Key indicators of the German biopharmaceutical industry

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Stephen Woerner and Thomas Reiss

Dr Thomas Reiss
is head of the department 'Innovations in Biotechnology' at the Fraunhofer Institute for Systems and Innovation Research (ISI). He has a background in molecular biology and has been working since more than ten years on foresight, technology assessment and innovation policies in biotechnology. Since 1999 he has been a member of an expert group for biotechnology of the *Bündnis für Arbeit* which has been convened by Chancellor Gerhard Schröder.

Stefan Woerner
is a PhD student at the department 'Innovations in Biotechnology'. His special interest lies in real options valuation in the biopharmaceutical industry.

Abstract The biotechnological paradigm has an enormous influence on the pharmaceutical industry, creating a new type of enterprise active in the biopharmaceutical sector. Building on a sound statistical basis, key indicators of this industry in Germany are discussed. The findings suggest an ongoing maturation process in the German biopharmaceutical industry, emphasising commercial orientation towards international markets. Technology portfolios are identified, suggesting four groups of companies producing or using similar products and technologies respectively. Based on these insights, conclusions are drawn on the expected future development of the sector.

Keywords: biopharmaceutical, system of innovation, Germany

Introduction

The impact of biotechnology on the pharmaceutical industry has been twofold. Firstly, it became one of the crucial techniques in medical and pharmaceutical R&D. Novel approaches based on molecular biology and gene technology are central in the investigation of diseases. Secondly, biotechnology has gained influence in the development and production of pharmaceutical products.[1]

These effects led to the foundation of a new type of firms at the interface of biotechnology and pharmacy: biopharmaceutical enterprises. Commercial prosperity of such companies often depends on the success of the development of a single drug, diagnostic or innovative therapy. Business prospects seem abundant, indicated by a strong interest from financial institutions for instance.

State of the industry

Through desk research, 260 companies in Germany were identified that were potentially active in the biopharmaceutical sector. A questionnaire was sent out to these companies in late 1999. Of the 260 firms, 7 per cent had to be excluded because they replied that they did not apply to our sector definition, or because they were merely sales organisations of larger groups from abroad without advanced R&D facilities in Germany, or were pure contract research organisations (CROs). The sector definition is based on a list of products and technologies related to biopharmaceuticals (cf. Appendix A). The analysis of data collected through our survey is based on responses from 71 individual enterprises and provided main characteristics of the biopharmaceutical industry in Germany, which are summarised in Table 1.[2]

Stefan Woerner
Fraunhofer Institute for Systems and Innovation Research,
Breslauer Strasse 48,
76139 Karlsruhe, Germany

Tel: +721 6809 161/160
Fax: +721 6809 176/476
E-mail:
Stefan.woerner@isi.fhg.de

Table 1 Key indicators of the German biopharmaceutical industry (data for 1999 if not indicated otherwise)

Indicator	Value
Number of companies	242
Size distribution (no of employees):	
1–20	55%
21–50	28%
51–100	9%
>100	9%
Agencies funding research	BMBF, BMG, DFG, AiF, Länder ministries, Stifterverband der Deutschen Wissenschaft; European Commission
Total public funding (1994–1998)	€1,710 million
Number of dedicated biotechnology institutes	28
Number of degrees awarded during 1994–1998[a]	
master	2,944
PhD	808
Total turnover (based on median)	€61 million
Total biotechnology turnover (based on median)	€19 million
Median turnover of dedicated biotechnology firms	€150,000
Average share of biotechnology turnover	
$\frac{\Sigma\,[\text{Biotechnology revenue}(\%)_i \times \text{total revenue}\ (\in)_i]}{\Sigma\ \text{total revenue}\ [\in]_1}$	40%
Main source of biotechnology turnover	Research
Main target markets	Domestic
Location of main public sector research collaborators	Domestic
Location of main firm collaborators	Domestic

[a]See Appendix B for methodology.
Source: Federal Ministry of Education and Research (BMBF), Federal Ministry of Health (BMG), German Research Society (DFG), Association of Industrial Research (AiF).

The numbers on firms and industry turnover are based on data extrapolated from information of our recent national survey. They could be biased upwards and may represent an upper bound for the actual data. The distribution of the annual turnover is heavily skewed to the right as the respective figures using the mean are manifoldly higher. This should explain the deviation of our data from other industry statistics. The latter usually calculate the mean instead of the median, which would be less appropriate for this purpose keeping the size distribution of the biotechnology sector (many small enterprises, a few large firms) in mind. Median turnover of dedicated biotechnology firms (with 100 per cent turnover in biotechnology) within the sector amounts to €150,000. The average share of biotechnology turnover is 40 per cent, mainly generated in R&D. The expected value for the total number of employees based on the survey data is 9,450 individuals. According to our experience in this industry and other statistics, this value should be at the upper end of the actual range.

Most of the firms in our sample (54 per cent) are small firms employing 1–20 individuals. Twenty-eight per cent of the firms employ between 21 and 50 people whereas 9 per cent of the companies have a workforce of 51–100 and more than 100 people respectively.

The majority of companies (59 per cent) were established independently. Around one-third grew out of public sector research (PSR) and only some (9 per cent) were founded as a spin-off from another firm.

Only 43 per cent of the firms are older than three years. Nearly a quarter of the firms earned below €50,000 in 1999. Some 34 per cent had a turnover between €100,000 and €1 million, 20 per cent between €1 million and €5 million. Only 7 per cent of the firms were in the position to receive more than €10million in 1999 from biotechnology sales. The median of turnover of the biopharmaceutical sample was €250,000 in total and €80,000 in biotechnology (32 per cent).

Most of the firms (51 per cent) achieve 100 per cent of their total annual sales in

biotechnology. A relatively large number of companies (23 per cent) make less than 20 per cent of their annual turnover in biotechnology.

Taking all the data presented up to now together, it is concluded that there are many firms solely involved into biotechnology (they make 100 per cent of their total turnover in biotechnology), but still generating relatively low annual turnovers. On the other hand, there are other bigger (and older) pharmaceutical firms diversifying into biotechnology. Their average share of biotechnology turnover is less than in the core biotechnology firms but in terms of absolute numbers, they play the major role.

In order to answer the question on the geographical orientation of the firms in the sample and to further characterise the German biopharmaceutical industry, some more indicators were extracted (Table 2). Of the companies in our sample 62 per cent actually sell biotechnology products. The main product market for 41 per cent of the firms is Germany, followed by countries in the rest of the EU (33 per cent) and the USA (22 per cent). More than 60 per cent of the firms offer services related to biotechnology, 42 per cent are also CROs (those firms that are solely CROs were excluded by the definition of the sector). Almost half of the sample (49 per cent) offer their services mainly in Germany. The rest of Europe emerged to be the main service market for 31 per cent of the companies and 20 per cent mainly focus on the USA as a market-place for their services. Other regions do not play a significant role. Only 12 per cent of the firms reported licensing income.

Comparing the share of the product- and service-oriented companies of our sample shows that the domestic orientation is stronger for companies offering services related to biopharmaceuticals. This observation could be interpreted first as evidence for the importance of geographical proximity when providing services. Second, it could also indicate that the international competitive position of the product-oriented firms is stronger compared with the service-oriented enterprises. The data indicate that most of the companies are oriented internationally. About 20 per cent of the firms have even succeeded in establishing the USA as their main market, where they compete with the strong US biopharmaceutical industry. Thus the geographical orientation of German biopharmaceutical firms underpins the impression that the industry is on its way to maturation.

Table 2 Main product and service market of the biopharmaceutical companies in our sample

	Main product market (%)	Main service market (%)
Germany	41	49
Rest of the EU	33	31
USA	22	20

On average, each company has between one and two patents providing national (31 per cent) or potentially international claims (30 per cent) on an invention. Intellectual property rights (IPRs) restricted to Europe or the USA totalled 22 and 17 per cent respectively. Under the condition that a firm has at least one patent, the average number of patents is between three and four. The high share of patents with the option on worldwide protection mimics the fact that the pharma industry is working internationally and is not constrained to national boundaries. Together with the findings that 62 per cent of the companies have sales in biotechnology (with a high share in foreign markets) and that there are very many start-ups not older than three years in the sample, this could give a hint on the phase in the life cycle the companies are in at the moment, ie that they are beginning to exploit their inventions in international markets.

Some 86 per cent of the firms from this sector have reported R&D collaborations either with organisations from PSR or with other companies. As far as collaborative R&D with PSR is concerned, the partner for the firms in our sample is usually located in Germany (90 per cent). This fact should underpin the importance of geographical proximity for the establishment and success

of collaborations in science often mentioned in studies on public–private networks. It furthermore is a rationale for national public funding because it emphasises the importance of a well-developed national science base even in a global business such as biopharmaceuticals.

Regarding research cooperations with other companies the partner is located in Germany in most cases (58 per cent). US companies play an important role and contribute more than one-quarter of the research partnerships. This could have several reasons, eg scientific and commercial excellence due to the lead of American biotechnology, or a gain in reputation through a collaboration partner from the USA.

Although the roots of the domestic biopharmaceutical companies in our sample are in the German market in both commercial and scientific terms, strong activities have been developed in international markets as well. We expect an increasing relevance of the EU and US market in future as the companies proceed through their life cycle.

Product and technology portfolios

A principal components analysis using SPSS 8.0.0 revealed four groups of companies in the biopharmaceutical sector producing or applying the same products and/or technologies. The groups and the corresponding factor loading are shown in Table 3.

It is apparent that the first two groups concern the highly sophisticated platform technologies applied in the biopharmaceutical industry while the last cohort represents the protein/antibody group. The latter group also represents companies with a stronger product orientation. The third cohort reflects gene therapy activities. Unfortunately, these groups show only weak correlation with other variables.

By counting the relative occurrence of certain products or technologies in the questionnaires and grouping the variables into seven categories, the aggregated technology portfolio of the companies of our sample is obtained, thus representing an estimation for the most frequently applied or offered technologies and products in the German biopharmaceutical sector, as shown in Table 4.

A large number of companies are obviously concerned with genomics and genomics related platform technologies (combinatorial chemistry, DNA/protein sequencing, HTS, bioinformatics and molecular modelling). Immune products such as vaccines and antibodies, monoclonal antibodies and diagnostics are another major business area. The second important product category is biotherapeutics which is in the portfolio of 13 per cent of our sample firms. Nearly all companies are based on a

Table 3 Groups of products and technologies produced or applied by the companies of the sample and corresponding factor loading calculated by principal component analysis

Product/platform technology	Factor loading
Genomics	0.628
DNA/protein synthesis	0.577
DNA/protein sequencing	0.688
High throughput sequencing (HTS)	0.662
Bioinformatics	0.698
Model animals	0.544
Combinatorial chemistry	0.520
Molecular modelling	0.625
Gene therapy	0.707
Blood products	0.561
Recombinant proteins	0.721
Vaccines/antibodies	0.752
Monoclonal antibodies	0.539

Table 4 Relative occurrence of products and technologies at companies of the sample[a]

Product/technology	Occurrence in the sample (%)
Genomic platform technologies (genomics)	34
Immune products	29
Biotherapeutics	13
Gene therapy	8
DNA/protein synthesis	7
Model animals	7
Transgenics	2

[a]See Appendix C for the composition of the groups.

genomics-related technology portfolio. However, product categories such as immune products and biotherapeutics are already part of the portfolio of about three-quarters of the firms. This underpins the observation of an evolving maturation of the industry.

The future development of the biopharmaceuticals industry in Germany will be influenced by scientific, economic, legal and financial factors. Federal and state innovation policy may further support the sector. It is arguable that appropriate measures should aim at improving the framework conditions for the commercial development of the maturing industry (rather than further increasing the number of companies).

Future prospects

German research organisations and companies are linked to the international scientific system. Global advances in pharmaceutical R&D will thus be transferred to German institutions as well. It is expected that in the mid-term, the genes causing many of the most important diseases will be identified. The genesis of the diseases would then become clear, offering a wide area for new and better treatments. Although there have been severe setbacks for gene therapy, it is expected that it will become a powerful treatment option in the long term. A number of the fastest growing biopharmaceutical companies in Germany are working in this field. Modern biotechnology will also help to find improved ways of drug administration (eg regarding orally available insulin) and to develop more efficient production processes for the pharmaceutical industry.

There are a number of economic factors determing future prospects of the biopharmaceutical industry. Positive impulses may come from the trend of pharmaceutical companies to outsource certain stages in R&D, in the drug application process and in production, as well as from the ageing population in Germany (as the expenditures for drugs increase considerably with higher age). Cost containment pressure in the public health-care sector may negatively influence the business opportunities of the biopharmaceutical companies and of their customers. It can be argued that only some firms will be able to take advantage of that growth potential. The market in Germany and the rest of Europe is still fragmented. Compared with their US counterparts, European companies may not be able to exploit the full commercial potential of future scientific advances.

Legal factors concern the reformation process of public healthcare systems (the system in Germany has been changed by several laws four times in the past 11 years) and the harmonisation efforts regarding the European (and international) drug application process. Despite such deregulation efforts, there still are many barriers for a rapid liberalisation of the market.

The financial environment for the German top-tier biopharmaceutical companies should remain advantageous in the future as the number of firms reporting advances in research phases and product sales should increase as well as the number of companies listed at the *Neuer Markt*. The high demand of the firms for financial resources should thus be backed by the strong supply of venture capital and institutional and private investors at the stock exchanges. However, many experts predict a consolidation process among German biotechnology companies in the coming years. Such firms with lower or negative growth rates may not be able to fund second or later financing rounds. Hence the gap between successful and rather weak firms should open up in the future.

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References

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Appendix A

Table A.1 Sector definition of the biopharmaceutical sector. Only those enterprises active in at least one of the listed technologies and/or markets were included in the sample.

Recombinant proteins	DNA/protein sequencing
Gene therapy	Transgenics
Antisense	Combinatorial chemistry
Vaccines/antibodies	High throughput sequencing
Monoclonal antibodies	Bioinformatics
Diagnostics	Molecular modelling
Genomics	Model animals for trials
DNA/protein synthesis	Blood products

Appendix B

In order to estimate the quantity and breadth of human capital in the biopharmaceutical sector in Germany, we collected numbers provided by the Federal Statistical Office (1999) on students studying biotechnology and related fields at German universities as well as the number of dissertations completed in these subjects. The problem of such an approach is that the official figures for 'biotechnology' represent only a minor fraction of the disciplines relevant to biotechnology. Therefore we had to scan all science disciplines covered by the statistics and determine which ones were relevant for the sector under consideration. The subjects finally taken into account are: medical computer science, biochemistry, pharmaceutics and biology.

Numbers on subjects such as molecular biology and microbiology are included in the numbers for biology. On the other hand, 'biology' also includes subjects such as systematic botany or animal systematics which are not relevant for our purpose. We therefore tried to estimate the number of students studying biology in relevant fields. We asked deans responsible for biology at nine major universities (Freiburg, Heidelberg, Tübingen, Munich, Frankfurt, Köln, Düsseldorf, Münster, Berlin) to give estimates about the relative distribution of their biology students in fields 'relevant for biotechnology' and 'not relevant for biotechnology'. With these statements we calculated a mean (54 per cent) and multiplied it with the total numbers for biology provided by the Federal Statistical Office.

We also included the subject of pharmaceuticals in our statistics although most of the graduates join the dispensing chemists. Nevertheless, we found this proceeding appropriate as we intended to estimate the manpower that is potentially relevant for occupations in biotechnology. This applies to pharmacists who experienced an education that enables them to do scientific research in biotechnology – irrespective of what their first job will actually be in most cases.

Appendix C

Table C.1 Composition of the subgroups of the sector definition listed in Table 4

Subsector	Components
Immune products	Vaccines/antibodies
	Monoclonal antibodies
	Diagnostics
Biotherapeutics	Recombinant proteins
	Blood products
Genomic platform technologies (genomics)	Genomics
	DNA/protein sequencing
	Combinatorial chemistry
	HTS
	Bioinformatics
	Molecular modelling
Gene therapy	Gene therapy
	Antisense
DNA/protein synthesis	
Transgenics	
Model animals	