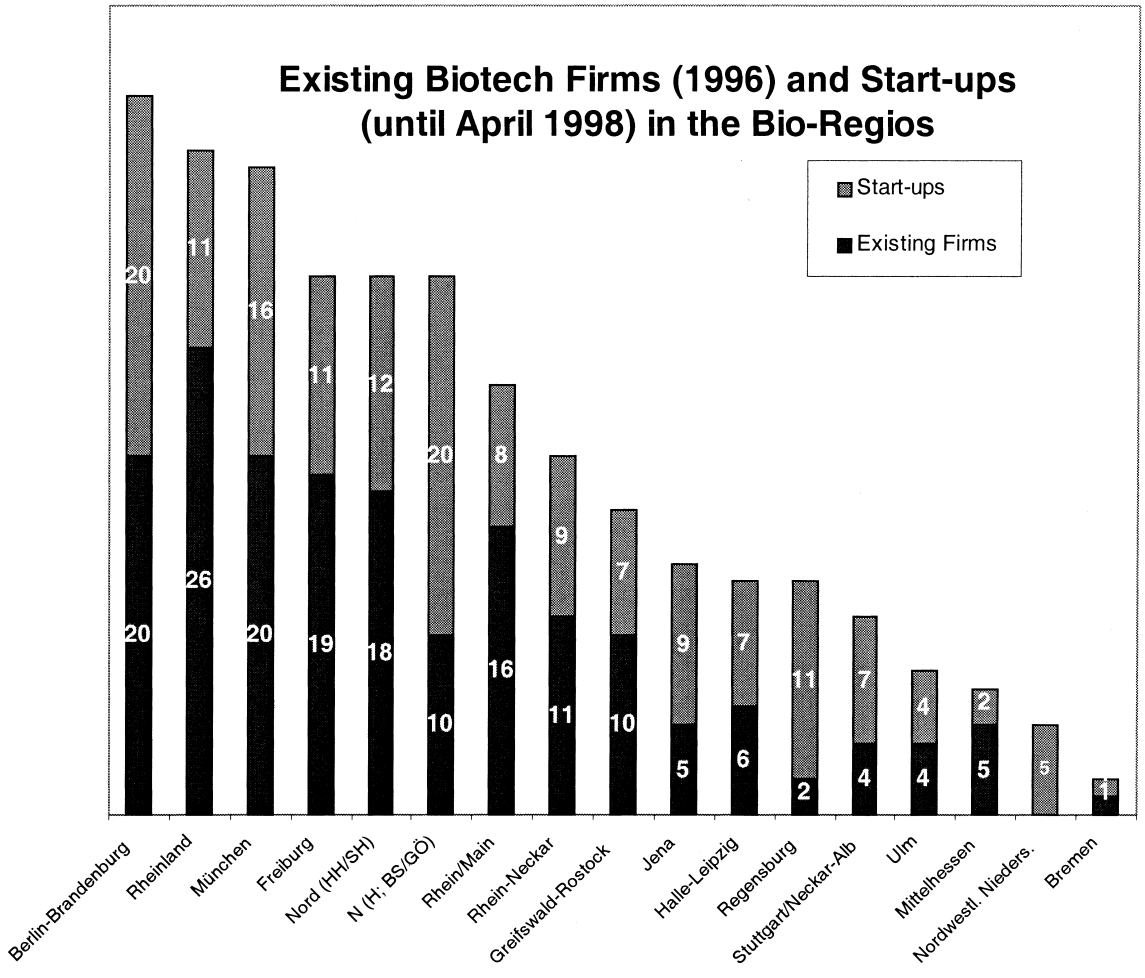
Its major advantages — as perceived by those who perform innovative activities and apply for public funding — are the enhancement of communication and cooperation among the regional key actors, the establishment of an innovation prone regional environment, the furthering of research cooperation within the BioRegios and the stimulation of interregional competition for technology. Its major shortcoming — apart from discriminating against innovative firms located outside the BioRegios — is that it contributes little to reducing regulatory obstacles to innovation at the national level.

For the BioRegio instrument to become fully effective, favourable framework conditions on product and labour markets as well as an innovation-friendly regulatory environment need to be in place. This suggests that the BioRegio instrument should be complemented by a policy aiming at reduction of impediments to innovation at the national level. Stressing the importance of the regions and of inter-regional competition for technology is by no means to say that the national level with its comprehensive regulatory, institutional and tax competence becomes meaningless for a successful technology policy.

Acknowledgements

I would like to thank three anonymous referees for particularly helpful comments.

Appendix A. Regional distribution of Biotech start-ups in Germany



Source: Informations-Sekretariat Biotechnologie, 1999.

Appendix B. Questionaire concerning the BRC

Please answer questions (1) to (4) with _a_ = definitely true, _b_ = partly true or _c_ = not true. Answer questions (5) to (9) with [yes] or [no].

The competitive situation of the German biotech industry

(1)	Was there a technology gap in the field of biotechnology between Germany and its main competitors (the US and the UK) in the mid 1990s?	__
	If this is true, in which areas existed such a gap:	
	In basic research?	__
	In applied research?	__
	In transformation of research results into new products/commercialisation?	__
	Has the situation improved since then?	__
(2)	What are — in your assessment — the most important obstacles to biotech innovation in Germany?	
	Over-regulation	__
	Risk aversity of German entrepreneurs	__
	Lacking acceptance of biotech in the public	__
	Lack of highly qualified researchers	__
	Insufficient technology transfer between firms and universities	__
	Lack of research cooperation between firms	__
	Lacking communication and cooperation among the regional key actors (firms, research institutions, policy/administration, banks)	__
	Lack of public funding	__
	Lack of venture capital	__
	Further obstacles (please name them):	

Advantages and problems of the BRC

(3)	What are — in your assessment — the most? important advantages of the BRC	
	The BRC enhances the communication and cooperation among the regional key actors	__
	The BRC furthers research cooperation within the BioRegios	__
	The BRC furthers the faster diffusion of knowledge within the regions	__
	The BRC helps forward the evolution of an innovation prone regional environment	__
	The BRC stimulates interregional competition for technology	__
	The BRC stimulates intraregional competition	__
	The BRC furthers the break up of innovation-hampering political and administrative structures in the regions	__
	Further advantages (please name them):	

(4)	What are — in your assessment — the most important problems of the BRC?	
	The BRC leads to a strengthening of the strong, dynamic regions and neglects the less favored regions at the periphery	––
	The BRC causes an injury to innovative firms located at peripheral regions	––
	The rules of the game (criteria for the selection of winning regions) are not appropriate	––
	The winning regions were known in advance	––
	The BRC is an efficiency-deterring intervention into the market process	––
	The BRC funding is based on the observed capabilities of the regions in late 1995; it does not adequately consider the most recent developments in the regions	––
	The BRC does not lead to a reduction of regulation at the national level	––
	The BRC leads to free rider effects	––
	Further problems (please name them):	

General assessment of the BRC

(5)	Do you consider the BRC a successful policy instrument that should be continued with? What should be changed in case? (please specify):	[Yes]/[No]
(6)	Do you think that the BRC has reached its objective to make Germany more competitive in the field of biotechnology?	[Yes]/[No]
	Do you think that the BRC has contributed to creating new jobs to a considerable degree?	[Yes]/[No]
	Do you think that the BRC has contributed to an improved provision of venture capital?	[Yes]/[No]
(7)	Does the BRC funding reach the most innovative biotech firms in Germany?	[Yes]/[No]
	Is interregional competition for public funding a suitable means of increasing the efficiency of government support for technology?	[Yes]/[No]
(8)	Has your firm actively participated in the BRC?	[Yes]/[No]
	Does your firm receive funding from the BioRegio-Programme?	[Yes]/[No]
(9)	Are you interested in the results of our investigation?	[Yes]/[No]

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