DEVELOPING EXCELLENCE IN MEDICAL TECHNOLOGIES

Benchmark Report for Germany

A report prepared for
Advantage West Midlands

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1. National Overview

1.1. Economic Overview

Germany has a population of 82 million and, in 2002, had a GDP of over 2,110 billion. It remains the third largest economy in the world, behind the US and Japan. However, in each of the past ten years, growth has been less than even the modest rates achieved in the *Euro-countries,* demonstrating that Germany suffers from problems that are more structural than cyclical.

Table 1: Basic Figures 2001: Germany, France, UK

	Population in million	GDP per capita ($)*	Disposable income per capita ($)*	Unemploy-ment rate	Long-term unemployment (>12 months as % of total)	Export as % of GDP	Import as % of GDP
Germany	82.3	26,321	16,391	7.8	51.5	30.8	26.2
France	59.2	26,177	16,630	8.5	37.6	22.6	22.4
UK	59.8	26,369	16,667	5.0	27.7	19.2	23.1

*Current prices and current PPPs (purchasing power parities)
Source: OECD, Basic Structural Statistics, 2003

The structural problems resulted to some extent from the consequences of the reunification after 1989. But the reunification merely accelerated developments that would have happened anyway. One main reason for Germany's economic problems is its social security system which is composed of statutory national insurance with five different elements (Table 2), organised as a *pay-as-you-earn-system*. It depends heavily on working people who pay the contributions from which the social benefits for the elderly, the sick and the unemployed people are financed.

Table 2: Statutory Social Insurance System in Germany in Billion Euro, 2001

Statutory Social Insurance	Expenses in billion Euro	Per cent of total	Average contri-bution rate (% of gross salary)
Retirement	226	50	19,5
Health	136	30	14,0
Unemployment	65	14	6,5
Nursing Care	17	4	1,7
Accident (contribution rate paid by companies only)	11	2	
Total *	**455**	**100**	

*The actual expenses are 419 billion Euro – the higher amount is due to insurance internal clearing.
Source: Verdi, 2003

Owing to the continuous expansion of social benefits and services, social contribution rates have increased over the previous decade in conjunction with tax rates. Therefore, social insurance rates (including employee and employer contributions) currently add to over 42 per cent of gross income. This trend has been associated with declining levels of employment (Table 3) and consequently with falling income for the social insurance agencies.

Table 3: Employees subject to Social Insurance Contribution in Germany, 1993=100

1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
103.0	100.0	98.7	98.3	97.0	95.4	95.1	96.1	97.3	97.3

Source: Federal Employment Service

Reforms of the social security system including the health service have been recommended by national and international organisations, including the *EU* because the current budget deficit is in excess of the three per cent limit set by the *EU's Growth and Stability Pact*. If Germany wants to solve its problems, structural reform of the social insurance system is unavoidable (see also Chapter 1.6).

1.2. Technology and Innovation Policy

Data on R&D

Although the economic outlook seems unfavourable, Germany still has a well trained and motivated workforce, innovative companies and an excellent scientific and technical infrastructure that gives the country a leading global position in technology and innovation. International comparisons show that Germany spends 2.48 per cent of its GDP on R&D while France spends 2.15 per cent and the UK 1.86 per cent. Only Japan, Finland and Sweden spend about three per cent. The US spends 2.7 per cent, excluding capital expenditures (OECD 2002)[1]. In 2001, expenditure for research and development in Germany was split between public institutions, universities and the private sector in the following proportions: 14 per cent; 16 per cent; and 70 per cent (Table 4) which clearly shows the strong involvement of the business enterprise sector in innovation and research. However, public support, made up of federal programmes and joint *Federal-Länder* schemes including non-university institutes[2] are also of enormous importance. In recent years those programmes were the driving force behind innovation in fields such as biotechnology and information technology, areas that were neglected by the private sector for historical reasons. In addition, they supported new organisational structures such as networking and increasingly stressed the regional aspects of collaboration (through, for example, *competence centres*).

Table 4: Expenditures for R&D by Sector in Million Euro; Germany

	Public institutions and private institutions without pecuniary interests	Universities	Business enterprise sector	Total
2001	**7,146**	**8,442**	**36,350**	**51,938**
1995	6,266	7,378	27,014	40,658
1991	5,457	6,145	26,421	38,023

Source: Federal Statistical Office

Table 5: People employed in R&D by Sector; Germany

	Public institutions and private institutions without pecuniary interests	Universities	Business enterprise sector	Total
2001	**71 906**	**101 443**	**314 330**	**487 679**
1995	75 148	100 674	283 316	459 138
1991	90 711	103 864	321 756	516 331

Source: Federal Statistical Office

[1] For more information on R&D expenditures see Bundesministerium für Bildung und Forschung: Fact & Figures Research 2002.

[2] The key players in Germany 's research landscape – such as the Max Planck Society (MPG), the Fraunhofer Society (FhG), the Centres of the Hermann von Helmholtz Association (HGF), the "Blue List"-institutions, and the Science Council (Wissenschaftsrat) – are jointly funded by the Federal Government and the Länder governments.

In 2000, the Federal Government's expenditure on research and development amounted to Euro 8.4 billion, which was 2.3 per cent higher than the comparable figure in the previous year. The 2001 budget appropriated a total of Euro 9.0 billion for R&D, an increase of 7.1 per cent over 2000.

The Federal Ministry of Education and Research (BMBF)

The BMBF plays a prominent role in innovation policy and finances nearly two thirds of all federal R&D expenditure. The budget is 8,364 billion Euro or 3.3 per cent of the entire federal budget. Thirty-eight per cent of the BMBF budget is spent on the promotion of technology and innovation; 21 percent on knowledge oriented and cross-programme basic research; and 14 per cent on research and development to provide for the future. The Ministry's research promotion schemes contain two areas which are particularly relevant for medical technology: *biotechnology/health research* and *innovation support and technology transfer*. Under *project funding*, the research report of the Ministry summarises the position as follows:

> *One particular form of project funding is support of 'competence networks', involving use of competitive procedures to identify and support 'innovation clusters'. The members of such clusters, representing different industries, technologies and parts of the value chain, solve problems co-operatively. A first example of this approach, the BioRegio competition, has been followed by competitions for centres of excellence in nanotechnology, competence networks for medicine and centres of excellence for medical technology, and the InnoRegio regional competition, which is not tied to any specific areas. In this context, mention should also be made of the BMWi's (now BMWA) Promotion of Innovative Networks (InnoNet) Programme, which is used to support the development of research networks comprising both small and medium-sized enterprises and research institutions. (BMBF 2002a).*

In addition, the BMBF is also responsible for the Deutsche Forschungsgemeinschaft, (DFG). This is the central, self-governing body that promotes research at universities and other publicly financed research institutions in Germany. It serves all branches of science by funding research projects and facilitating cooperation among researchers. It disposes of funds of almost 1.3 billion Euro.

In 2000, the Federal Government passed an extensive **federal health research programme** (*Health Research for the People*[3]) that sets out the main areas of development in the health sector including research on diseases and prevention; structural changes in the research infrastructure; and better collaboration between academia and the private sector. It refers to medication, medical technology and information and communication technology (*telematics*) as important fields of research that are closely connected with collaborations with private enterprises. The programme structure with its four areas for action and its financial setting comes under the responsibility of the Federal Ministry of Education and Research and the Ministry of Health (Table 6).

[3] Gesundheitsforschungsprogramm der Bundesregierung: "Gesundheitsforschung: Forschung für den Menschen". (Programme of the German Federal Government: Health Research: Scientific Research for the People), 2001.

Table 6 Project Funding by the Federal Health Research Programme

Areas for Action (I.-IV.)		2000 (mill. Euro)	2001 (mill. Euro)	2002 (planned, mill. Euro)
I.	Effective Disease Control	46.1	49.2	58.5
II.	Health Care System Research	7.8	6.3	6.4
III.	**Collaborative Health Research between Private Enterprise and Science (drug therapy, medical technology, telematics)**	**18.9**	**25.4**	**22.3**
IV.	Strengthening the Research Landscape by Optimising Structures	34.1	32.1	28.8
Total		106.9	113	116

Source: Federal Ministry of Education and Research

Medical technology funding as part of the third area for action concentrates on the following:

- Technical aids for disabled people;
- Promotion of regional networks of competence (Kompetenznetzwerke, see below);
- Stimulation of new fields of knowledge in medical technology.

The *networks of competence* are regional alliances that cut across scientific and technical as well as industrial sectors and include all stages of the development of a product, up to its the market launch. In the late 1990s, the BMBF developed the programme for supporting widespread networks, based on the concept of *technology clusters* like Silicon Valley, with a focus on supporting structures rather then individual projects. It was important to support networks which included the full value-added chain to take advantage of vertical synergy effects. This is achieved through the networks by combining participants from universities; from hospitals; from manufacturing; from health insurance companies; from trade unions; and from local communities. The goal of the networks is to create a synthesis of different regional organisations, with the support of politicians and municipalities. Usually, the ventures focus on specific fields within the sector of their industry. Once an idea of a *network of competence* is developed, it can apply to the advisory council of the VDI (Verein Deutscher Ingenieure) an association of German engineers, which works on behalf of the BMBF, and supports the networks in public affairs. For example, it established a communication platform for the networks of competence (www.kompetenznetze.de). The BMBF itself helps the networks by funding and professional promotion through project executing organisations, which are mainly associations of the particular technology sector. Not all of the networks included in the VDI-platform receive funding from the BMBF. The advisory council of the VDI continuously evaluates both new and established networks. A recent evaluation of the networks made favourable judgements of their performance. In 1999, the BMBF started a competition in which excellent networks in the medical technology sector could apply for support from the BMBF and the VDI. Eight centres were selected for funding and two of them were in Baden-Württemberg. The centres chosen not only had a well organised infrastructure but also submitted convincing project proposals on advanced medical technology subjects to be realised during the development phase. Each centre receives up to 770,000 Euro per year for building up their organisational structure and for running selected research projects over five years (that is to say, 3.8 million Euro per network). In the meantime an additional network, Erlangen-Nürnberg in Bavaria, was established.

The winners of the 1999 competition by the BMBF were:

- Aachen: Competence Centre for Medical Technology – focused on miniaturized medical technology

- Weser-Ems Region: HörTech - Centre of Competence for Hearing Aid Technology – focused on hearing instruments
- Bochum: Ruhr-Centre of Competence for Medical Engineering – focused on Diagnostics Ultrasound
- Hannover: Medimplant – focused on therapeutical effective cardiovascular implants
- Tuebingen-Tuttlingen: Minimally Invasive Medicine & Technology (MITT)
- St. Ingbert/Berlin: Competence Centre for Miniaturized Monitoring and Intervention Systems (MOTIV)
- Thueringen: Competence Center OphthalmoInnovation Thueringen – focused on systems for diagnosis and therapy of the most common eye complaints
- Bochum/Karlsruhe: TELTRA competence center – focused on telecommunications and computing in the area of traumatology
- Erlangen/Nürnberg: Medical Technology– focused on minimally invasive diagnosis and therapies

Another role of health technology promotion is to help new innovative ideas to gain acceptance, according to *area of action III*. The funding is primarily aimed at the improvement of basic research in science and technology. An *innovation competition* for medical technology takes place annually to support individual research ideas of a highly innovative and original character. The goal of this measure is to overcome barriers to innovation transfer and provide help in speeding up the development process, from the generation of a promising idea to the completion of a usable method or a commercially viable product. In 2002, eleven research teams were successful in the competition and shared two million Euro between them.

In addition, *innovative single actions*, in which university researchers and companies throughout Germany take part, may be supported as well.

1.3. Innovation Policy and Regionalisation

Owing to the federal organisation of Germany, regional economic development has always come under the responsibility of both the federal level and the single Länder (for example, through the joint State-Länder *Improvement of Regional Economic Structures*, one of the largest subsidy programmes in Germany, which supports regional development mainly in weak areas). For some years now, federal laws and programmes have been explicitly supporting regional development strategies, in research and development but also in other fields. For instance, labour market organisation is currently under reform with the aim of streamlining bureaucracy and of giving more responsibility to the regional and local employment offices.

In terms of research and development, Germany has a strongly decentralised structure, especially compared with France and the UK where research is largely concentrated in localities around the capitals. A regionalised research structure is viewed as an advantage in the diffusion of new technologies because decentralised R&D centres help new technology to spread more rapidly over geographical areas and to be taken up more quickly by companies. This seems to be particularly true in an early phase of the innovation cycle when the exchange of knowledge is especially important and tied to personnel, personal contacts and close relationships with universities and research institutes. [4]

[4] For further information see Fraunhofer Institut für Systemtechnik (2000).

The main promotional approaches of the German Government to stimulate regional competences in pioneering areas of technology are shown in Table 7.

Table 7: Most Important Federal Programmes for Regional Development

Programme	Description
Joint State/Länder-Task "Improvement of Regional Economic Structures"	Biggest investment promotion measure in Germany (founded 1969) which covers the structurally weak regions and which now supports a growing number of innovation projects such as technology centres to attract new businesses, projects to train human capital and R&D projects by SMEs. Between 1995 and 2001 about 900 million Euro in promotion flowed to innovative projects.
Competence Networks	Promotion of regional networks in new technology fields including innovation chains from basic research to application, with complementary measures, like training skilled personnel.
InnoRegio	Support of 23 regions in the new Länder to help to implement their innovation concepts (255 million Euro until 2006).
InnoNet	A competition since 1999 where at least 2 research institutes and at least 4 SMEs can receive funding. No focus on a technology or branch.
BioProfile	A competition to sharpen regional profiling by coordinating biotechnology research and the transfer of research results into applications (50 million Euro over five years).
Innovative Regional Growth Cores	A new programme that supports collaborative projects with a high market potential. So far nine growth cores have been awarded about 40 million Euro for a period of three years. More projects will be included.
Interregional Alliances for the Markets of Tomorrow	Forums in the new Länder where "early stage" innovative initiatives are assessed.

Source: Ministry of Economics and Labour, 2002

Owing to their tax revenues, the single Länder can implement their own industry policies. The ways in which Bavaria and Baden-Württemberg are taking advantage of this in terms of medical technology support programmes and innovation polices will be described in Chapter 3.

1.4. Industrial Relation System

The German labour market is highly regulated by law and collective agreements. The German industrial relations system delegates a great deal of authority to the social partners to reach binding agreements. The Federal Union of German Employers' Associations (Bundesvereinigung der Deutschen Arbeitgeberverbände) has two levels of association: industry associations and state associations. Most companies belong to one or more industry associations and possibly also a state association. The employers' associations do not correspond exactly to the number of unions, and frequently several employer organisations negotiate with one union. Under certain conditions, employers may also bargain individually with unions.

On the trade union side, the most important confederation of trade unions is the DGB (Deutscher Gewerkschaftsbund) which has 7.7 million members. There are eight industry trade unions affiliated to the DGB including the world's largest service sector union *ver.di* which was created from five white collar unions in 2001 (including the public service union; retail trade and banking sector union; and media union) and which represents more than 2.7 million members. Another 1.1 million public officials are organised in the German Civil Service Federation (Deutscher Beamtenbund). Finally, a small number of workers (0.3 million) is organised in unions under the Christian Trade Union Confederation. Collective bargaining over wages and working conditions does take place at a regional level but the bargaining system is nevertheless highly centralised.

At the plant level, the works councils play a crucial role in regulating working conditions and training. Works councils are elected bodies with rights to information, consultation and participation at the plant and company levels. Employees in plants with at least five regular employees are entitled to elect representatives to a works council. But small enterprises often do not have a works council. Works councils have the right to negotiate with management about a wide range of topics like the scheduling of the working day; incentive pay; job design; the development of guidelines for hiring, layoffs, and reclassification; the training plan; and social plans. In addition, they have rights to information and consultation over health and safety measures; personnel planning; and general company planning. The rights of works councils are governed by law (Betriebsverfassungsgesetz). The law was recently amended to ease the election procedures of works councils and especially to strengthen their powers in SMEs. A further element of the German industrial relations system is *codetermination* which applies to companies with at least 500 employees and gives the workers the right of representation on supervisory boards.

1.5. The National Educational and Training System

1.5.1. The Dual Training System

Initial vocational training in Germany is regulated by the Federal Government, the social partners and industrial organisations and can be characterised as a *dual system*, which balances theoretical and practical training between public vocational schools and private companies. Training is carried out at the workplace (usually three days a week) and in the school. It is a corporate tripartite system. The government, the employers' organisations and trade unions are included in the process of regulating, financing, administering and controlling of training. Young people are trained in one of the 360 State recognised occupations requiring formal training.

The aim of the dual system is to provide a broadly based vocational education and the necessary skills and knowledge required to practise an occupation in a properly structured course of training. The general structure of the training consists of a first year offering a wide ranging basic training course; a second year with increasing specialisation; and a third year ending with the examination for a skilled worker (Facharbeiter).

The Federal Ministry for Education and Research is responsible for vocational training policy. It is supported by the scientific advice of the Federal Institute for Vocational Training (Bundesinstitut für Berufsbildung BIBB). The board of the Federal Institute is composed of employers, workers, the Länder and the Federal Government. The members of the board follow the principle of consensus. The aim of its research, development and counselling activities are to identify the future functions of vocational training; to promote innovation in vocational training; and to develop new and practically viable solutions for

use in initial and continuing training. A pivotal task of the Institute is to prepare the curricula of training. The procedure of drawing up or changing training regulations for the State-recognised occupations involves the participation of the employers' associations, the trade unions, the relevant Ministries, and the Federal Institute for Vocational Training. In addition, there is an established procedure for drawing on results from occupational research; from pilot projects; and from tests carried out by the Federal Institute for Vocational Training. Employers provide dual training in recognised occupations listed by the Federal Institute. As compliance with training regulations is obligatory, a uniform national standard is assured.

The skills and knowledge to be taught at the workplace are established in a framework plan (Rahmenplan) for the trade or occupation. The training company incorporates this into its own individual training plan. The occupational subjects to be taught at the vocational school (Berufsschule) are stipulated for each trade or occupation in a framework curriculum. The Länder, who control the school based part of the dual system, either adopt the framework curriculum as it is or convert its provisions into their own curricula. Initial training at the workplace is governed primarily by law (Berufsbildungsgesetz) and the relevant regulations of the Chamber of Trades (Handwerksordnung). Training is provided on the basis of a civil law contract between the business providing the training and the young person concerned.

The Chambers of Commerce and Trade play an important role in the preparation, administration and control of the on-the-job portion of the dual training system. They award training licences; control the delivery of on-the-job training; release examination regulations; organise the examination of apprentices; and offer continuing training courses for instructors. Following the Vocational Training Act of 1969 the chambers set up a vocational training committee composed of representatives of employers, employees and teachers. Their main function is the organisation of apprenticeship examinations. Successful examination candidates are awarded a certificate showing proficiency as a skilled worker (Facharbeiterbrief); commercial assistant; (Kaufmannsgehilfenbrief); or journeyman (Gesellenbrief).

The companies engaged in dual training have to acquire eligibility to provide training. This can be achieved through a trainer examination at the Chambers of Commerce or the Chambers of Trades. The majority of approvals is acquired through the masters' examinations in different trades. In 1998 there were 780,000 approved trainers in the dual system. The ratio between apprentices and trainers was 2:1 on average.

Employers are not required to hire the apprentice after he or she has finished his or her training. In 1998, 58 per cent of young people were employed by company where they were trained after they completed their apprenticeship.[5]

Small enterprises play a crucial role in the *dual system* of vocational training. In 1998, one fifth of the apprentices were trained in companies employing 1 to 9 persons and a furtherr 32 percent in companies with 10-49 employees. This represents a higher proportion of trainees in relation to the employees in small companies than in large companies and companies of medium size.[6]

As Table 8 shows, the dual training is largely financed by companies.

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5 Federal Ministry for Education and Research: Berufsbildungsbericht 2000 (Occupational Training Report).

6 Federal Ministry for Education and Research: Berufsbildungsbericht 2000.

Table 8: Financing of the Dual Training System

	Billion Euro 2001
Enterprises	
Gross expenditure	21.7
Net expenditure	*12.9*
(minus output value of apprenticeship work)	
Federal and Länder Governments	
Vocational schools	3.2
Specific training programs	0.4
Federal Employment Service	3.7
Total	20.2

Source: Berufsbildungsbericht 2002.

The companies pay trainees a wage, which is subject to a contractual collective bargaining agreement. In 2001, the average apprentice wage amounted to Euro 582 per month in western Germany. In total, companies spent about 21.7 billion Euro in 2001 for training in the *dual system*. Training schools (Berufsschule) was financed by public funds with 3.2 billion Euro. Additional public funds were available to support the training of disabled or socially disadvantaged young people, and the training of foreigners.

If firms are not able to provide training under the set training regulations they can still be involved in the training scheme through complementary training measures at supra-company training centres (ueberbetriebliche Berufsbildungsstätten). Owing to the restructuring problems facing industry, young people in the new *Länder*, who are unable to find a training place in a company, may receive initial vocational training at a publicly funded training centre (außerbetriebliche Berufsbildungsstätte). The practical aspects of training programmes normally covered in a company are carried out in training workshops and learning offices set up by the bodies responsible for training.

For some occupations, vocational training is carried out at full-time vocational colleges (Berufsfachschule). There are full-time vocational colleges for, among others, business occupations; occupations specialised in foreign languages; crafts industry occupations; social work occupations; health sector occupations; and artistic occupations. In cases where such schools do not provide a full career qualification, the period of attendance may, under certain conditions, be recognised as equivalent to the first year of vocational training in the dual system. The duration of education at the collegess varies, but it takes at least one school year and normally leads to a final examination.

1.5.2. Continuing and Professional Training

Compared with initial vocational training, further and continuing vocational training is fairly unregulated. This type of training is mostly organised by companies, but other institutions, such as the Chambers of Industry and Commerce; the Chambers of Trade; and training centres of the unions, are also involved. But further training in order to become a master craftsman or foreman (Meister) is regulated like state recognised occupations. At the enterprise level, works councils have participation rights regarding continuing training.

About 14 per cent of the labour force has a university degree (Universität and Fachhochschule)[7]. In 2002, about 1.9 million students were enrolled in higher education. Business administration was the course most frequently studied. Biology and chemistry and medicine figured among the top ten, together with several engineering courses.

[7] Federal Statistical Office: Statistisches Jahrbuch 1998.

From 2001 to 2002 the number of new entrants to engineering course increased by seven per cent.[8]

1.5.3. Strengths and Weaknesses

Major problems of the German vocational training system are, first, the mismatch between the qualifications in which young people are trained and those that are actually required; and, secondly, the mismatch between the supply of and the demand for training places. The training rate (defined as the number of trainees in relation to the number of employees) has been declining during the 1990s. In 1998, the training rate was considerably lower in most industries than in 1990. Therefore, in 1998 the employers and unions agreed an employment pact which is not only tackling the problem of high unemployment rates in Germany but also the problems related to vocational training (Buendnis fuer Arbeit, Ausbildung und Wettbewerbsfähigkeit). Since then, the balance between supply and demand for training has improved and steps towards a more modern and more flexible system of vocational training were implemented. In addition, the federal state and the social partners are developing new concepts and strategies for ensuring a transparent and flexible system of continuing and further training. The partners involved are also debating training issues at a regional level, on a regular basis.

Despite the fact, that the German dual system of vocational training is frequently held up as a model, the system has been criticised for the quality of vocational training; the mismatch between the training and the skills required by the economy; and slow adaptation to new technologies. The slow adaptation to demographic, social, technological and economic changes was identified as one reason for Germany's slow growth and late transition into the services economy. Thus, the Ministry for Education, Science and Technology is increasing flexibility by speeding up the adaptation of training regulations. This process used to take many years as a consensus agreement was required between the social partners before any change. Between 1996 and 1999, however, the regulation of about 90 occupations was revised.[9] In order to increase the flexibility of the vocational training system the *modularisation* or *unitisation* has been being discussed since the mid-1990s. Recently, the first initial traineeship programme with a modular format was introduced.[10] A series of pilot projects on *add-on* qualifications is being implemented and the certification of qualification units is being elaborated. The underlying aim is more flexible access to qualifications at the level of skilled workers and a link between initial and continuing vocational training by means of *add-on* qualifications. All parties, the social partners and the government, share the view that formal qualifications need to be subject to requirements applicable nationwide, if they are to be transferable and transparent.[11].

Nevertheless, criticism of the dual training system has continued. A focal point is still the partial mismatch between the occupations being trained and the jobs in the economy. In 1998, 27 per cent of apprentices became unemployed, after finishing their apprenticeship.[12] Questions have also been raised as to the appropriateness of training for rigidly defined occupations in an era of rapid technological change. The skills acquired are highly specific to the training of a particular occupation. This may become a weakness in the future, as the needs for broader qualification profiles and lifelong *learning* become apparent. In principle, a similar criticism may be made of university courses as they also prepare young people for specific occupations.

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8 Federal Statistical Office: 2003.
9 Federal Ministry for Education and Research: Berufsbildungsbericht 2000.
10 Reuling, 2000.
11 Büchtemann, Vogler-Ludwig, 1997.
12 Federal Ministry for Education and Research: Berufsbildungsbericht 2000.

Intensive research on a better matching of qualifications with labour market demands is under way. But the results of the studies are only rarely implemented owing to the requirements of the industrial relations system and the agreement of the social partners. One institution for the analysis of qualification needs is *FreQueNz*, a research network of eight research institutes that aims at identifying qualification needs; developing options for action; and providing the results of the research projects (www.frenquenz.net). The projects of the partner institutes participating in the research network cover a large variety of research ranging from direct observation of changes at the workplace to an international comparison of early identification activities in competitor countries. The network is supported by the Federal Ministry of Education and Research.

1.6. Organisation of the Health Care System

1.6.1. General Remarks

About 2.1 million people work in a medical occupation in Germany. Taking into account all people working indirectly for the health care system, the total rises to four million (who represent 11.1 per cent of all economically active people) which makes the sector one of Germany's most important fields of employment. The sector's annual turnover is about 218 billion Euros and accounts for 11 per cent of the country's gross domestic product[13] (see Annex 1 for a time series of Germany's GDP and health data).

The cornerstone of German social legislation including the health sector is the Social Code Book that regulates all questions related to the statutory social insurance schemes. The Social Code Book V (Sozialgesetzbuch V) contains the legal framework for the German statutory health insurance (Gesetzliche Krankenversicherung, GKV), for its organization; its method of working; and its services and benefits. The following types of benefits are currently legally included in the benefit package, usually in generic terms:

- prevention of disease,
- screening for disease,
- treatment of disease (outpatient medical care, dental care, drugs, non-physician care, medical devices, inpatient/hospital care, nursing care at home, and certain areas of rehabilitative care),
- transportation.

Almost 90 per cent of the German population, or 73 million people, are insured with a statutory health insurance fund (SHI)[14] due to mandatory membership up to a monthly gross pay of 3,450 Euro. People earning above this amount can decide to stay in the SHI or insure themselves in a private health insurance fund (7.3 million people). In 2001, the SHI alone spent about 138.7 billon Euros annually (130.6 billion Euro for health care measures; 8.2 billion for administration and other expenditure), which represents about 61 per cent of turnover in the entire health care sector.

[13] "Health expenditures" contain payments of the statutory health, retirement, long-term care and accident insurance, private health insurances, employers, public and private households. Expenditures are for treatment in kind, personnel and materials costs of the social insurances, investments and investment subsidies (medical research in companies is not included). Beyond the 218 billion Euro another 64,8 billion Euro so-called "income-benefits" were spent health related in 2000. Income benefits are sick-pays (Krankengeld), continued salary payments in case of sickness or motherhood (Entgeltfortzahlung), or early retirement payments in case of occupational disability. The statistics were split in 1998.

[14] The number of SHIs decreased from over 1,200 after the unification in 1990 to 356 in 2002 due to strong concentration processes. 287 of the 356 SHIs are company-based health funds, most of which opened up to the public in recent years.

In the SHI all members are entitled to the same level of benefits while contributions are a certain percentage of salary (principle of solidarity). Aside from funds which specialise in insuring miners, seafarers or farmers, most funds can be chosen regardless of occupation or location. At present, depending on the fund, the compulsory contribution rate is about 14.5 per cent (the estimate for 2003) of gross salary which is split equally between employee and employer.

A distinctive aspect of the German health care system is that decision making powers are delegated to non-governmental corporatist bodies. That is to say, certain rights of the federal state as defined by law are handed over to corporatist self-governing institutions. The corporatist institutions have mandatory membership and the right to raise their own financial resources under the auspices of, and regulation by, the state. In addition, they have the right and obligation to negotiate and sign contracts with other corporatist institutions and to finance or deliver services to their members. For the statutory health insurance scheme, corporatism is represented by the (statutory health insurance-contracted) physicians' and dentists' legal associations on the provider side and the health funds and their associations on the purchasers' side. While the framework for the SHI system and levels of patient contributions are set by law at the national level, most decisions on the actual contents of the uniform benefits catalogue and the delivery of curative health services are made through joint negotiations between the associations of the physicians and the SHI both at regional and national levels. Reforms including cuts would therefore require the (unlikely) support of both the health funds and the providers[15].

To reduce increasing health care expenditures (from 1992 to 2000, health care costs increased by almost 34 per cent in real terms) and to relieve employers from high workforce related costs, there were many reforms over the past decade which sought to make health care delivery affordable and more cost-effective. They included the following:

1989 Health Care Reform Act (Gesundheitsreformgesetz)
1993 Health Care Structure Act (Gesundheitsstrukturgesetz)
1997 SHI Contribution Exoneration Act (Beitragsentlastungsgesetz)
1997 First and Second SHI Restructuring Act (GKV-Neuordnungsgesetze)
1999 Act to Strengthen Solidarity in SHI (Solidaritätsstärkungsgesetz) – cancelling most of the Restructuring Act regulations by the new elected federal Government
2000 Reform Act of SHI 2000 (GKV-Gesundheitsreform 2000)
2002 New hospital compensation system: Diagnosis Related Groups (DRG)
2003 Contribution Rate Protection Act (Beitragssatzsicherungsgesetz)

Over the years, various instruments were also introduced, of which the most important were the following:

- budgets for sectors or individual providers,
- reference-price setting for pharmaceuticals,
- restrictions on high cost technology equipment and number of ambulatory care physicians per geographic planning region,
- increased contributions from patients (both in terms of level and number of services).

[15] European Observatory on Health Care Systems, 2000.

The reforms were always introduced when health care expenditures showed a steeper rise and they were able to reduce expenditure for one or two years. Thereafter, apparently the stakeholders found a way to avoid some of the measures and expenditure began to grow again. In contrast with the public view of a *cost explosion* in the health care sector, the measures were indeed able to stabilise expenditures at least in part, as shown by the level of health expenditure as a share GDP and the contribution rate for employers and employees over the past decade (Table 9).

Table 9: Health Expenditure Shares, Contribution Rates and Balance of the SHI, 1992 to 2002

Year	Health Expenditures in share of GDP	Average Contribution Rate of Gross Salary to SHI	Balance of SHI in Million Euro
1992	10.1	12.71	-4,783
1993	10.2	13.22	5,323
1994	10.4	13.17	1,402
1995	10.8	13.15	-3,659
1996	11.1	13.48	-3,552
1997	10.9	13.58	861
1998	10.8	13.62	277
1999	10.8	13.60	284
2000	10.7	13.57	-15
2001	10.9	13.54	-3,034
2002 (est.)	11.0	14.00	-2,960

Source: Federal Ministry of Health and Social Security

However, the future financing of the system without rationing, quality cutting or much higher payments from patients is likely to become increasingly difficult owing to the following well-known influences:

a) Expenditure on health care will rise because
- rate of the elderly population increases with higher health costs,
- technical progress makes diagnosis and therapy more expensive,
- labour intensive sector leads to high labour force costs,
- well informed patients demand excellent treatment,
- multiple incentives for health care providers and patients to extend health care services (moral hazard).

b) Lower revenues for SHI due to
- more retirees,
- high unemployment,
- low growth of salaries,
- increasing rates of employment not subject to social insurance contribution (including precarious and marginal employment, freelancing, self-employment, illegal employment),
- higherl earning (and mainly healthier) employees choosing private insurance.[16]

Despite these factors the German health system still provides a great degree of freedom, at some cost. Patients are entitled freely to choose general practitioners and specialists and hospital care, even if that involves changing doctors during a period of treatment. The physicians' right of *therapeutic freedom* has led to an underdeveloped use of evidenced-based medicine and hindered standardised practises. Strict data protection legislation makes it almost impossible for health funds to implement cost-controlling

[16] Sachverständigen Rat zur Konzertierten Aktion im Gesundheitswesen (Advisory Council for the Concerted Action in Health Care): Gutachten (Annual Report) 2003.

controlling instruments, such as disease management programmes for the chronically ill. Patients' contributions to the costs of drugs, hospital stay, and non-physician care have been sensibly increased over recent years but the benefit of increases have been limited by a range of social exceptions.

> *The German system puts more emphasis on free access, high numbers of providers and technological equipment than on cost effectiveness or cost-containment per se (in spite of all the cost-containment acts which have been passed). (European Observatory on Health Care Systems, 2000)*

1.6.2. Update on Current German Health Reform

In May 2003 the German Government published its *Draft on the modernisation of the health sector* (Gesetz zur Modernisierung des Gesundheitswesens). Because the conservative opposition controls the majority in the Bundesrat upper house of parliament, the Government is forced to hold consensus talks with all parties to seek for compromises.

The actual compromise paper, that does not yet have the status of an official draft, contains the following main points:

- dental prosthesis will not be part of the SHI as from 2005 and has to be covered separately by patients with mandatory insurance;
- sick-pay (Krankengeld) will not be part of the SHI as from 2006 and is likely to be covered by patients with mandatory insurance;,
- there will be new patients contributions outpatient care and higher contributions for pharmaceuticals and hospital care;
- the strengthening of patients' rights;
- the establishment of a foundation and of an institute for quality and efficiency in the medical sector;
- the mandatory training for physicians;
- general practitioners will become *gate keepers* (voluntarily);
- non SHI reimbursement for OTC drugs;
- reference (fixed) prices for pharmaceuticals even with patent protection;
- pharmaceutical industry has to give to SHI a 16 per cent rebate (instead of six per cent) in 2004 on those drugs which are not yet part of the fixed price system, totalling 1 billion Euro.

Expected effects

Patients can expect to pay higher contributions, while employers will be relieved in small parts from high non-wage labour costs (it is estimated that the SHI contribution rate will be reduced to 13.6 per cent in 2004 and 12.15 per cent in 2006). According to SHI calculations, patients will contribute to the savings by eight billion Euro in 2004 as only one billion Euro will come from the drug sector and no contribution will be made by other sectors. Hospitals will be only marginally affected.

Pharmacies are a strictly regulated sector in Germany. They were able to stop some of the proposals such as a wide usage of *Internet pharmacies* and the permitting of pharmacy chains.

The pharmaceutical industry is affected by the high mandatory rebate of one billion Euro in 2004. But it seems that the *positive list* will not be introduced, a project that has been proposed by all health ministers over the past decade. The expansion of the reference price system will lower the pharmaceutical price level in Germany (which is one of the

highest compared with other industrialised countries). The inclusion of patent-protected drugs (a point that is not yet finally decided upon) in the reference price system is without question a negative signal for the research-intensive pharmaceutical industry in Germany and may lead to a further relocation of research sites outside of Germany. After all, the drug sector, pharmaceutical companies and pharmacies, will be burdened with approximately three billion Euro. The medical technology industry is not directly affected. Only the sector of medical aids (Hilfsmittel) is mentioned in the reform draft but there are no deeper cuts.

The official negotiations began in September 2003 and it seems likely that the Act will be passed soon. Structural changes, such as reform of the corporatist system, that have already been announced will not be part of the reform nor will obligatory SHI mergers. Because the actual reforms do not really cut into the structures of the German health system, independent experts and even politicians are already urging the need for a far-reaching process of reform, as soon as the Act is passed.

1.6.3. Licensing and Reimbursement of Medical Technology in the Health Care System

The regulation of health technologies in terms of licensing, coverage and steering of diffusion and use of technologies is quite complex and inconsistent as between the two health care sectors. In general, the outpatient sector is more highly regulated than the hospital sector (Table 10).

Licensing is required for pharmaceuticals and medical devices as a prerequisite for providing services to be reimbursed by the SHI. Medical products and devices are defined as instruments, appliances, materials and other products, which do not produce their main effect in a pharmacological, immunological or metabolic way. Since 1995 all medical devices must conform to the essential requirements of the Medical Device Act (Medizinproduktegesetz) that is consistent with EU directives. The licensing itself is the responsibility of authorised institutions (notified bodies). The question of safety and of technical suitability for the planned operational purpose of a device is the primary criterion for admission to the market. It is the duty of the manufacturers to demonstrate that the device conforms to all relevant requirements such as quality and efficiency.

Reimbursement decisions on medical devices depend on their use. If they are used directly by patients they are called *medical aids* (Hilfsmittel) and the reimbursement decisions are made explicitly through the federal SHI's association. It publishes an alphabetical catalogue of all medical aids and a listing with those that are reimbursed by the SHI (the positive list). Medical aids with a small or disputed therapeutic benefit or low selling prices, such as ear flaps, are excluded. In 2000, the SHI spent about 5 billion Euro on medical aids; private households spent a further 4.8 billion Euro.

Table 10: Regulation of Drugs and Medical Devices in Germany

	Drugs	Medical Devices used by Patient (Medical Aids)	Medical Devices used in Ambulant Care	Medical Devices used in Hospital Care
Licensing	Federal Institute for Pharmaceutical and Medical Devices (BfArM)	Supervising authority: BfArM Medical Device Act according to EU directives; certification through accredited inspection authorities (notified bodies).		
Decision on Reimbursement through SHI	Automatically, except negative list	According to positive list of medical aids	Federal Committee of Physicians and SHI and its Working Committee on Medical Treatment (Uniform Value Scale determines physicians' fee)	Starting 2003: Diagnosis Related Groups (DRGs); Committee of Hospitals (utilisation of medical devices is parts of the lump sum)
Implementation/ Control of Technology's Use	- Drug guidelines by the Federal Committee of Physicians and SHI, - drug budgets, - reference price system	Guidelines on remedies and therapeutic appliances by the Federal Committee of Physicians and SHI (Richtlinien zu Heil- und Hilfsmitteln)	Guidelines on remedies and therapeutic appliances by the Federal Committee of Physicians and SHI (Richtlinien zu Heil- und Hilfsmitteln)	Hospital planning by states, Federal Committee of Physicians and SHI

Source: Wörz, et al., Economix.

The regulation of medical devices and technologies in the outpatient sector is combined with the reimbursement of the physician's services. In the fee distribution system of the oupatient sector (Uniform Value Scale [Einheitlicher Bewertungsmaßstab]) each single service including medical devices and technology is valued in points. The scale lists all services which can be provided by physicians for remuneration within the SHI system. Total payment for all SHI-affiliated physicians is negotiated by the corporatist bodies of the physicians and the SHI. To split the sum paid to each individual doctor, according to the scale, is the task of the physicians' association. For expensive equipment that is not listed on the scale, the regional physicians' associations have their own rules about whether the physician can charge for these services, and, if so, how much. The reimbursement is subject to further control mechanisms to prevent over-utilisation or false claims. And so physicians may be subject to *utilisation reviews* at random or if their levels of service provision are higher than those of comparable colleagues.

The Working Committee on Medical Treatment (Arbeitsausschuss Ärztliche Behandlung) (a sub-division of the Federal Committee of Physicians and SHI) identifies new medical technologies for evaluation and existing technologies for re-evaluation. The medical associations and possibly individual experts are invited to submit evidence concerning the benefit, medical necessity and efficiency of the technology. After having examined the quality of evidence presented by the applicant, the medical associations and individual experts and literature searches, the Committee can decide a) to include the medical technology in the benefit catalogue, b) to exclude it from the SHI system, or c) to exclude it from the benefit catalogue but leave the decision about whether or not it should be reimbursed to individual sickness funds. Then another committee (Valuation Committee) sets the relative value of the treatment procedure or technology on the Uniform Value Scale.

Explicit coverage decisions are currently non-existent for the **hospital sector**. This is due to the fact that coverage of medical devices and expensive medical equipment falls under budget negotiations at hospital level and hospital plans at state level[17]. Until now, the introduction of new procedures and technologies has usually been managed by indi-

[17] The range of services provided in the hospital sector is determined through the hospital plan of the state government, and the negotiations between the health funds and each individual hospital (a result of the fact that the hospitals do not have a collective corporatist body). While the decision of the state government determines the flow of capital for investments, the negotiations determine whether the costs for running these services (incl. the use of medical equipment) are reimbursed by the health funds.

vidual hospitals in the context of budget negotiations. The new Committee for Hospital Care is expected to develop health technology assessments for the hospital sector indirectly supported by the new payment system starting in 2003 (payment by DRG - Diagnosis Related Groups).

In future, the intention, as laid out in the Reform Act of SHI 2000, is both to extend existing health technology assessment mechanisms to other sectors, especially the hospital sector, and also to ensure that assessments and coverage decisions are coordinated between sectors. In addition, the new treatment guidelines are an attempt to steer the appropriate use of technologies.

Expensive Medical Devices (Medizinsch-Technische Großgeräte)

The following devices are classified in most states as expensive medical equipment (*big ticket technologies*):

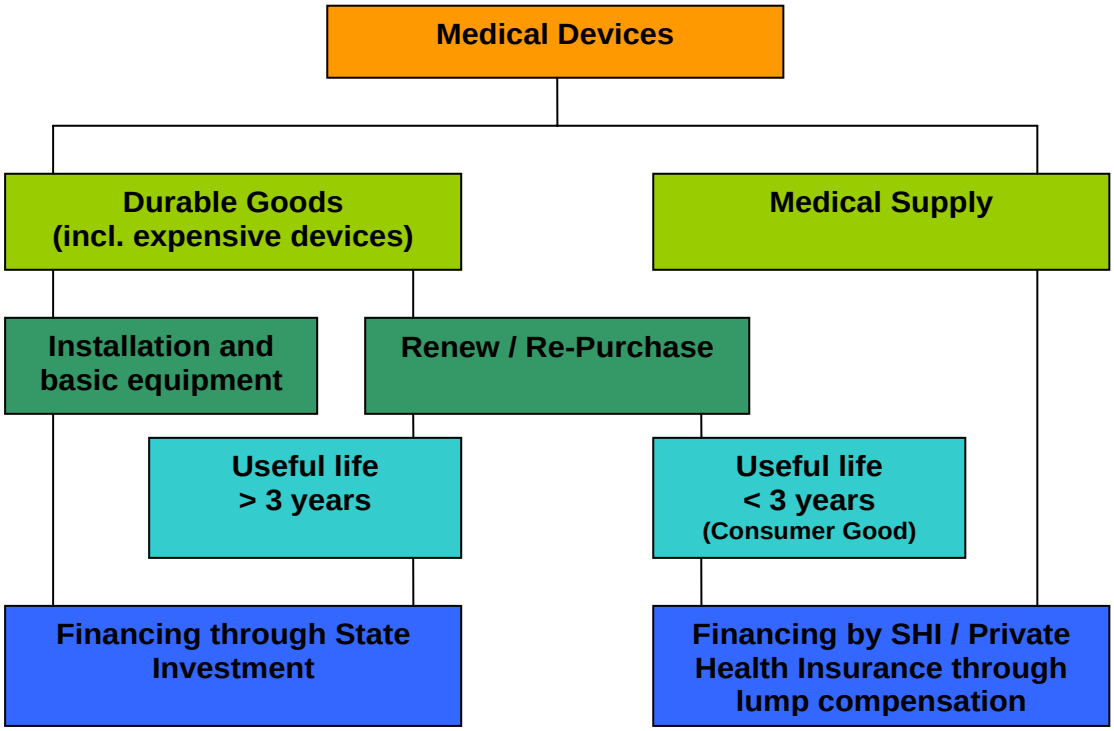
- left heart catheterization units
- computer-tomographs
- magnetic resonance imaging devices
- positron-emission tomographs
- linear accelerators
- tele-cobalt-devices
- high-voltage therapy devices
- lithotripters.

They are characterised by high investment, and consequently high costs; by competitive interests between hospitals; and a complicated system for join usage by hospitals and oupatient practices.

Federal regulations have tried to limit the acquisition of expensive medical equipment over the past decades without success. Since 1997 (when the joint planning process for expensive medical devices conducted by outpatient, hospital and state representatives was abolished by law), the self-governing corporate bodies have to guarantee the efficient use of expensive equipment, through the joint utilisation of equipment by outpatient and hospital sectors, via remuneration regulations.

When hospitals apply for single support for investments (*Einzelförderung von Investitionen*), the state Ministries remain responsible for the supply of expensive medical devices in hospitals.

Figure 1: Financing Medical Devices in the Hospital Sector



Source: Neubauer et.al. (2000)

For the manufacturers of health technology products the current reimbursement regulations are unsatisfactory. They complain about the reluctance of the SHI to invest in high standard and innovative products. Instead of supporting the high-value and innovative sector (one of the leading export sectors in Germany), medical technology is often discounted as *machine medicine* by the SHI which increases health care costs without demonstrating their benefits in terms of quality and patient satisfaction.

The Federal Government is more and more sensitive to the complaints of SHI's about expensive or *cost accelerating* medical technology. On the other hand, it is committed to patients' rights and quality assessment. The Government addresses the conflict in the following statement:

> *An increased consideration of health care economics has to be included in the development of new technological applications. The expected or demonstrable medical added value will have to justify costs arising from its use within the health care system, or the medical technology innovations will have to be more cost-effective than existing comparable methods." (Health Research Programme of the Federal Government 2001).*

2. The Medical Technologies Sector

Problems of Sector Definition

No wholly reliable data is available on the medical technology sector in Germany. Neither the SHI nor the Federal Health Monitoring System (Gesundheitsberichterstattung des Bundes) which is a part of the Federal Statistical Office has exact information on expenditure for medical devices, equipment or technology, owing to the complicated reimbursement system in the outpatient and hospital sectors. The medical technology industry itself does not provide reliable statistical data, neither on market size nor on the industry structure. This is surprising in view of the importance of the medical device and technology industry in Germany. Apparently, companies are not willing to publish potentially sensitive information. A further problem is that the medical technology sector is not represented by one association or interest group but by four, each of which focuses on a different market segment, as follows:

- German Medical Technology Association (represents about 200 members);
- Association of the Diagnostics Industry (78 members; focus on laboratory and home diagnostics);
- Association of Electro-Medical Engineering (about 100 members; focus on electric/electronic investment goods);
- German Industrial Association for Optical, Medical and Mechatronical Technologies (called *Spectaris*, about 400 members but not all involved in medical technology).

The German Medical Technology Association acts mainly for those companies that produce consumer goods for patients (medical aids) and equipment (bandages, wound healing products, medical disposables, and so on). The Association of Electro-Medical Engineering and Spectaris founded a joint forum called *Forum Deutsche Medizintechnik* that represents most of the medical technology manufacturers and most of the sales done by investment goods.

In 1996, according to the Federal Ministry of Education and Research the share of sales in different medical device sectors in Germany was the following (Table 11):

Table 11: Shares of Sales of Various Medical Devices in Germany, 1996

Medical devices	21%
Medical technology products	20%
Diagnostics	13%
Electrical medical engineering devices	12%
Dental products	12%
Ophthalmic optics	9%
Optics, lasers, laboratory	8%
Others	5%

Source: Health Research Programme of the German Federal Government 2001, p. 38.

Medical technology products and electrical medical engineering devices account for about one-third of total sales. The most vigorous increase in turnover in recent years has been achieved by the ophthalmic, laser, laboratory engineering and medical devices sector.

However, for reasons of consistency, at least so far as data are concerned, this chapter uses data from the **Federal Statistical Office** that follows **International Standard Industrial Classification**, code 331: *Manufacture of medical appliances and instruments and appliances for measuring, checking, testing, navigating and other purposes, except optical instruments*. Only firms with 20 or more employees are included.

Market

After the United States (72 billion Euro in 2001) and Japan (25 billion), Germany (16.5 billion) is the third largest market for medical devices and medical technology equipment in the world, according to the German Medical Technology Association[18]. In Germany the hospital sector is the most important market place. It is assumed that in the year 2000 medical devices and technologies accounted for about 6.5 billion Euro in the hospital sector. Another 5 to 5.5 billion Euro were spent on medical devices in the outpatient sector. In the data of the association medical devices for consumption are included.

The Federal Statistical Office summarises medical technology as production of medical equipment and orthopaedic devices (see above). While the cluster contains dental products and devices, most of the *consumer goods* are not included. Turnover increased by 6.5 per cent in 2001 and by 12.7 per cent in 2002. The number of firms fell by 12 per cent in the previous five years (Table 12).

According to information from the Federal Statistical Office, 82,200 people were employed in the German medical technology sector in 2001. The latest data for 2002 indicate a further growth in employment by 2.8 per cent up to 84,500 people (and that increase is clearly contrary to the general trend in employment in Germany). According to the branch associations, as many as 100,000 people might be employed but that simply highlights, once again, the problem of inadequate and inconsistent information. In 2002, the employment of blue collar workers grew more than white collar employment for the first time. The share of white collar workers is approximately 40 per cent and above the average in manufacturing industry, generally, where it is 35 per cent.

[18] Bundesverband Medizintechnologie (German Medical Technology Association): Annual Report 2001/2002.

Table 12: Medical Technology Companies, 1997 to 2001, Turnover, Number of Firms, Employment, (Firms with 20 or more employees only)

	1998	1999	2000	2001	2002
Total Turnover (million Euro)	9,466	9,185	10,053	11,266	11,991
Domestic Sales (million Euro)	5,123	4,833	4,963	5,303	5,414
Export (million Euro)	4,343	4,352	5,090	5,962	6,577
Number of Firms*	1,357	1,280	1,196	1,192	1,189
People Employed	83,200	79,800	79,000	82,200	84,500
White Collar	32,600	31,800	32,300	34,200	34,900
Blue Collar	50,600	48,000	46,700	48,000	49,500
% change to previous year					
Total Turnover	--	-3.0	9.5	12.1	6.4
Domestic Sales	--	-5.7	2.7	6.9	2.1
Export	--	0.2	17.0	17.1	10.3
Number of Firms*	--	-5.7	-6.6	-0.3	-0.3
People Employed	--	-4.1	-1.0	4.1	2.8
White Collar	--	-2.5	1.6	5.9	2.0
Blue Collar	--	-5.1	-2.7	2.8	3.1

* Defined as “technical parts of factory” (fachliche Betriebsteile)
Source: Spectaris based on Federal Statistical Office data, 2003

The health technology sector is still dominated by many small and medium companies in relation to number employed (Table 13). But, in relation to the total sales volume, small and medium enterprises are not so important. Companies with fewer than 100 employees make up nearly two-thirds of companies but account for 28 per cent of total sales. Companies employing 1,000 or more people make up less than one per cent of the total but account for nearly 29 per cent of sales.

Table13: Medical Technology Companies, Number of Employees and Share of Sales, 1996

Number of Employees	Per cent of companies	Per cent of Total Sales
20-49	64.7	14.7
50-99	21.3	13.2
100-499	11.7	26.3
500-999	1.6	16.9
1.000 and more	0.6	28.8

Source: Federal Statistical Office

The medical technology sector in Germany is strongly export oriented and ranks number three, internationally, behind the US and Japanese manufacturers. In 2000, the share of exports equalled domestic sales for the first time. Since then, the growth of exports has been stronger than the modest growth of domestic sales. In 2002, exports represented 55 per cent of total turnover and were growing at an annual rate of 10.3 per cent compared with a growth rate in domestic turnover of 2.1 percent. Export sales currently exceed sales in the domestic market sales by over one billion Euro (6.6 compared with 5.4 billion Euro).

In the first half of 2002, the surplus on foreign was 1,536 million Euro. The main importing countries were as shown in Table 14.

Table 14: Importers by Country of German Medical Equipment, 1. half year 2002

Country	Million Euro	Per cent of total	Growth 1. half year 2002/2001 in per cent
USA	940	24.9	30.9
France	211	5.6	-9.8
Italy	206	5.5	-6.5
Japan	204	5.4	8.6
Netherlands	188	5.0	7.5
Switzerland	176	4.7	42.3
GB	162	4.3	-1.4
Russia	127	3.4	62.1
Spain	105	2.8	0.0
Austria	105	2.8	8.9
China	79	2.1	39.0
Others	1,266	33.6	-0.1
Total	3,769	100.0	10.0

Source: Spectaris based on Federal Statistical Office data.

3. Local Areas of Health Technology Concentration

3.1. The State of Bavaria

3.1.1. Main Characteristics of Area

Bavaria is the largest German state in terms of geographical area with 70,548 km² and the second largest in terms of number of citizens (about 12 million people). Annex 2 summarises data for the different German states The largest cities in Bavaria, and the main centres of industry, trade and education, are Munich (capital of the state); Nürnberg (forming a metropolitan region with the cities of Erlangen and Fürth); Augsburg; Wuerzburg; and Regensburg. Bavaria is located in the middle of the European market with no European capital or economic centre more than four hours away, by plane. The two airports of Munich and Nürnberg offer many national, continental and intercontinental air routes.

In 2001, Bavaria produced 17.3 per cent Germany's GNP; a total of Euro 29,103 per person compared with the German average of Euro 25,056 (STMWVT 2002, page 3).

Until the 1950s, Bavaria was a rural state with a tradition in agriculture; light industries;, tourism (The Alps); and trade (Augsburg, Munich); and high unemployment (STMWVT, 2002). Heavy industries were almost solely concentrated in the Nürnberg area. Beginning in the 1960s and 1970s Bavaria started to develop as a prime location for the banking and insurance sector and light industries, such as electrical engineering and automotive industries. The next stage was the development of new technologies in the information and communication technology sector. Most recently, Bio-medical and Medical technologies have started to thrive. Developments have been supported by a number of large companies, such as HypoVereinsbank, Allianz Insurances, Munich RE, Siemens, BMW, Audi, and GlaxoSmithKline.

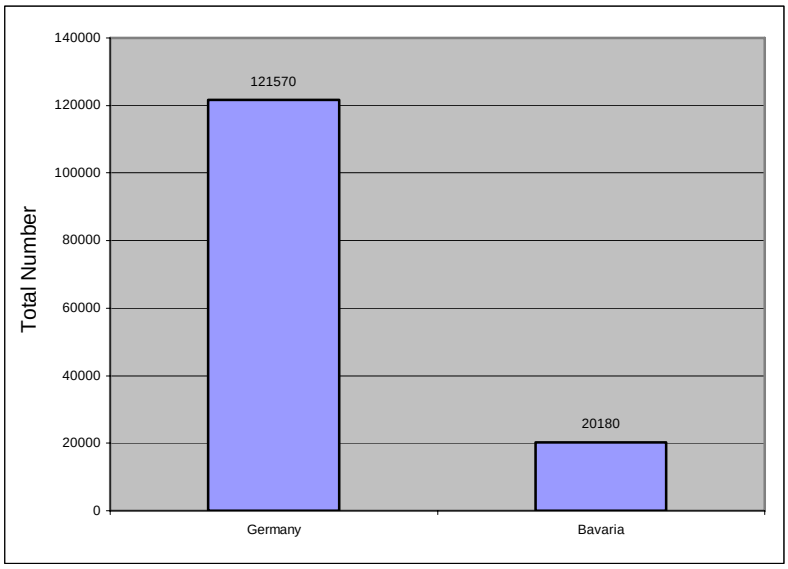
At the same time, however, companies of medium size, with between 100 and 5000 employees started to become the backbone of the Bavarian economy and main driving force behind research, job creation, and tax revenues. That is why the Bavarian Government continues to encourage and support companies of medium size at both the state and the national level.

The fact that Bavaria was relatively late in its economic development has, more recently proved to be an advantage. First, following the second world, new industries, mostly in the field of electrical and mechanical engineering, had to be developed and were thus supported by the state. At the same time, old heavy industries and mining did not become a burden upon the state's economy and finances when they could no longer compete in plunging world markets, as has happened in other German states and former economic powerhouses such as Northrhine-Westfalia in the 1970s and 1980s.

3.1.2. Main Characteristics of Medical Technologies Sector in Bavaria

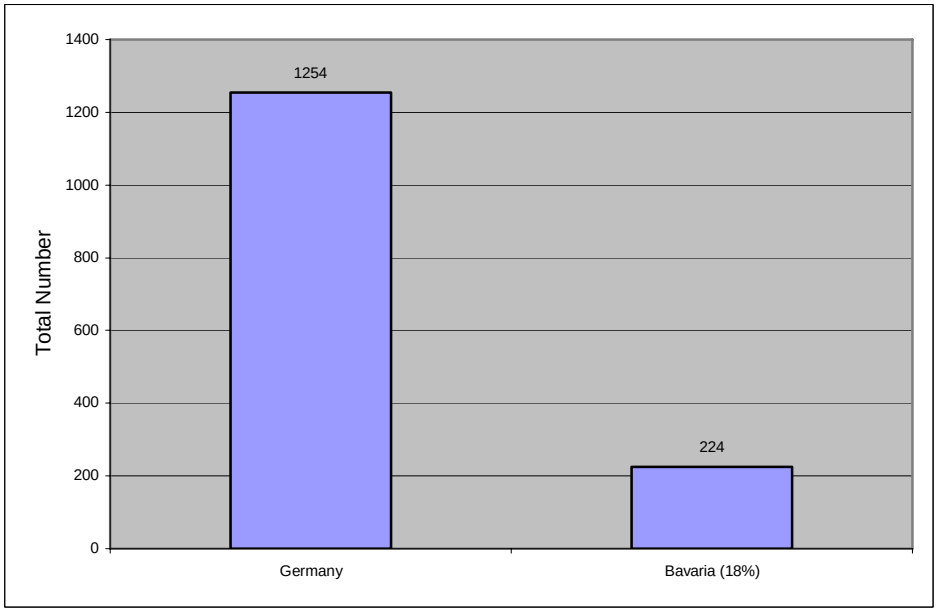
Bavaria is a centre for the medical technology industry in Germany. In 1998 more than 224 companies from this sector had their headquarters in the state. That represented about 20 per cent of the German total and the companies employed 20,000 people.

Table 15: Employees in the Health Technology Industry 1996, without lab diagnostics, in Germany and Bavaria



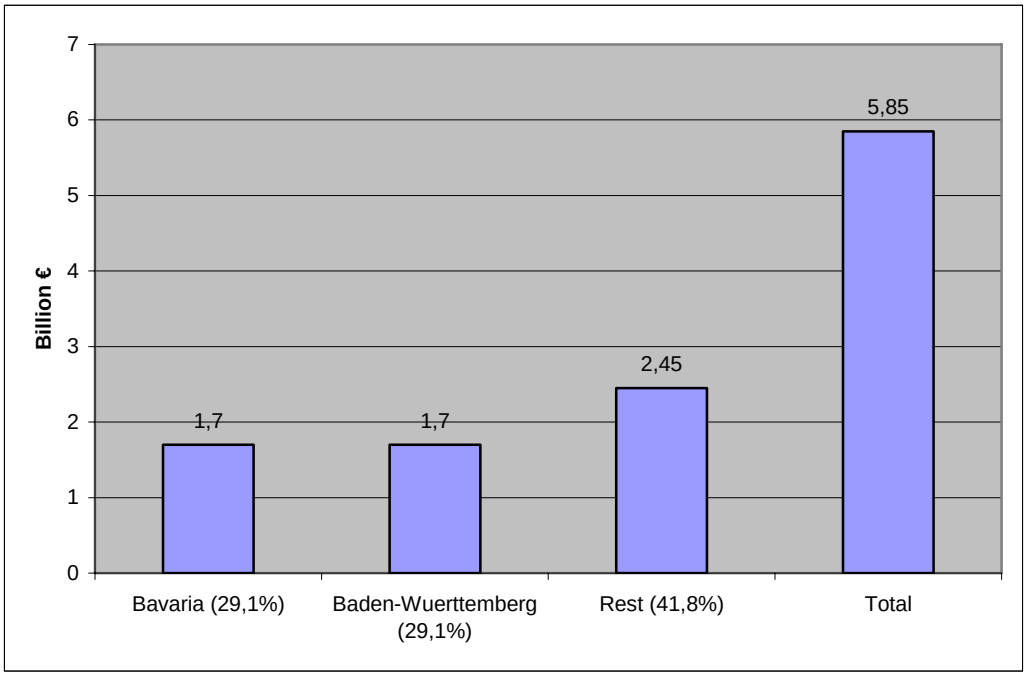
Source: STMWVT, 1997

Table 16: Number of Medical Technology Companies in Germany and Bavaria, 1996



Source: STMWVT, 1997

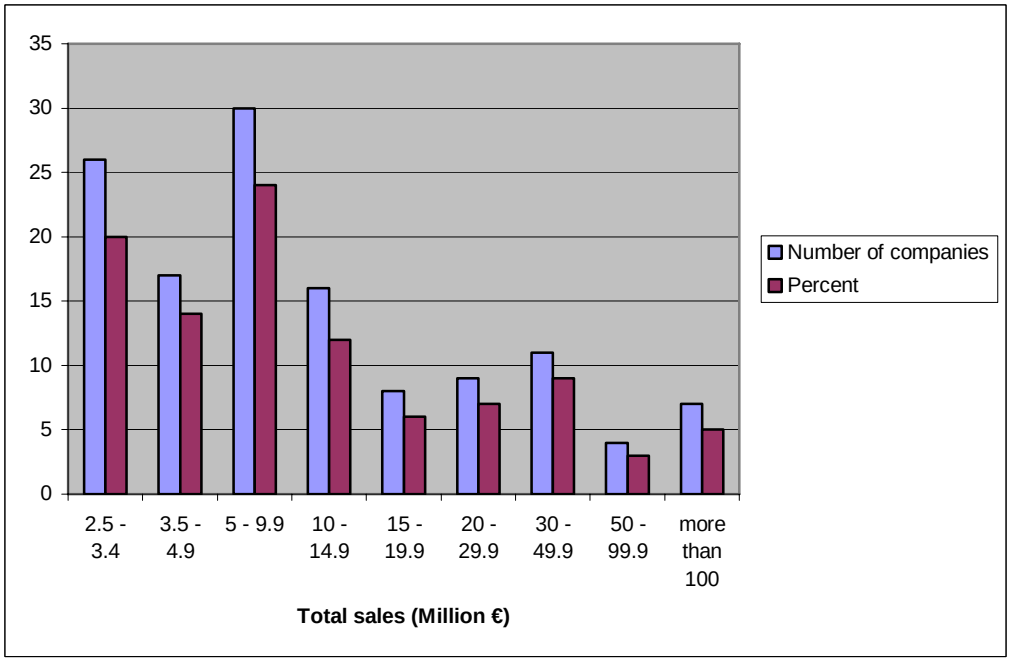
Table 17: Volume of German Medical Technology Sales (without lab-diagnostics), 1996



Source: STMWVT, 1997

Fourteen of the 50 largest (by total revenue) medical technology and pharmaceutical companies have a main branch in Bavaria. They include global organisation such as Siemens Medical Technology division; Baxter; GlaxoSmithKline; Novartis; Pharma; and Roche. In addition, a large number of companies of medium size are located in the state (STMWVT invest I): At the same time, about 60 per cent of medical technology companies in Bavaria have less than 10 million Euro in annual sales (Table 18).

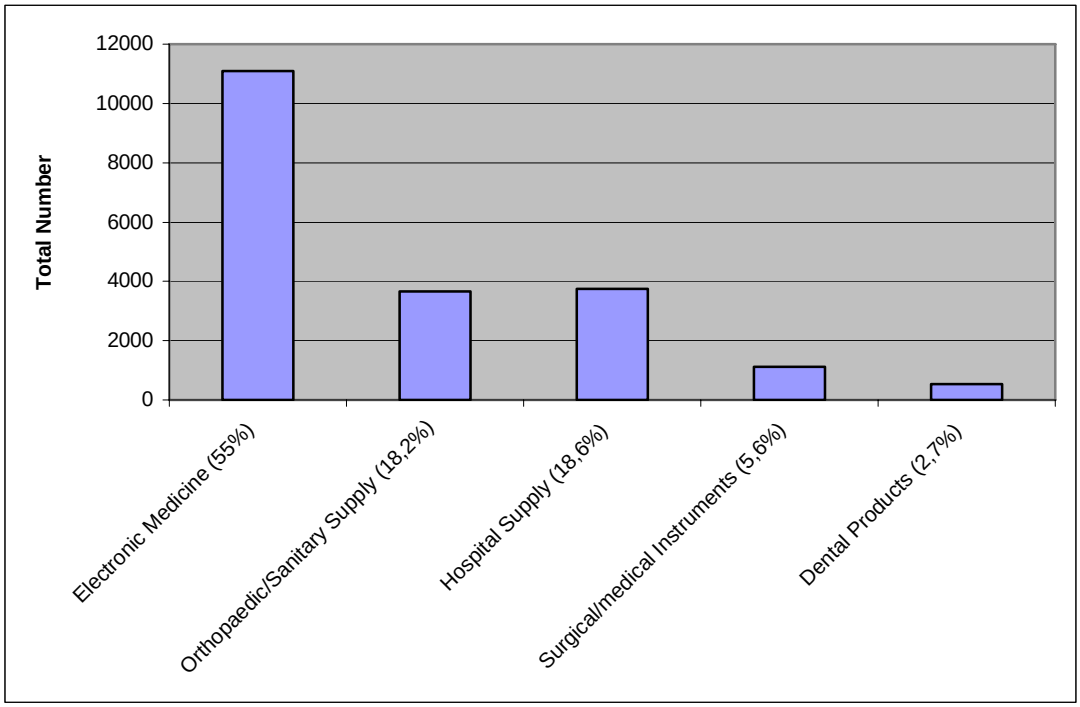
Table 18: Sales Volume and Size of Medical Technology Companies in Bavaria



Source: STMWVT, 1997

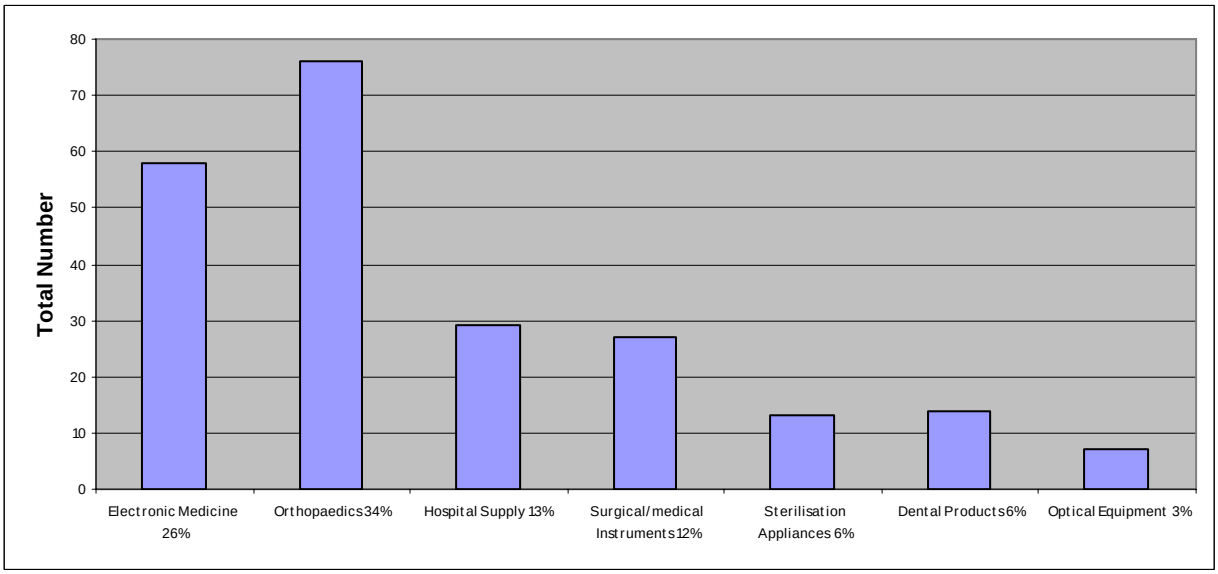
The most important product groups in Bavaria are electro-medical devices with 67 per cent followed by orthopaedic-mechanical goods with 11 per cent (STMWVT 1997, page 21). Fifty per cent of all electro-medical devices and 30 per cent of Germany's medical-technological output comes from Bavaria (STMWVT invest I).

Table 19: Employees in Bavaria in the Medical Technology Sector (without lab diagnostics), 1996



Source: STMWVT, 1997

Table 20: Production of Bavarian Medical Technology Companies (without lab diagnostics), 1996



Source: STMWVT, 1997

Two localities are central to the medical technology sector in Bavaria: Munich and Erlangen, in conjunction with Wuerzburg und Bayreuth/Regensburg.

3.1.3. Bavaria's Assistance for Medical Technology Industry Development

The key element in the success of the health technology sector in Bavaria is what the Bavarian Ministry for Economics, Transport and Technology (STMWVT invest I) calls a *quick transfer of technology*. It is the aim of the state to bring companies and researchers together to promote aggressive research and successful product innovations.

Exceeding the state's normal annual business development budget of 500 million Euro, the state has invested an additional four billion Euro since 1994 in education; research; technology transfer; entrepreneurship; and the specific business fields of ICT; new materials; environmental and medical technologies; and mechatronics. This happened mainly through two state programmes: ***Offensive Zukunft Bayern*** (starting in 1994 with a budget of about 2.8 billion Euro) and ***High-Tec Offensive*** (starting in 2000 with a budget of about 1.35 billion Euro) (STMWVT, 2002). The enormous financial support was possible through a large sale of shares of former state owned companies by the state of Bavaria in the middle of the 1990s.

First, research and information networks have been promoted. The *Forum MedizinTechnik und Pharma (http://www.forum-Medical technology-pharma.de)* was founded to act as an information node between all stakeholders in the sector: large and small companies; investors; academic researchers; and hospitals. Before the establishment of the *Forum*, a corresponding problem existed because there was a lack of connection between scientific ideas and investment capital. In addition, a *Working Group of Bavarian Research Networks (Arbeitsgemeinschaft der bayrischen Forschungsverbuende www.abayfor.de)* was founded to bring together researchers from all disciplines including medical technology and related sectors. The *Bavarian Research Foundation (Bayrische Forschungsstiftung)*, a long established organisation to finance single research projects with matching capital from the private sector, is also fully engaged in the strategy.

Secondly, four **regional competence centres** were identified and are being intensely supported by the Bavarian Government. They are as follows:

- Erlangen/Nürnberg is the seat of Siemens' medical technology division. It is the centre for medical technology in Bavaria, especially imaging methods and virological and pharmaceutical research. The state's engagement in this area is especially strong because the district has structural problems and relatively high unemployment. Erlangen/Nürnberg is furthermore integrated in the nation-wide *competence-network project (Kompetenznetze, www.kompetenznetze.de)* funded by the *Federal Ministry for Education and Research.*
- In München the universities with their attached hospitals are the centre for institutionalised research. For further technology transfer, the *Max-Planck-Research-Institutes (MPI)* for biochemistry, neurobiology, and physics that have their bass-ess in Munich, are fully involved. The MPIs are a public-private research partnership specific to Germany. The *Research Centre for the Environment and Health (Forschungszentrum fuer Umwelt und Gesundheit, GSF)*[19], is involved as well.
- Regensburg and Würzburg, both cities with universities, cooperate closely with Erlangen/Nürnberg.

A more detailed analysis of these localities, including the local arrangement and cooperative processes, will be made on the basis of the results of the case studies.

[19] The GSF belongs to the *Helmholtz-Research-Societies* (similar the *Max-Planck-Institutes*). See also footnote 2 and 22. The GSF's goal is to "identify health risks for humans and the ecosystem, to estimate the environment's capacity for usage and to develop concepts to avoid lasting damages".

3.1.4. Linkages to Other Industries (locally, nationally, internationally)

While in Anglo-Saxon countries, especially the United States, the terms biotechnology and medical technology are combined to form the category *Life Sciences*, the situation is different in Germany.

Traditionally the medical technology industry is linked to the electrical engineering and precision mechanic faculties and companies, and Siemens is a good example. Biotechnology, on the other hand, is counted among the biological and chemical disciplines, both with regard to education and research-based innovation and entrepreneurship.

As stated above 14 of the world's largest companies have a base in Bavaria. A large number of national companies of medium size are also located in the area or the close vicinity, namely the state Baden-Württemberg (see the next chapter). In addition, as stated above, Bavaria (and especially Baden-Württemberg) is a centre for manufacturing industry with a tradition in electrical engineering and other light industries. Medical technology companies located in the area, whether big or small, are able consequently to profit from inter-industry and intra-industry networks that span the state, Germany and the world. The network also includes research institutions and universities.

3.1.5. The Importance of Local Skills Supply

Because education falls under the responsibilities of the states, the level of education tends to differ from state to state. The more southern states tend to perform better than the northern or eastern states. Bavaria and Baden-Württemberg always perform particularly well in international comparisons, such as the PISA study, in which Bavaria ranked very high while Germany as a whole performed poorly.

In relation to higher education, Bavaria enjoys the benefit of the following:

- nine public *general universities* (Augsburg, Bamberg, Bayreuth, Erlangen-Nürnberg, Munich [Ludwig-Maximilians-University und Technical University], Passau, Regensburg und Würzburg);

- seventeen public *universities of applied sciences* (Amberg-Weiden, Ansbach, Aschaffenburg, Augsburg, Coburg, Deggendorf, Hof, Ingolstadt, Kempten, Landshut, Munich, New-Ulm, Nürnberg, Regensburg, Rosenheim, Weihenstephan, Würzburg-Schweinfurt).

Although most of these institutions do not offer a specific degree in medical technologies, they guarantee an ample supply of engineers, biologists, chemists, physicists, and doctors. Types of courses vary from university to university: some offer their students the opportunity to specialise in medical technology within their general studies (such as, electrical engineering); others offer an entire medical technologies master programme. Just recently the new *Institute of Medical Technology* was founded by Munich's Technical University. It is a graduate programme including classes, among others, in biocompatible materials; physiology; quality; management; law; biomechanics; optomechatronical measurement systems; telemedicine; macromolecular chemistry; and so on. (http://www.zimt.tum.de/). At *Munich's University of Applied Sciences* a specialism exists within the courses on microelectronics; at *Ansbach's,* there is one within the course programme for industrial engineers.

In addition, Technical Schools in Regenstauf and Ansbach offer courses to become a *state-approved technician for medical technologies (Staatlich gepruefter Medizintechniker)*.

The survey and the case studies will further clarify whether companies situated in the region rely on the region's schools, and the extent to which the schools provide enough experts for their needs. They will also help to understand how industry and educational institutions interact today and have worked together in the past to create and promote new kinds of course and programme.

3.2. The State of Baden-Württemberg

3.2.1. Main Characteristics of Area

Baden-Württemberg shares its eastern boarders with Bavaria and its western border with France. 10,537,000 people live in this state which covers an area of 35.751 km². Baden-Württemberg consists of various regions that were united after World War II to create today's state. That is the reason why the state does not have a large, major city. The capital is Stuttgart which has about 550,000 citizens. Karlsruhe, the next largest city, has about 420,000. Other centres are Freiburg (200,000) and Ulm (112,000). Most of the population live the vicinity of the suburbs of these cities and so the density of population is fairly high at about 300 persons per square kilometre. Just like its eastern neighbour, Baden-Württemberg is located in the middle of Europe with no European capital or economic centre more than four hours away, by plane.

In total, 4.977 million people work in the state and 4.450 million of them are employed by the state or private businesses (Argedonau, 2003). Self employment is not high, compared with other German states. In 2001 Baden-Württemberg produced a GDP of 307 billion Euro, which is about Euro 28,920 per person compare with the German average of Euro 25,650 (see Annex 2).

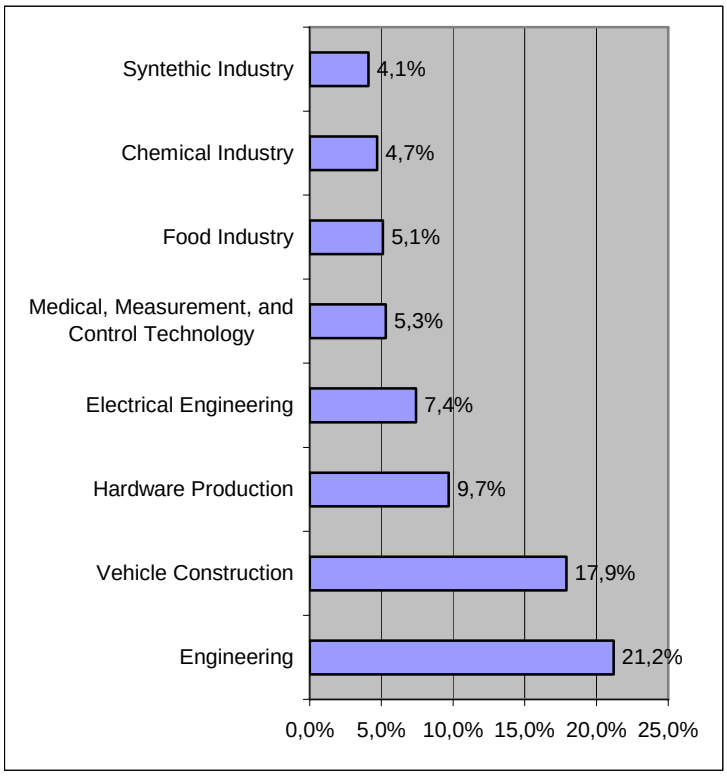
The area has a long tradition in manufacturing, engineering and light industry, including cotton manufacture and clock-making, starting in the 18th century; hardware production and steam engine and motor manufacture (Benz, Daimler) in the 19th century; and then airplane and automobile manufacturing in the 20th century. The area also saw an early engagement of the state in education. In 1825, Germany's first *Technische Hochschule (Technical University)* was founded in the city of Karlsruhe and in 1850 the *Staatliche Uhrmacherschule (State-run school for clock-making)* in Furthwangen. In 1889 the state also started to support the training of apprentices. As in Bavaria, the lack of raw materials restricted the development of mining and heavy industry and encouraged light industries, instead.

Although there have also been large enterprises in Baden-Württemberg (such as Bosch, Porsche, SAP, Heidelberg Printing Systems, and what is today Daimler-Chrysler) the economic backbone of the state has always been and continues to be small and medium-sized companies. But now there are also large international companies in Baden-Württemberg, like IBM, Hewlett-Packard, Sony, and Pfizer.

Baden-Württemberg spent 11 billion Euro in 1999 on research and development, the largest amount of any state in Germany (see Annex 2). Over 78 per cent of the 11 billion was contributed by the R&D expenditure of the state's companies; 10.5 per cent from university research and 10.7 per cent from non-university research organisations. The private sector contribution to R&D is growing and accounts for a quarter of all private R&D expenditure in Germany.

Today, over 50 per cent of all employees in the state are working in engineering, vehicle construction or hardware production, as Table 21 shows.

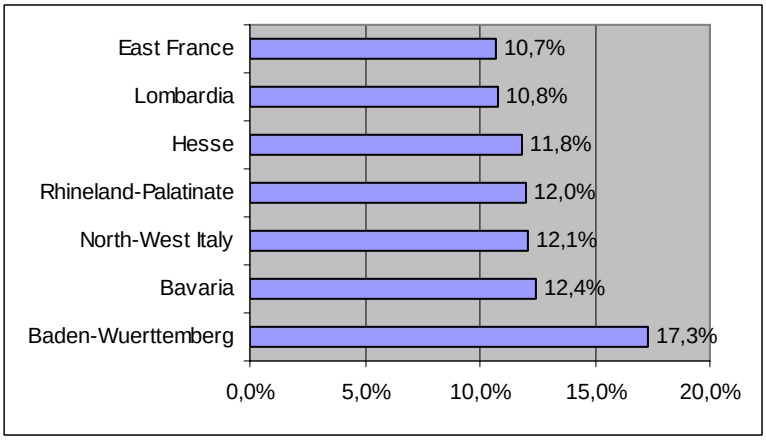
Table 21: Employees in Baden-Württemberg by Sector of Industry, 2000



Source: http://www.wm.baden-wuerttemberg.de/htm/bereich3/content3_5.htm

The tradition of work in engineering in Baden-Württemberg has made it to-day, a high technology and innovation driven economy. Table 22 compares shares of high technology employees in selected areas of middle Europe.

Table 22: Share of Employees in High-tech Industries in Selected European Regions



Source: http://www.wm.baden-wuerttemberg.de

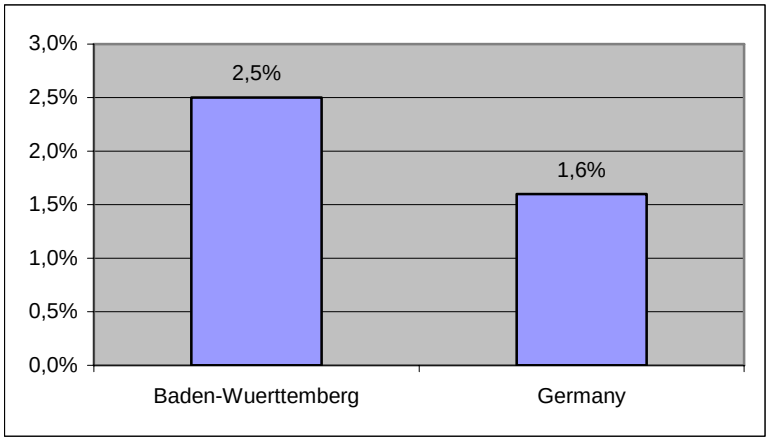
Baden-Württemberg depends heavily on the export of its goods: A third of the state's workplaces depend on exports. The export volume of the state is Euro 8,100 per person, compare with the German average of Euro 6,800 (Japan US$ 3,000; USA about US$ 2,500). About 1.7 per cent of the world's exports come from Baden-Württemberg.

3.2.2. Main Characteristics of Medical Technologies Sector

As stated above, the traditional strengths of the state lie in engineering, vehicle construction and electronic engineering. In addition, the annual rate of 112 patent registrations per 100,000 inhabitants in the state is the highest in European. With this background, the state of Baden-Württemberg is seeking to develop a strong position in microelectronic; information and communications technologies; biological technologies; and medical technologies in order to remain attractive as a location for production in the global economy.

State spending on R&D (four per cent of the GNP) is above that of the Germany average (2.3 per cent) and that of the United States or Japan. Private businesses in the state also spend more than average on R&D expenditures (about 17 per cent of their annual expenditure) and also employ more people than normal in R&D (Table 23).

Table 23: Share of Employees in R&D Positions: Baden-Württemberg and Germany



Source: www.bw-invest.de

As Table 17 already showed for Bavaria, Baden-Württemberg also produced 29,1 per cent of Germany's total production in the medical technology sector in 1996 (without lab-diagnostics).

Baden-Württemberg is in a strong position as a location for the medical technology industry in Europe. Industry and research combine to produce a great variety of products. About one half Germany's manufacturers in the sector are based in the state. There are multi-national companies with a great variety of products as well as small companies, which might make only a single product. Within the state, Tuttlingen and Tuebingen-Reutlingen are the centres of the medical technologies sector. The former accommodates about 400 companies, both suppliers and OEms; and the later accommodates about 200. According to *bw-invest*, a state network of technology transfer centres provides the bridge between private industry and research institutes and ensures rapid access to new ideas, innovations and research findings.

Another important centre for the sector is the *Research Centre Karlsruhe* which has its own subdivision for medical technology (http://www.fzk.de/as-med/).

Almost every product group within the sector is produced in the state, including, anaesthetic products; surgical instruments; sterilisation supplies; diagnostic instruments; imaging diagnostics; implants; laboratory supplies; and radio-therapy, laser-therapy and

ultrasonic-therapy.[20] But there is a growing a specialisation in minimal invasive surgery as described in the next chapter.

Currently, there is a trend towards an integrated portfolio of products and solutions among the companies in the sector. Although they still feel themselves technically superior to their global competitors, the companies are conscious of competition from lower cost production sites around the world. In order to finance relatively high labour costs they judge that they must sell services as added value to their products[21].

3.2.3. The State's Activities for Medical Technology Development

As in Bavaria, the state of Baden-Württemberg sees technology transfer as the key requirement for innovation and technology development. A major report by the State Ministry of Science, Research and Arts (*Strategies for the Baden-Württemberg Research Policy, 2000*) gave a clear analysis of the strengths and weaknesses of the research sector in the state and identified the most important areas for action. But there are indications that the state is not yet fully organized to cope with the weaknesses. A Roland Berger Strategy Consultants' study concluded, *In Baden-Württemberg various enterprises or public institutions of the health branch belong to the market leaders in their sector. However, the potential for synergies that lies in an early integration of these branches remains unused. The historically grown boundaries between these branches, such as Medical Technology; Fitness; Home Care; Pharma; and wholesale, remain too strong* (Roland Berger, page 52). Further research, especially detailed interviews with executives in the major organisations that are identified below, will provide a fuller and more up to date view of the situation in Baden-Württemberg, especially so far as the medical technology sector is concerned.

In addition to its research policy, the state is engaged in local marketing. In order to improve its marketing of industrial sites in the region, the Ministry for Economic Affairs of Baden-Württemberg founded the *Society for International Economic Cooperation Baden-Württemberg (Gesellschaft fuer internationale wirtschaftliche Zusammenarbeit Baden-Württemberg)*. Its principal aim is to generate new business development in new technology enterprises in Baden-Württemberg. In order to fulfil this aim, the Society helps foreign companies that want to invest in the state, but also companies from the state which want to invest abroad. Its services include providing country information; finding good locations and sites for new businesses; and dedicated market research. It is financed through the state and the *State Association of Industry (Landesverband der baden-württembergischen Industrie e.V.)*. A particular member of staff has responsibility for the medical technologies sector.

A further strong resource which assists the development of the industry is the strong research environment in Baden-Württemberg. It is estimated that about eight billion Euro are annually invested in research in the state. About 20 per cent of all *Max-Planck-Research-Institutes* and 30 per cent of the *Fraunhofer-Research-Institutes*, as well as 25 per cent of the research capacity of the *Hermann von Helmholtz-Society of German Research Centres*[22] are located in the state. There are about 100 independent research centres in the state, outside the universities. But they are connected with them through public and private initiatives, such as the *Competence Networks (Kompetenznetze.de)*, a

[20] A complete list can be found at www.bw-invest.de.
[21] Further reading: Fraunhofer Gesellschaft ISI: www.isi.fhg.de/pi/projekte/sa_lb_bwz.htm
[22] All named institutions belong to public-private research partnerships that form the third pillar of research in Germany besides all-public research in universities and all-private research in enterprises (see footnote 2).

result of cooperation between the German Federal Government and the individual states.

In the city of Karlsruhe, 94 out of every 1,000 industrial employees are engaged in research and development. This is the highest number in Europe. Within *Competence Networks* Baden-Württemberg supports a *Research Centre (Forschunszentrum Karlsruhe)* in the city that focuses on science and engineering. A subdivision is especially dedicated to medical technologies and benefits greatly from the scope for close inter-disciplinary research involving other divisions of the Centre and the city's university.

Also under the framework of *Competence Networks,* the state is currently engaged in the two areas Tuttlingen and Tuebingen-Reutlingen, as mentioned above. These two areas have developed over the past 130 years a globally unique concentration of about 600 companies specialising in surgical instruments. Over the past 15 years those mainly middle-sized companies have started to widen their portfolio of medical technological products. At the same time they are also specialising in instruments for minimal invasive surgery, supported by working groups of the University Hospitals of Tuebingen and Stuttgart. But systematic coordination between medical, technical-scientific and industrial contributors was lacking. The *Competence Centre Minimal Invasive Medicine & Technique (Kompetenzzentrum Minimal Invasive Medizin & Technik, MITT)* was founded in 2001 to fill the gap. This non-profit organization has as its goals the advancement of medical technical sciences; further education in the field of Medical Technology; and technological transfer between universities and business enterprises in the sector. Although supported by the state, the initiative for this *Competence Centre* came from universities, companies and hospitals.

The development of the sector in Baden-Württemberg has been largely based upon historical strengths and influences combined with initiatives from universities, research institutes and private businesses. The state's role has been relatively minor, certainly compared with that of Bavaria. But that now seems to be changing..

3.2.4. Linkages to Other Industries (locally, nationally, internationally)

As stated above, Baden-Württemberg is traditionally a stronghold of companies of medium size in manufacturing and engineering with an emphasis on research and innovation. Cross-industry linkages within the state were necessary for the sector to develop as it did.

Many of the medium-sized companies may be regarded as global players as they have a highly level of exports and some are world market leaders in their field. In addition, there are now, also, large and multi-national companies from all sectors of industry in the area, such as Hewlett-Packart, IBM and SAP. Bavaria is nearby and is the German centre for the software and multi-media industry. This provides companies in the state with the opportunity for linkages to the IT sector.

As the medical technologies sector is by its nature inter-disciplinary, linkages do exist but they could be improved still further.

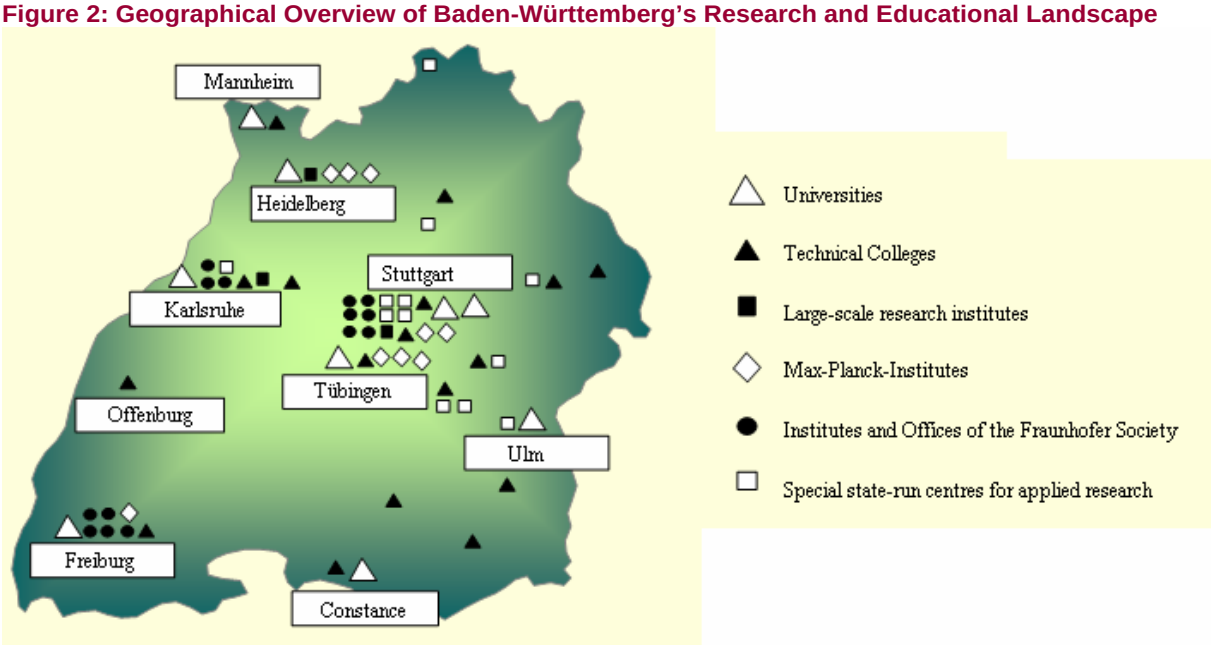
3.2.5. The Importance of Local Skills Supply

Baden-Württemberg is the German state with the highest density of educational institutions. There are two *technical universities* in Karlsruhe and Stuttgart; and seven *general universities* in Freiburg, Heidelberg, Hohenheim, Constance, Mannheim, Tuebingen and Ulm. There are 37 *universities of applied sciences;* eight *universities of cooperative edu-*

cation; three large research institutions; 14 *Max-Planck-Research-Institutes;* 14 research institutes of the *Fraunhofer Societie;* and ten institutions in cooperation with the private sector. Altogether, over 100 non-university research organisations are located in the state with plenty of links to the university sector. Figure 2 gives a geographical overview of the density of research and educational institutions in the state.

In Baden-Württemberg there is no dedicated educational course for the medical technologies sector. But there are many courses in particular disciplines where students can specialise in the field of medical technology, while still studying for a general degree in, for instance, electrical engineering. In addition, Technical Schools in Esslingen and Heidelberg offer courses to become a *state-approved technician for medical technologies (Staatlich geprueften Medizintechniker)* .

Figure 2: Geographical Overview of Baden-Württemberg's Research and Educational Landscape



Source: gwz.de

Figure 2 clearly shows the strength of the academic and educational infrastructure in the state. It suggests that the prospering manufacturing industry, in general, and the medical technology industry, in particular, depend heavily on that structure. Interviews with companies will reveal whether the schools, colleges and universities in the region provide them with enough recruits for their needs.

The interviews with companies will also provide details of the skills that are required by the medical technology sector. It remains unclear whether there has been a shortage of skilled personnel in Bavaria and Baden-Württemberg in recent years and what effect any shortage has had on the development of the industry. These questions can only be answered when the survey and interviews in the relevant companies have been completed.

4. Conclusion

A large part of German manufacturing industry, including the medical technology sector is still characterised by a high level of innovation, high value added and product differentiation in spite of structural problems in many areas. High labour productivity appears to depend only partly on technology and arises predominantly from the heavy investment in human capital. By tradition, German companies invest in human capital through vocational training of the young generation and thus can rely on a broad supply of skills at the intermediate level. The internationally well-known system of *dual training* which is the institutional backbone of vocational training in Germany has far reaching effects. Beyond its positive effects on labour productivity, it enables companies to operate complex production technologies; to enhance the quality of products and services; and to target the high price segments of world markets.

Also, in contrast with many other countries, vocational training is seen as a public good rather than a private investment. Still supported by a broad consensus among the social groups, the Federal and Länder governments continue to finance professional training at vocational schools, colleges and universities. The many chambers of commerce, employers associations and trade unions are heavily involved in the organisation of dual and continuing training. Companies are able to invest in the training of young people and their experienced staff with little fear of poaching because the labour market generally provides a sufficient number of trained workers. To some extent training is accepted by businesses as a social commitment which also produces high returns in terms of productivity. For individuals, finally, training is an asset that enables them to be competitive in the labour market.

At the same time, however*, Facharbeitermangel* (lack of qualified workers) and the lack of highly qualified people has been, for more than a decade, a problem for many companies. Shortages inhibit companies from taking advantage of opportunities to develop and reduce their capacity to innovate. The German education and qualification system has not been able to overcome the mismatch between the qualifications of unemployed people, on the one hand, and vacancies, on the other hand. It was the information technology (IT) sector that was most affected by the lack of qualified workers at the end of the 1990s and finally led to the German *IT Green C*ard system. But medical technology companies were also suffering, mainly because of a shortage of engineers; craftsmen and technicians; and other specialists.

The survey and the case studies will give a fuller understanding of the extent to which and the ways in which the shortage of skilled workers and the mismatch of qualifications in the labour market are influencing the German medical technology sector. In particular, the main question is the extent to which labour market constraints are inhibiting economic development, innovation, and growth in medical technology companies in the defined regions. In addition, the regional aspect of the study makes it possible to take account, at the same time, of historical developments; the educational infrastructure and policies; and the current regional and local policies of the state governments. The attempts of the responsible agencies (including the Federal and State governments; the Federal Employment Service with its extensive training opportunities; industry associations; and training institutions) to learn more about future qualification needs and direct the education and training system accordingly, will also be addressed in the further reports.

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Federal Statistical Office: www.destatis.de

OECD for basic data: www.oecd.org/dataoecd/8/4/1874420.pdf

Federal Ministry for Education and Research: www.bmbf.de

ANNEX 1

GDP and Health Expenditures in Germany 1992-2001

		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Population	Million	80.6	81.2	81.4	81.7	81.9	82.1	82.0	82.1	82.3	82.4
GDP*	Billion Euro	1,613.2	1,654.2	1,735.5	1,801.3	1,833.7	1,871.6	1,929.4	1,978.6	2,030.0	2,073.0
Growth Rate GDP	%	7.4%	2.5%	4.9%	3.8%	1.8%	2.1%	3.1%	2.6%	2.6%	2.2%
Health Expenditures	Billion Euro	163.2	168.1	180.2	194.0	203.0	203.9	208.4	214.3	218.8	225.9
Growth Rate Health Exp.	%	--	3.0%	7.2%	7.7%	4.6%	0.4%	2.2%	2.8%	2.1%	3.2%
Health Expenditures as share of GDP	%	10.1%	10.2%	10.4%	10.8%	11.1%	10.9%	10.8%	10.8%	10.8%	10.9%
Health Exp. Per Capita	Euro	2,020	2,070	2,210	2,380	2,480	2,480	2,540	2,610	2,660	2,740

*at current prices
Source: Federal Statistical Office, Ministry for Health and Social Security

ANNEX 2

Basic Data of German States 2002 (Bundesländer)

	Population in 1.000	GDP in million Euro	GDP in % of Ger-many's GDP	GDP 2002/2001 change in %	GDP per capita in Euro	R&D ex-penditures in billion Euro (1999)	Unemplo yment Rate %	Labour Force Participation Rate Female %	Labour Force Par-ticipation Rate Male %
Baden-Württemberg	**10,601**	**307,443**	**14.6**	**1.9**	**28,920**	**11.0**	**5.4**	**66.7**	**82.0**
Bayern	**12,330**	**368,917**	**17.5**	**2.3**	**29,858**	**9.6**	**6.0**	**67.1**	**82.3**
Berlin*	3,388	77,131	3.7	1.2	22,756	2.8	16.9	68.6	77.8
Brandenburg	2,593	44,117	2.1	1.2	17,054	0.7	17.5	73.8	80.1
Bremen*	660	22,962	1.1	2.3	34,753	0.5	12.6	61.6	77.4
Hamburg*	1,726	75,178	3.6	2.2	43,556	1.3	9.0	66.6	79.0
Hessen	6,078	191,610	9.1	1.9	31,496	4.5	6.9	65.3	80.8
Mecklenburg-Vorpommern	1,760	29,611	1.4	1.5	16,891	0.3	18.6	70.8	78.2
Niedersachsen	7,956	183,124	8.7	1.5	22,977	4.0	9.2	61.9	79.0
Nordrhein-Westfalen	18,052	463,963	22.0	1.3	25,690	7.8	9.2	59.7	78.8
Rheinland-Pfalz	4,049	93,300	4.4	2.5	23,038	1.9	7.2	62.2	80.6
Saarland	1,066	25,432	1.2	2.6	23,878	0.2	9.1	58.0	78.0
Sachsen	4,384	75,793	3.6	2.1	17,358	1.7	17.8	72.4	79.8
Sachsen-Anhalt	2,581	43,314	2.1	1.8	16,886	0.5	19.6	72.5	77.9
Schleswig-Holstein	2,804	65,637	3.1	1.8	23,362	0.7	8.7	64.5	80.7
Thüringen	2,411	40,667	1.9	1.3	16,929	0.6	15.9	71.9	79.5
Germany	**82,440**	**2,108,200**	**100.0**	**1.8**	**25,562**	**48.1**	**9.8**	**65.3**	**80.1**

* so called city-states that are not directly comparable with the other Länder

Sources: Statistisches Landesamt Baden-Württemberg; Statistisches Bundesamt 2003