New Biotechnology Firms in Germany: Heidelberg and the BioRegion Rhine-Neckar Triangle

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ABSTRACT. In Germany, in the second half of the nineties, a dynamic development of commercial biotechnology took place, undertaken by a considerable number of new firms. The following article deals with the foundation of biotechnological firms in the BioRegion Rhine-Neckar Triangle (with the center in Heidelberg). For a long time, the development of biotechnology in Germany and in the Rhine-Neckar Triangle was hindered by institutional barriers. The main reasons were the narrowing of company strategies of big chemical and pharmaceutical firms, the low impulses to found biotechnology companies out of academic research, the institutional surroundings not aligned to the needs of biotechnology (e.g. no venture capital market) and finally government restraints concerning the specific and particularly regional concentrated support of biotechnology. These particularities are also reflected by the structure of the population of young companies in the Rhine-Neckar Triangle. The main emphasis of biotechnology firms is placed on technological services (research on demand) and platform technologies, different sub-areas of therapeutics research (pharmaceutical basic materials, finding active substances), on the production for the diagnostics industry and on bioinformatics. These companies do not co-operate much, national and international relations predominate. Only a few scientists of regional research institutions want to found a biotechnology firm, although the region seems to attract a certain number of company founders from other regions.

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1. Introduction

The following article concentrates on the developments in the biotechnology area in a German region, the BioRegion Rhine-Neckar Triangle. This region is located in the southwest of Germany at the intersection of three *Länder*, Baden-Wurttemberg, Rhineland-Palatinate, and Hesse, and is known for its importance in research, either publicly or privately funded. In the region of Heidelberg, the state-run research institutions in medicine and biotechnology are especially well established. Here we find several research institutes internationally renowned for their basic research. This local concentration of public top research seemed to be of less importance in the past for the economic development of this region. The academic basic knowledge in these institutions hardly played a role for the companies in this region, and had only limited influence in founding new biotechnology firms. The economic exploitation of new knowledge, took place in the U.S. competence centers for commercial biotechnology, and not in the region of Heidelberg and the Rhine-Neckar Triangle or in any other German regions.

While the scientific institutions located in the Heidelberg region had a highly specialized competence in their scientific area, a corresponding competence concerning the economic exploitation, and the building of new high-tech enterprises was missing. It rarely happened that a company was founded by a scientist from one of the public research institutes or the university. Finally, there were no venture capital firms in the vicinity which could have provided the necessary support for a high-tech start-up, and which would have had the necessary experience.

Nevertheless, in the 90s more biotechnology companies were founded. This development was

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favored by a new government policy to explicitly promote biotechnology in German biotechnology regions. The following contribution concentrates on these recent changes, and is illustrated by case studies of young biotechnology firms in the Heidelberg region. Thereby, we consider on the one hand the design of founding and developing these companies, on the other hand their embeddedness in regional and supra-regional/international connections. The structure of the founding process in biotechnology of this region partly reflects the still fragile starting of the biotechnology firms at the beginning of these changes.

2. The model region "BioRegion Rhine-Neckar Triangle"

During the last years the German federal government supported the development of biotechnology in numerous ways. The Ministry for Education, Science, Research, and Technology developed different programs of which the BioRegio Program was one of the most interesting. This program aimed at the development of regionally concentrated complexes in related biotechnology areas. The first step was to have the regions compete with each other in order to finally concentrate the public funds on the winning regions. Within this special program the BioRegion Rhine-Neckar Triangle was chosen as a pilot region and was supported with public funds (a total of 50m DM), by which private funds were also mobilized on a larger scale. Without these public funds the region would not be what it is and neither would so many biotechnological firms have been set up. In the run-up to the BioRegio competition, the BioRegion Rhine-Neckar Triangle was formed around the highly developed research capacities in biotechnology of the region, taking Heidelberg as the center. Heidelberg is an exemplary location, especially with regard to molecular biology, genetics, and cancer research, and moreover it is home to a number of renowned research and university institutes and clinics.

3. The initial situation and institutional infrastructure

3.1. *Only few biotechnology start-ups in the eighties*

Traditionally, the Rhine-Neckar Triangle has been one of the most important regions for the chemical and pharmaceutical industry. Ludwigshafen is one of the main industrial bases with its companies BASF and Knoll. For a long time the companies of this sector used exclusively chemical procedures: up into the 80s biotechnological procedures and processes were only applied in state-financed academic basic research and experimental practice of public research laboratories. Attempts at economic exploitation were made first at locations in the U.S.A.

Like many established companies in the pharmaceutical field in North America, Japan, and Western Europe, the chemical and pharmaceutical firms BASF, Boehringer Mannheim (nowadays Roche), and Merck located in the Rhine-Neckar Triangle entered this new field of technology rather late and hesitatingly. Due to their power of research, production, and market share they were able to catch up quickly (Dolata, 1994). The most remarkable signs of German pharmaceutical companies catching up in the area of modern biotechnology were their increasing investments in research and production plants in the U.S.A.[1]

The fact that in the early nineties a series of German regions could not mobilize significant production factors ("endogenous potential") or if they did, in a rather unsatisfactory way, has to be considered within the context of constitutional specialities of German innovation and production systems (Casper, 1999). The impact of this system relies on incrementally improved innovations based on experienced technology paths ("mature technologies"). In the case of the innovation system of Baden-Wurttemberg these characteristics are essentially emphasized. In Baden-Wurttemberg the technological basis consists of strong industrial clusters built over decades (i.e. institutionally embedded, regionally concentrated, and highly integrated business populations) in mature branches. These use a high percentage of material and immaterial resources available in the country (see Heidenreich and Krauss, 1998;

Krauss, 1999a). Under these conditions it is quite difficult to develop and further progress new technology fields and future business branches as e.g. biotechnology (Krauss and Wolf, 2000). Based on this, the economic and social embeddedness of biotechnology could not progress in the Rhine-Neckar Triangle for a long period of time. The decisive factors were the policy of wait-and-see adopted by the government (a restrictive genetic engineering law, inadequate government support of biotechnological research projects with reference towards application and biotechnological business start-ups), the inadequate utilization of academic basic researchers, first of all, however, the low interest of established companies of related economic sectors such as the chemical and pharmaceutical industry which did not show much tendency to enter into cooperations and business relations with young biotechnology enterprises *in the region*.[2] Furthermore, the institutional environment was hardly geared towards the requirements of the biotechnological industry. This included different aspects, i.e. the financial side (inadequate resources, risk capital, investors and banks shying away from risk), problems of being accepted in the public, in the late past also time-consuming and complicated approval procedures (factually holding-up). Nonetheless, the Rhine-Neckar Triangle (especially Heidelberg) could show a number of start-ups, however small, in the commercial area of biotechnology during the first half of the 80s.

3.2. *Institutional equipment of the region*

An industry such as biotechnology, which has to rely on a permanent supply of knowledge as well as external investors with readily available capital, requires an environment of supporting institutions open to the new technology and able to satisfy the needs of the biotechnology firms. The Rhine-Neckar Triangle has a high concentration of public and private research institutes: there are about 20 universities and colleges as well as well equipped research capacities outside the universities in the private and public sector. The research activities in the economic sector are of special interest. These are especially extended in this region and are above the already high federal average (Egeln et al., 1996, p. 119). The main emphases of the research infrastructure are in the area of medicine, bio sciences, and physics. A number of internationally renowned institutions working in the area of biotechnology are situated in Heidelberg. We may name e.g. the German Cancer Research Center (DKFZ), the European Molecular Biological Laboratory (EMBL), the Center for Molecular Biology Heidelberg (ZMBH), and the Max-Planck-Institute for Medical Research. Besides the research capacities in public basic research the big chemical and pharmaceutical companies also maintain extensive research capacities in biotechnology: In 1996 the then Boehringer Mannheim company (today: Roche Diagnostics) was number one, followed by BASF, Knoll, and Merck (see initiation circle "BioRegion Rhine-Neckar Triangle", 1996, p. 9).

The delayed development in the biotechnology industry indicates a generally low level in the risk capital branch in Germany. Here, the venture capital market was traditionally underdeveloped. Respective supporting programs and public investment instruments were initiated by the government in order to try to compensate for the lack of venture capital and the unwillingness of private finance institutes and banks to take risks in financing unconventional, more risky innovation and technology plans of existing enterprises and newly founded companies. The primary way of financing innovative plans remained the credit financing.

The BioRegio competition meanwhile lead to an improvement of offers of active venture capital for biotechnology firms in local and regional areas. For example, in October 1997 a venture capital fund the "Heidelberg Innovation GmbH & Co. BioScience Venture KG" (BSV) was founded in the BioRegion Rhine-Neckar Triangle, meanwhile with a capital of 24m DM (equity capital). Among the meanwhile 24 limited partners of the fund are the most important pharmaceutical companies and saving banks of the region, as well as national credit institutions. The saving banks have the major part of the fund. This seed capital fund grants active venture capital in contrast to those financial institutions operating with public investments, and works on the basis of profit, i.e. is financed by the profit from selling higher valued shares of the different companies.

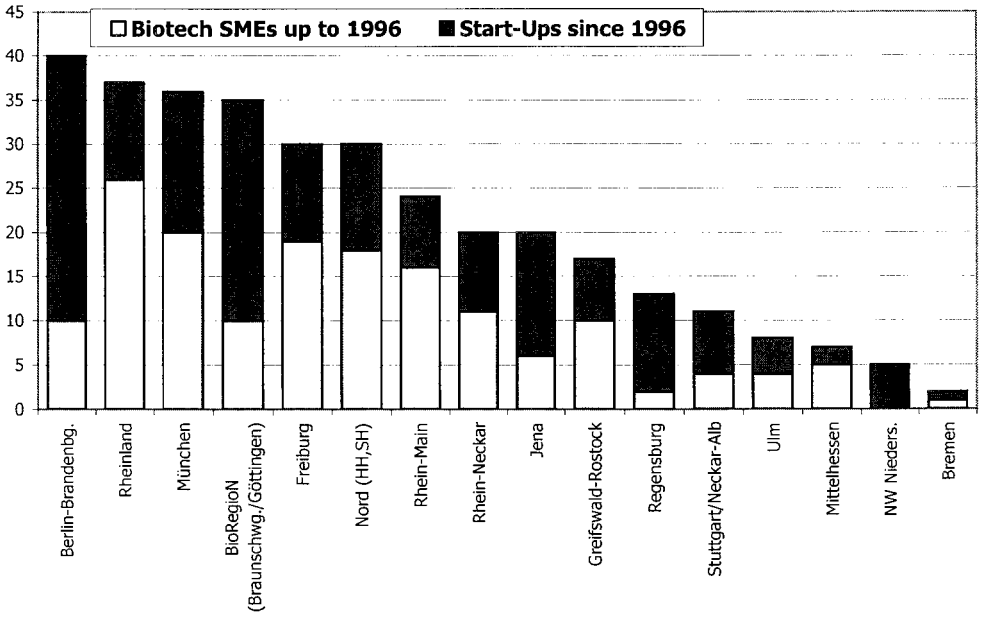
Finally, the establishment of additional institu-

tions was initiated by means of the BioRegio competition. The BioRegio concept of the region included the idea to found a virtual biotechnology center Heidelberg (BTH), consisting of the three legally independent entities "BioRegion Rhine-Neckar Triangle e. V.", "Heidelberg Innovation GmbH", and the above mentioned venture capital fund BSV. This center was established in the Heidelberg technology park. While the BioRegion Rhine-Neckar Triangle e. V. is in charge of the activities in the precompetitive section, Heidelberg Innovation is at the cross-section of the competitive area by offering services for biotech start-ups, and managing the Heidelberg Innovation GmbH & Co. BioScience Venture KG. It constitutes the center for company founders in the region to close the circle between precompetitive basic research and market-oriented company foundations. The Heidelberg Innovation GmbH (HI) offers clients consulting and support in exchange for a minor share of the companies to be founded with the aim to prepare for a middle- to long-term stock market transaction (or other exit possibilities). The service catalogue of the Heidelberg Innovation includes the identification of promising project ideas, the technology evaluation seen from the point of view of the client and of the market, the concept of strategic competitive advantages, helping to define research aims, to develop strategies for patents, to develop financial strategies on the basis of a business plan which has been worked on together, and finally the support of the "Heidelberg Innovation Early Starters Program EOS" (help for company founders). HI understands itself as a consultant and advocate of young businesses. HI's services are paid in shares of the new firms.

4. Industrial biotechnology: catching up in development in the 1990s

4.1. *Diffusion of biotechnology into the market: structural view*

With growing political support for biotechnology, rising acceptance in industry and society as well as positive developments in the venture capital market, the second half of the 1990s saw quite a dynamic increase in company. The first German biotechnology report by Schitag, Ernst & Young in 1998 showed that half of all German biotechnology companies were located in only three



Source: Barnett et al., 1998.

Figure 1. Number of biotechnology firms in the different biotech regions in July 1998.

Länder, the largest proportion of which were in Baden-Wurttemberg, followed by North Rhine-Westfalia and Bavaria. Berlin and Hesse ranked fourth and fifth (Köhler, 1998; Schitag, Ernst & Young, 1998, p. 14). Another study of the situation of biotechnology in Germany in 1998 presents for the first time figures of newly founded firms and created jobs in the different biotech regions (see Barnett et al., 1998). According to this study, most of the companies have been founded in the region of Berlin-Brandenburg; compared to all other German biotech regions the Rhine-Neckar Triangle ranked only eighth (altogether 20 firms, 9 start-ups since 1996, see Figure 2). Nevertheless, in relation to the number of jobs created, the balance for the Rhine-Neckar Triangle is much better: since 1997 200 new jobs have been created, putting the Rhine-Neckar Triangle together with Berlin-Brandenburg at third place (after the regions Munich and Rheinland with 250 respectively 240 jobs). However, it must be taken into account that since 1998 further companies were founded in the Rhine-Neckar Triangle, in addition to important investments for the expansion of existing firms. The total number of jobs created is considered to be more than 300 at the moment (July 2000).

4.2. *Functional view*

The commercial focus of this region is in the fields of pharmaceutics and diagnostics, with the main focus on contract research and production (e.g. antibodies) as well as platform technologies

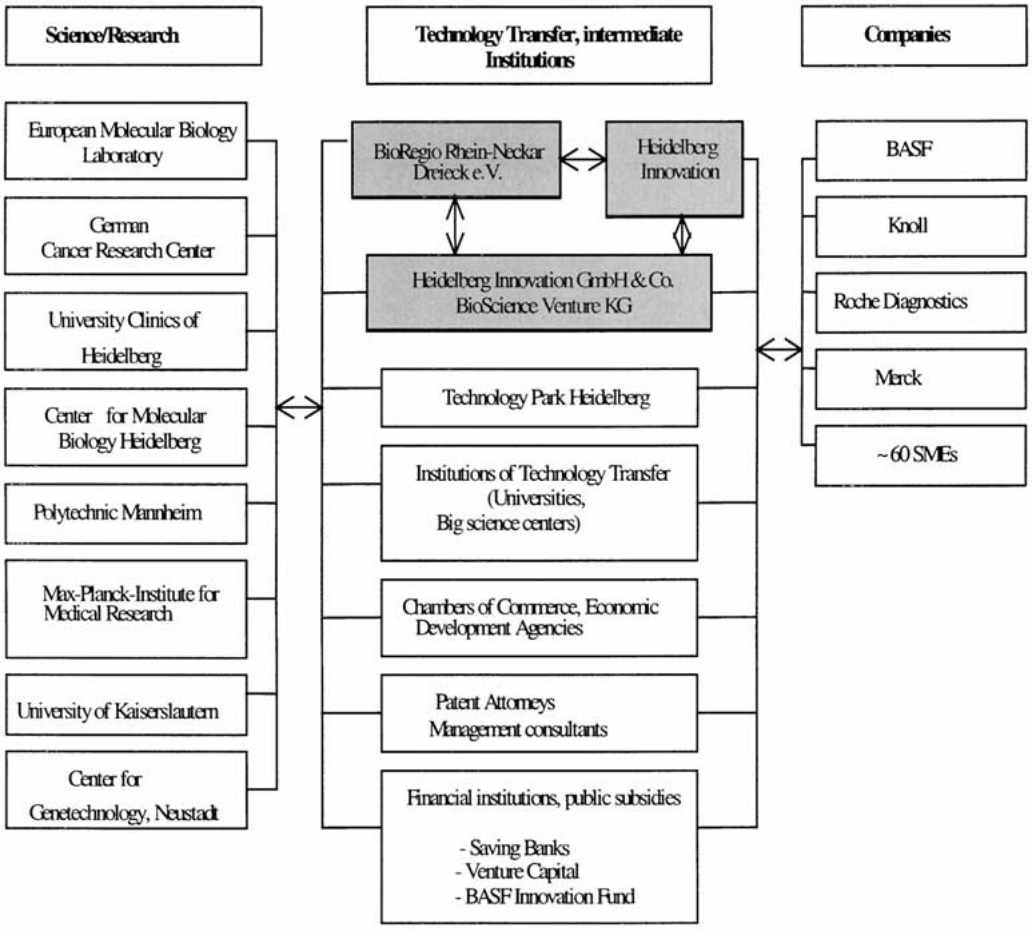


Figure 2. Structure of the BioRegion Rhine-Neckar Triangle.

(cf., for example, Köhler, 1998). By comparison, companies engaged in the fields of "green biotechnology" (Agro-Food) and environmental biotechnology are relatively under-represented, although this is actually in keeping with the trend throughout Germany. A considerable number of production and service-oriented diagnostics firms have settled in the region in the meantime. In spite of a high degree of automation, many of these firms are still increasing their labour force (mainly non-academic employees such as technical assistants). Apart from the diagnostics companies there are also a number of so-called "royalty-income-based pharmaceutical companies" (see Manth, 1995) which have also settled in the region. They are providers of pharmaceutical basic substances (biopharmaceutical active ingredients and substances) for which pharmaceutical companies obtain licenses or the right to use the patents and integrate them in the clinical phases. The biotechnology company issuing licenses has the advantage to participate in the market and the value added chain via so-called "milestone payments" (in contrast to simple contract research). Because of extremely high technical and financial risks in the area of discovering active substances, these companies have to rely on "strategic partnerships" with established and powerful pharmaceutical companies on the market, which undertake the clinical development and later on the licensing and production. From the point of view of the pharmaceutical companies this may be a kind of "risk-outsourcing" which, in addition, is supported by several federal programs encouraging the creation of new biotechnology firms (BioRegio, BioChance, BioProfile). Because the discovery of active substances is very much based on basic research, the regional proximity to the infrastructure of science and research plays quite an important role. Often, projects based on the division of labour are exclusively planned with institutions inside the Rhine-Neckar Triangle to ensure the prompt exchange of the results and data, and to exploit regional synergy. For regions with a pharmaceuticals industry of national and international significance such as the Rhine-Neckar Triangle, royalty-based pharmaceutical companies present an interesting case from the point of view of regional economics because they raise the regional share in the value-added chain for medical drugs (from production-oriented R&D on to the production and sales of innovative medicines). A broad spectrum of preparatory measures at a very high standard requiring a high degree of know-how are also contingent upon a corresponding demand and upon trade relations with local (large-scale) industry as partners (customers).

A further area of competence in the Rhine-Neckar Triangle is formed by companies specializing in bioinformatics, BioChip technologies and the development of database functions. Companies focusing on diagnostics represent another main focus of competence. Often, these are providers of new technologies (machines, robots) for the diagnostics industry. Some of these companies are both development-oriented and production-oriented (components for the diagnostics industry, diagnostics tests etc.). However, a lot of firms mainly provide services. Similar to the "royalty-income-based pharmaceutical companies", the regional scientific community and regional synergy play a special role.

Biotechnology companies with their own department for developing drugs (in the following we call them "fully integrated pharmaceutical companies" for simplification purposes),[3] however, are rather the exception. Only one single company (as a management-buy-out of Boehringer Mannheim) can be classified as this type of company up to now. Since such foundations of firms require an enormous investment volume and are very risky too, their small share is not necessarily an indicator for deficiency of innovation and location. Though, as examples in the U.S.A. and also recently in Munich indicate, such radical innovations in the biotechnology and pharmaceutical industry in certain cases may be quite possible. The few existing examples show that such projects may stimulate rapid growth and thus can have great effects on employment and exploitation.

Strong links to science are characteristic for all listed types of companies. The strong scientific base in the Rhine-Neckar Triangle is a most important locational factor. Not all of the biotechnology companies succeed in obtaining venture capital, but for those receiving venture capital, the regional proximity to the connected venture capital company proves to be necessary and profitable. This is all the more so, the less the founders of

TABLE I
Functional typification of biotechnology companies

	"Royalty-income-based pharmaceutical company"	"Fully integrated (Bio-) pharmaceutical company"	Diagnostic companies with functioning as service sectors	Real service companies	Bioinformatics companies
Function	*Extremely research oriented*; Innovative discovery of active substances; Pharmaceutical basic material, technology platforms; in general issuing licenses of substances before the expensive clinical phases of development	*Discovery of active substances and development of drugs on their own*; Own product-pipeline; in general development up to the clinical proof of effectiveness (phase II)	*Development* of diagnostic technologies (machines, robots), process technologies; *Production-oriented*: components, diagnostics-tests; *service function*: biotechnological service, screening	Research on demand; isolation of active substances (e.g. out of plants), quality controls of active substances	Development of software, *Development* of biochips, databases, DNA-systems of sequence informatics
Customers	Strategic alliances of research, in general "big pharma"	"Big pharma" with world-wide distribution; possibly pharmaceutical wholesaler	Diagnostics industry, often sales via global partners	Other biotechnology companies, pharmaceutical companies, diagnostics industry	Biotechnology companies, pharmaceutical companies, diagnostics companies
Market	World-wide, especially North-America, strong growing market, high demand	World-wide	World-wide	Rather regional/national market; strong pressure of competition	National and international market, growing market
Regional embeddedness	Scientific links: primarily regional; regional synergy required; proximity to venture capitalists important; proximity to customers not important	Strong regional scientific relationship in the first phase; regional labour market partly important (technical staff)	Regional scientific relationship, proximity to venture capital; proximity to industry as customers is important in the case of prototypes; proximity to hospitals and access to patients important	Loose regional relationship; less research	Proximity to biotechnology industry important, exploit regional synergy; regional proximity important for venture capital investment
Other characteristics	High interdisciplinarity, high standards of automation, extremely risky projects, often VC-financed, extremely specialized, niches' suppliers	Massive growth necessary, extremely high investment; IPO required; often buying companies or parts of companies	Often strategic niches; growth as highest objective	Often small technological platforms, small investments; growth of size important, often shop with regular customers	High interdisciplinarity: medical, biological and informational-technical formulations of questions, qualified staff as minimum factor

Source: G. Krauss and T. Stahlecker.

biotechnology companies have experience in management or in big industry.

4.3. *Relations of interaction*

The intensity and quality of network and communication relationships play a major role for biotechnology firms during their "early stage phase". In this phase technological, financial, marketing and internal business problems are critical factors (for example if the founder has no experience in business management), which could endanger the existence or growth of the company. Regional innovation networks, which can be politically induced (for example the German bioregions) or which have been growing for a longer period of time, certainly can be a risk-reducing component in the national innovation system for young technology companies. The intensive integration in regional networks, however, cannot replace the founder's necessary ability and competence.

The existing incentive structures in research institutions have hardly promoted the foundation of new biotechnology companies by scientists until now. It is notable that hitherto there have been no or at least too few companies established as spin-offs from universities or local research institutions. Many of the newly established life science companies have been set up by founders from research institutions outside the region. In some cases the founders have had experience in the relevant industries and have, at best, informal relations with local university institutes, research groups and industry. These companies would appear to maintain equally intense professional contacts beyond the Rhine-Neckar Triangle as they do within. This fact permits certain conclusions concerning the interdisciplinary nature of the field of technology and the relatively limited "location-function" of close proximity for technology transfer.

Obviously, location-building factors such as financial incentives, an excellent scientific and research infrastructure, consultancy and support institutions, the image of the region as a prime biotech location, agglomeration advantages as well as a high degree of living and leisure quality, have the effect to mobilize biotechnology know-how from outside the region. This empirical observation coincides with findings from other high tech districts. In the United States regions such as South California, Silicon Valley or the Boston region are able in a similar way to absorb non-local, supra-regional and foreign productive capital in form of highly specialized know-how. While the Rhine-Neckar Triangle certainly cannot be compared to the mentioned American technology regions, it is true that this is an interesting location-building fact.

The increasing importance of young, innovative life science companies in the region offers the opportunity for the large established companies of the traditionally strong chemical and pharmaceutical industry for co-operation at short distances and thus to benefit from geographical proximity. Whereas in the United States the modernization of the pharmaceuticals and diagnostics industries would seem to succeed in "mature" locations without any direct geographical contact with the young life science industries, in the BioRegion Rhine-Neckar Triangle big local incumbents meet a productive and creative environment of start-up biotech firms.

Further developments are contingent on the question of the extent to which co-operations between established companies and young biotech firms already exist in the region and which are the barriers hindering the further development of cooperative relationships. In this connection, the attitude of local (large-scale) industry towards the newly emerging life science companies in their direct vicinity is most interesting. In other words: are co-operations, business relationships and "strategic alliances" for instance for joint product developments, research projects or for achieving exclusive customer relationships (license agreements, patent rights) between the local pharmaceuticals and diagnostics industry and the young innovators in the life science disciplines actually being achieved? Or, in spite of existing technological and thematic links, is preference given to the global network and global co-operation?

In this respect, it is notable that the biotechnology firms are indeed partly successful in initiating supra-regional, national and European alliances, but sometimes have certain difficulties to realize a co-operation with established companies in the region. From the point of view of big pharma companies, the realization of co-opera-

tions is contingent, on the one hand, on the quality of the products and services offered by the young biotech firms, and on the other hand on the question to what extent these products and services fit into the portfolio of the big incumbents. In fact an increasing trend of German pharmaceutical companies can be observed to develop interest for young biotech start-ups. On the other hand, the case studies in the BioRegion Rhine-Neckar Triangle indicate that the realization of co-operations needs relatively strong efforts from all the actors involved. First concrete engagements of the big incumbents in the region began to develop only late and still do not represent the common case. The established pharmaceutical companies are currently still playing the part of neutral observers of the emerging life science scene. Common interest is mainly reduced to improving the conditions of life science R&D. Large-scale industry tends to seek business relations and co-operative partnerships in the form of alliances still on an international scale, often with American life science companies. The main reason for this is possibly the years of experience between German companies and American life science companies as well as the technological edge due to many years of commercialization and industrial exploitation.

5. Conclusion

In Germany, in the second half of the nineties, a dynamic development of commercial biotechnology took place, based on a considerable number of new firms. The dominance of young, innovative companies, a strong orientation towards science, an extremely high need for capital and various relations between basic research, the venture capital industry and companies are characteristic for this technology field.

Beside their ability to establish relations, the success of these small specialized biotechnology firms also depends on the question, whether and in which way their innovative impulses are absorbed by the established and powerful companies. In this respect co-operations ("strategic alliances") between biotechnology firms and large chemical-pharmaceutical firms over large distances are not excluded; by contrast, they are even often the case. In addition, large spatial distances also are very common for co-operations between young biotechnology firms and internationally acknowledged scientists with more consultative or representative function inside the company (Audretsch and Stephan, 1996). This shows a characteristic element in biotechnology in general, which is the big importance of global know-how transfer (Dolata, 1999). This can be confirmed in the examined region Rhine-Neckar Triangle: an integration in national and global interaction connections on the part of the pharmaceutical and biotechnology companies ("born global") plays an important part in local and regional relations as well. Finally, the region seems to be successful in recruiting a considerable number of its founders from outside.

In contrast to the United States and other European countries, the development of biotechnology in Germany and in the Rhine-Neckar Triangle was hindered and delayed by institutional barriers. The main reasons were among others the narrowing of company strategies of big chemical and pharmaceutical firms, who for a long time showed only few interest for the new biotechnology, as well as the low impulses from academic basic research to found new biotechnology firms, the institutional surroundings not aligned to the needs of biotechnology and finally government restraints concerning the specific and particularly regionally concentrated support of biotechnology. It was the main purpose of the BioRegio promotion to close this gap, leading to positive developments in the model regions. In fact, important intermediate institutions have been established in the Rhine-Neckar Triangle which offer support for young biotech firms and for founders of biotech start-ups. In addition, the strong public promotion of pre-competitive activities in the area of biotechnology had a catalytic effect on further firm foundation in this field. These more or less radical changes within few years nevertheless can be seen only as the entry into this still young technology field which is characterised by strong global competition. Considering the starting conditions in the BioRegion Rhine-Neckar Triangle the change is, in fact, considerable. However, in comparison to the leading biotech districts in the world, the structure of the young biotechnology sector in the BioRegion Rhine-Neckar Triangle still reflects certain weaknesses. The difficulties in establishing

business relations with local incumbents as well as the even today insufficient impulses to found biotechnology companies out of academic research indicate that the new biotechnology firms which have settled in the region did not yet secure their position and that their social embeddedness is still fragile.

The young biotechnology firms in the Rhine-Neckar Triangle cover a relatively broad spectrum of different products and services: companies concentrate mainly on technology-related services (i.e. contract research), therapeutics research (pharmaceutical basic substances, discovery of active substances), production for the diagnostics industry and bioinformatics. It is noticeable that an important number of companies is working in the segments of platform technology and, to a lesser extent, development of therapeutics. These two segments differ clearly from each other. For example, projects in the development of new therapeutics are much more long-term-oriented, require a much higher internal stability of the firm, of its central competencies and, above all, of its relations to clinics and academic research institutions. To what degree the activities in the mentioned segments will be successful in the long run cannot be assessed definitely at this time. In particular it should be examined more in detail of what relevance the majority of the German biotech firms for the globally operating big companies is and whether the latter could be interested in co-operations with the former.

Finally, the closeness of biotechnology and chemical and pharmaceutical industry in the Rhine-Neckar Triangle BioRegion may offer the opportunity for the region to develop a specific competence profile to equip it for global competition in Life Science. It could be the future basis for achieving lasting regional value creation and growth effects. It is not, however, possible at present to judge conclusively to what degree the region is able to make use of this opportunity.

Notes

[1] BASF founded for instance a center for pharmaceutical research in Worcester (BASF Bioresearch Corp.), in the direct vicinity of Boston, one of the world-wide leading biotechnology regions. In 1990 the Bayer daughter Cutton in Berkeley (the equivalent to Boston at the West Coast of the U.S.A.) started the production of the blood clot factor VIII (comp. Theisen, 1991; Dolata, 1994).

[2] This may result in an obstacle to innovation since young high technology enterprises need support by incumbents, if they do not have support from strong, experienced venture capital companies anyway (Krauss, 1999b, c).

[3] Strictly seen, this type is not a fully integrated company in the classical sense, since the clinical phases II and III and the following production are still run by the pharmaceutical industry. In general, the companies of this type are developing drugs up to phase II, which shows that an active substance has an effect on the human body (clinical proof of effectiveness). In this sense these companies differ clearly from the numerous fully integrated pharmaceutical companies of the classical (non-biotech) areas of development and production of drugs.

References

Audretsch, D. B. and P. E. Stephan, 1996, 'Company-scientist Locational Links: The Case of Biotechnology', *American Economic Review* **86**(3), 641–652.

Barnett, R., G. J. Clements, J. N. Grindley, N. M. MacKenzie, U. Roos, and D. Yarrow, 1998, *Biotechnology in Germany. Report of an IST Expert Mission*, Bonn: British Embassy.

Casper, S., 1999, *National Institutional Frameworks and High Technology Innovation in Germany. The Case of Biotechnology*. Discussion Paper FS I 99-306. Berlin: Wissenschaftszentrum für Sozialforschung.

Dolata, U., 1994, 'Nachholende Modernisierung und internationales Innovationsmanagement – Strategien der deutschen Chemie- und Pharmakonzerne, in T. von Schell and H. Mohr (eds.), *Biotechnologie – Gentechnik. Eine Chance für neue Industrien*, Berlin: Springer, pp. 456–480.

Dolata, U., 1996, *Politische Ökonomie der Gentechnik. Konzernstrategien, Forschungsprogramme, Technologiewettläufe*, Berlin: Sigma.

Dolata, U., 1999, *Hot House. Konkurrenz, Kooperation und Netzwerkbildung in der Biotechnologie*, Artec-Paper Nr. 69 (Juli 1999). Bremen: Forschungszentrum Arbeit und Technik (artec).

Egeln, J., M. Erbsland, A. Hügel, P. Schmidt, and H. Seitz, 1996, *Der Wirtschaftsstandort 'Rhein-Neckar-Dreieck'. Standortprofil und Unternehmensdynamik*, Baden-Baden: Nomos.

Heidenreich, M. and G. Krauss, 1998, 'The Baden-Württemberg Production and Innovation Regime: Past Successes and New Challenges, in H.-J. Braczyk, P. Cooke and M. Heidenreich (eds.), *Regional Innovation Systems: The Role of Governances in a Globalized World* [With Editorial Assistance from G. Krauss], London: UCL Press, pp. 214–244.

Initiativkreis 'BioRegion Rhein-Neckar-Dreieck', 1996, *BioRegion Rhein-Neckar-Dreieck*, Antrag zum BioRegio-Wettbewerb, Vol. 1.

Köhler, I., 1998, *Biotechnologie in Deutschland – Aufbruchstimmung in Baden-Württemberg* (Handout zum Vortrag auf der Innovationsbörse Biotechnologie am 9.Juli 1998 in Heidelberg).

Krauss, G., 1999a, 'Les problèmes d'adaptation d'une économie régionale forte: changement et inerties en Bade-Wurtemberg [Steering Problems in a Vibrant Regional Economy: Keeping Baden-Württemberg Technology Firms on Track]', in *Revue d'Économie Régionale et Urbaine* (RERU) 1999/2, pp. 353–376.

Krauss, G., 1999b, *Technologieorientierte Unternehmensgründungen in einer sich wandelnden Regionalökonomie: Unterstützungsmodelle für die Praxis in Baden-Württemberg* (Arbeitsbericht Nr. 148 der Akademie für Technikfolgenabschätzung in Baden-Wurttemberg, Stuttgart).

Krauss, G., 1999c, 'Technologieorientierte Unternehmensgründungen – zur Bedeutung regionaler Netzwerke im Zeitalter der Globalisierung', in G. Fuchs, G. Krauss and H.-G. Wolf (eds.), *Die Bindungen der Globalisierung: Interorganisationsbeziehungen im regionalen und globalen Wirtschaftsraum*, Marburg: Metropolis-Verlag, pp. 285–308.

Krauss, G. and T. Stahlecker, 2000, *Die BioRegion Rhein-Neckar-Dreieck: Von der Grundlagenforschung zur wirtschaftlichen Verwertung?*, Arbeitsbericht Nr. 158 der Akademie für Technikfolgenabschätzung in Baden-Württemberg, Stuttgart (Juni 2000).

Krauss, G. and H.-G. Wolf, 2000, 'Technological Strengths in Mature Sectors – An Impediment or an Asset for Regional Economic Restructuring? The Case of Multimedia and Biotechnology in Baden-Wuerttemberg', in *Journal of Technology Transfer* (Special Issue 'Regional Innovation Systems in Europe' edited by P. Cooke, L. Leydesdorff and M. Olazaran) (Forthcoming).

Manth, S., 1995, 'Die Biotechnologie in der pharmazeutischen Industrie', in M. Lonsert, K.-J. Preuß and E. Kucher (eds.), *Handbuch Pharma-Management*, Band 2, Wiesbaden, pp. 802–826.

Prevezer, M., 1997, 'The Dynamics of Industrial Clustering in Biotechnology', *Small Business Economics* **9**, 255–271.

Schitag, Ernst & Young, 1998, *Aufbruchstimmung 1998. Der erste Report der Schitag, Ernst & Young Unternehmensberatung über die Biotechnologie-Industrie in Deutschland*, Stuttgart: Schitag, Ernst & Young.

Theisen, H., 1991, *Bio- und Gentechnologie – Eine politische Herausforderung*, Stuttgart, Berlin, Köln: Kohlhammer.

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