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**Turnover and Output Measurement for
Scientific Research and Development
Activities in Germany**

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1 Definition of research and development activities

Research and development (R&D) is one specific type of scientific activities. It is defined as systematic, creative work which aims at enlarging knowledge and also comprises activities exploring new applications for existing knowledge. Its main characteristic is further development. In Germany three sectors operate in R&D: government including universities, private non-profit institutions and the business sector.¹ In the business sector there are enterprises that execute R&D as an ancillary activity (e.g. R&D section of a vehicle manufacturing company) and enterprises whose main economic activity is R&D (e.g. private R&D institute). The latter are classified in the NACE Rev. 2 division 72 and their output/turnover is covered by German structural business statistics in services industries. The division scientific research and development is one part of the superordinate NACE Rev. 2 section M “professional, scientific and technical activities” all characterised as being skill-intensive.

The NACE Rev. 2 division 72 “scientific research and development” generally includes the activities of three types of R&D:

- basic research,
- applied research,
- experimental development.

The NACE Rev. 2 division “scientific research and development” (72) is divided into two groups. The NACE Rev. 2 group 72.1 “research and experimental development on natural sciences and engineering” that again is divided into two NACE Rev. 2 classes:

- 72.11 “Research and experimental development on biotechnology”,
- 72.19 “Other and experimental development on natural sciences and engineering”.

The second group belonging to the NACE Rev. 2 division 72 is “research and experimental development on social sciences and humanities” (72.2) consisting of just one class.²

NACE Rev. 2 is the revised version of NACE Rev. 1.1. In the NACE Rev. 1.1 “research and development activities” were covered by the NACE Rev. 1.1 division 72.

¹ See: <http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/EN/Navigation/Statistics/BildungForschungKultur/ForschungEntwicklung/ForschungEntwicklung.psml>

² See: Regulation (EC) No 1893/2006 of the European Parliament and of the Council of 20 December 2006 establishing the statistical classification of economic activities NACE Revision 2 and amending Council Regulation (EEC) No 3037/90 as well as certain EC Regulations on specific statistical domains.

2 Output measurement in scientific research and development activities

The output of R&D activities is measured as turnover. Since reference period 2000 these data are collected for structural business statistics (SBS) on a yearly basis. Turnover is measured in euro and the statistical observation unit is the enterprise. At present turnover analysed by product classifications is not surveyed.

Turnover of R&D activities in structural business statistics is defined as total market sales of goods and services supplied to third parties including all duties and taxes on the good or service except for value added tax, all other charges to the customer (e.g. transport, packaging). Income such as other operating income, financial income and extraordinary income in company accounts is not included in turnover. Also excluded are operating subsidies received from public authorities or the institutions of the European Union.³

3 Turnover/output data method(s) and criteria for choosing various output/turnover methods

Due to the European Council Regulation No. 58/97 that became into effect in 1997, Germany had to deliver data about enterprises active in services industries⁴ to Eurostat on an annual frequency from reference period 1995 onwards.⁵ To fulfil these data requirements structural business statistics has been carried out annually in the German services industries since reference period 2000.⁶ The economic activity scientific R&D is not captured by short-term statistics.

According to the European SBS Regulation the services industries cover, among others, the economic activities of R&D. Around 15% of all enterprises⁷ of the relevant services branches having an annual turnover of more than EUR 17,500 are surveyed annually. For that purpose a random sample is drawn from the business register. The sample is strati-

³ See: Commission Regulation (EC) No 250/2009 of 11 March 2009 implementing Regulation (EC) No 295/2008 of the European Parliament and of the Council as regards the definitions of characteristics, the technical format for the transmission of data, the double reporting requirements for NACE Rev.1.1 and NACE Rev.2 and derogations to be granted for structural business statistics.

⁴ For the purpose of this paper “services industries” are the economic activities of the NACE Rev. 1.1 sections I “Transport, storage and communication” and K “Real estate, renting and business activities”.

⁵ See: Council Regulation (EC, Euratom) No 58/97 of 20 December 1996 concerning structural business statistics.

⁶ See: „Gesetz über Statistiken im Dienstleistungsbereich (Dienstleistungstatistikgesetz – DIStatG) vom 19. Dezember 2000”.

⁷ In terms of the European SBS regulation, enterprises are those units which wholly or partially exercise an economic activity that contributes to the gross domestic product.

fied for the 16 *Länder*⁸, the economic activities and turnover size classes. The enterprises selected are obliged to provide information about their principal economic activity, their legal form, the number of local units, turnover and other operating income, subsidies, the number of persons employed, wages and salaries, social security costs, material costs, taxes, investments and so on. Enterprises having establishments in several *Länder* have to split turnover, wages and salaries, investments and number of persons employed by *Länder*. To reduce response burden small enterprises with an annual turnover of less than 250,000 euro in the reporting year are surveyed only with a shortened questionnaire. The survey is carried out by the *Land* Statistical Offices. They send out the questionnaires, collect and record the data. Furthermore, they are responsible for checking and correcting the micro data and to compile the results by variable on the level of the *Länder*. The *Land* Statistical Offices deliver their results to the Federal Statistical Office where the national results are compiled, delivered to Eurostat and published.

In 2007 around 1.5 million enterprises existed in the German services industries. Altogether 14.7% of these enterprises were surveyed – see table 1. Due to the stratification of the sample, the share of enterprises surveyed in each economic activity differed. In NAVE Rev. 1.1 division R&D 36.9% of the 11,107 existing enterprises were surveyed. The share of R&D enterprises surveyed was relatively high compared to the share of other NACE Rev. 1.1 divisions. Among these, 11% answered that their economic activity was not R&D. 3.1% of enterprises refused to answer, which was below average.

NACE Rev. 1.1	Amount of units in the sampling frame	Sample size as share of units in the sampling frame	Enterprises misclassified as share of sample size ⁹	Genuine non-response
I	185,540	22.6%	3.3%	4.4%
60	108,223	16.2%	3.0%	4.7%
61	4,605	62.4%	1.5%	1.8%
62	790	90.9%	3.3%	2.9%
63	51,646	30.9%	3.8%	4.3%
64	20,276	23.9%	3.9%	5.4%
K	1,275,486	13.5%	5.7%	3.6%
70	380,281	11.8%	3.1%	3.0%
71	34,669	33.6%	12.2%	3.7%
72	100,994	17.8%	5.9%	4.3%
73	11,107	36.9%	11.0%	3.1%
74	748,435	12.5%	5.9%	3.9%
Total	1,461,026	14.7%	5.2%	3.8%

Table 1: Sample survey for services industries in 2007

⁸ Germany is a federal parliamentary republic of 16 states called *Länder*. Besides the Federal Statistical Office in each Land there is a *Land* Statistical Office.

⁹ This figure applies to enterprises which answered that their economic activity is outside the services industries covered by structural business statistics.

4 Market conditions and constraints

In 2007 German enterprises of R&D activities generated total turnover of 8.9 billion euro, growing at an average rate of 8.0% over the last five years – see table 2. The total turnover generated by the enterprises of the NACE Rev. 1.1 group “research and experimental development on natural sciences and engineering” increased from year to year except in 2006. In contrast to this, total turnover in “research and experimental development on social sciences and humanities” activities ranged between 0.3 and 0.7 billion euro.

NACE Rev. 1.1	Description	Total turnover in billion euro				
		2003	2004	2005	2006	2007
73	Research and development	6.0	6.4	7.5	7.5	8.2
73.1	Research and experimental development on natural sciences and engineering	5.5	6.1	6.9	6.9	7.6
73.2	Research and experimental development on social sciences and humanities	0.5	0.3	0.6	0.7	0.6

Table 2: Turnover by economic activities (billion euro) in 2007

In 2007 around 93% of the total turnover was allotted to NACE Rev. 1.1 group 73.1 “research and experimental development on natural sciences and engineering”. The remaining 7% were generated by NACE Rev. 1.1 group 73.2 “research and experimental development on social sciences and humanities” – see table 4. Also the number of enterprises showed that the market share of “research and experimental development on natural sciences and engineering” was around ninefold as high as the market share of “research and experimental development on social sciences and humanities”.¹⁰

The market of R&D activities in Germany was dominated by a small number of large enterprises (those having an annual income¹¹ of at least 10 million euro) dominate the market – see table 3.

NACE Rev. 1.1	Share of largest enterprises in %*	Share of income earned by largest enterprises in %
73	2.9	67.4
73.1	3.1	67.5
73.2	0.4	66.7

* Only establishments/enterprises with total receipts of more than 17,500 euro

Table 3: Large enterprises in R&D activities in 2007

In 2007 the large enterprises which amount to 3% of all R&D enterprises realised 67% of the total turnover. This is similarly for the two NACE Rev. 1.1 groups “research and experimental development on natural sciences and engineering” (73.1) and “research and

¹⁰ See: Federal Statistical Office of Germany (2009): „Strukturerhebung im Dienstleistungsbereich Grundstücks- und Wohnungswesen, Vermietung beweglicher Sachen, Erbringung von wirtschaftlichen Dienstleistungen, a.n.g. Fachserie 9, Reihe 2.“

¹¹ Income is defined as turnover plus other income.

experimental development on social sciences and humanities” (73.2). Another specific characteristic is that subsidies form a substantial share of the total receipts (total receipts include turnover, other income and subsidies) for R&D enterprises, whereas the share of subsidies for the enterprises classified in the other divisions of the superordinate NACE Rev. 1.1 section K “real estate, renting and business activity” ranges between 0.0% and 0.4% – see table 4. But although R&D enterprises receive around 70% of all subsidies paid to enterprises of NACE Rev. 1.1 section K they generate only 1.9% of total turnover.

NACE Rev. 1.1	Total receipts in million euro	Thereof income in %	Thereof subsidies in %
K	476.1	99.6	0.4
70	112.3	99.8	0.2
71	32.2	100.0	0.0
72	68.3	99.9	0.1
73	10.4	85.5	14.5
74	252.8	99.9	0.1

Table 4: Total receipts for specific services industries in 2007

5 Standard classification structure and product levels

5.1 Classification of economic activities

Enterprises are classified according to their economic activity using a top down approach. Enterprises being active in more than one economic activity will be classified under their principal activity, normally the one that generates the largest amount of turnover.¹²

The German classification of economic activities is called WZ 2008. It is based on NACE Rev. 2 which is derived from ISIC Rev. 4 – see table 5.¹³ The German classification of economic activities comprises an additional hierarchical level of sub classes (five-digit level) compared to the NACE. The fifth level reflects specific structural characteristics of the economic activities in Germany.

¹² See: Eurostat, NACE Rev. 2 Introductory Guidelines, pages 14-18.

¹³ The requirements for an implementation of WZ 2008 for statistical purposes arise from the Council Regulation of the European Community (EC) No 1893/2006 of 20 December 2006. Statistics referring to economic activities performed from 1 January 2008 onwards (reference period) shall be produced using NACE Rev. 2. Therefore, WZ 2008 has been implemented in German structural business statistics with reference period 2008.

WZ 2008 Code	WZ 2008 – Description	NACE Rev. 2	ISIC Rev. 4
72	Scientific research and development	72	
72.1	Research and experimental development on natural sciences and engineering	72.1	
72.11	Research and experimental development on biotechnology	72.11	7210
72.11.0	Research and experimental development on biotechnology		
72.19	Other research and experimental development on natural sciences and engineering	72.19	7210
72.19.0	Other research and experimental development on natural sciences and engineering		
72.2	Research and experimental development on social sciences and humanities	72.2	
72.20	Research and experimental development on social sciences and humanities	72.20	7220
72.20.0	Research and experimental development on social sciences and humanities		

Table 5: Scientific R&D activities in German classification of economic activities – WZ 2008

The rule on using WZ 2008 from reference period 2008 onwards does not apply for the production of all statistics. For example national accounts statistics on the basis of Regulation (EC) No 2223/96 will implement WZ 2008 from reference period 2011 onwards. Until then WZ 2003 is still used – see table 6. It is based on NACE Rev. 1.1 which is derived from ISIC Rev. 3.1.

WZ 2003 Code	WZ 2003 – Description	ISIC Rev. 3.1
73	Research and development	
73.1	Research and experimental development on natural sciences and engineering	731
73.10	Research and experimental development on natural sciences and engineering	7310
73.10.1	Research and experimental development on natural sciences and mathematics	
73.10.2	Research and experimental development on engineering	
73.10.3	Research and experimental development on agriculture, forestry and nutrition sciences	
73.10.4	Research and experimental development on medical sciences	
73.10.5	Research and experimental development in the environment sector	
73.2	Research and experimental development on social sciences and humanities	732
73.20	Research and experimental development on social sciences and humanities	7320
73.20.1	Research and experimental development on social sciences	
73.20.2	Research and experimental development on humanities	

Table 6: Scientific R&D activities in German classification of economic activities – WZ 2003

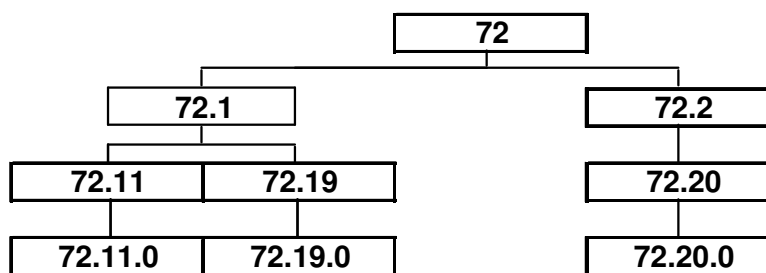
Over the last four decades the importance of the different economic activities in the German economy and on the international level changed. The economical weight of services industries changed most significantly. Due to these changes the international and national classifications of economic activities had to be revised.¹⁴ The revision of WZ 2003 leading to WZ 2008 also affected the R&D activities. Figure 1 illustrates the changes of R&D activities between WZ 2003 and WZ 2008. Restructuring the national

¹⁴ See: Seidel, Anke: „Umstellung der Konjunkturstatistik in bestimmten Dienstleistungsbereichen auf die Wirtschaftszweigklassifikation NACE Rev. 2.“ in *Wirtschaft und Statistik* 3/2010, page 255 ff.

classification aimed at omitting those sub-classes (5-digit level) for which no statistical results are produced and whose overall economic importance has decreased.

At the 3-digit level the economic activity R&D was just recoded – see figure 1. The WZ 2008 group 72.2 (WZ 2003 73.2) still includes one WZ 2008 class (72.20). The WZ 2008 group 72.1 (WZ 2003 73.1) was revised on the level of WZ classes and sub-classes. The WZ 2003 group 73.1 consisted of one WZ 2003 class (73.10 “research and experimental development on natural sciences and engineering”). The national classification divided that class in five subclasses. WZ 2008 group 72.1 is now divided into two classes, “research and experimental development on biotechnology” (WZ 2008 72.11) and “other research and experimental development on natural sciences and engineering” (WZ 2008 72.19). Under these classes further sub-classes do not exist any more.

WZ 2008



WZ 2003

73.10.1*	73.10.1*	73.20.1
73.10.2*	73.10.2*	73.20.2
73.10.3*	73.10.3*	
73.10.4*	73.10.4*	
73.10.5*	73.10.5*	

* Splitting of past economic activity (WZ 2003)

Figure 1: Conversion of German classification of economic activities in R&D activities

5.2 Product classification

The European version of the central product classification (CPC) is called statistical classification of products by activity within the European Economic Community 2008 (CPA 2008) whose elements are related to activities as defined by NACE Rev. 2. In R&D activities there are 23 items at detailed 6-digit product level – see table 7. Up to now turnover for enterprises in R&D activities has not been collected on the product level in structural business statistics, unlike in some areas of the services industries such as advertising or activities of employment.

CPA 2008 Code	CPA 2008 – Description
72	Scientific research and development services
72.1	Research and experimental development services in natural sciences and engineering
72.11	Research and experimental development services in biotechnology
72.11.1	Research and experimental development services in health, environmental, agricultural and other biotechnology
72.11.11	Research and experimental development services in health biotechnology
72.11.12	Research and experimental development services in environmental and industrial biotechnology
72.11.13	Research and experimental development services in agricultural biotechnology
72.11.2	Research and development originals in biotechnology
72.11.20	Research and development originals in biotechnology
72.19	Research and experimental development services in other natural sciences and engineering
72.19.1	Research and experimental development services in other natural sciences
72.19.11	Research and experimental development services in mathematics
72.19.12	Research and experimental development services in computer and information sciences
72.19.13	Research and experimental development services in physical sciences
72.19.14	Research and experimental development services in chemistry
72.19.15	Research and experimental development services in earth and related environmental sciences
72.19.16	Research and experimental development services in biological sciences
72.19.19	Research and experimental development services in other natural sciences
72.19.2	Research and experimental development services in engineering and technology, except biotechnology
72.19.21	Research and experimental development services in nanotechnology
72.19.29	Other research and experimental development services in engineering and technology, except biotechnology
72.19.3	Research and experimental development services in medical sciences
72.19.30	Research and experimental development services in medical sciences
72.19.4	Research and experimental development services in agricultural sciences
72.19.40	Research and experimental development services in agricultural sciences
72.19.5	Research and development originals in natural sciences and engineering, except for biotechnology
72.19.50	Research and development originals in natural sciences and engineering, except for biotechnology
72.2	Research and experimental development services in social sciences and humanities
72.20	Research and experimental development services in social sciences and humanities
72.20.1	Research and experimental development services in social sciences
72.20.11	Research and experimental development services in economics and business
72.20.12	Research and experimental development services in psychology
72.20.13	Research and experimental development services in law
72.20.19	Research and experimental development services in other social sciences
72.20.2	Research and experimental development services in humanities
72.20.21	Research and experimental development services in languages and literature
72.20.29	Other research and experimental development services in humanities
72.20.3	Research and development originals in social sciences and humanities
72.20.30	Research and development originals in social sciences and humanities

Table 7: Scientific R&D services in EU classification of products by activity – CPA 2008

6 Evaluation of standard vs. definition and market conditions

Structural business statistics in services industries collects information about the turnover of enterprises whose main economic activity is R&D. In Germany these enterprises are just one part of institutions are engaged in R&D activities. The government, universities and private non-profit institutions as well as enterprises of other economic activities that execute R&D as an ancillary activity are not covered.¹⁵ But there are other publications that give an idea about their economic importance. These publications both have a focus on the input side of R&D activities. German R&D statistics that collect data about R&D expenditures, revenues and personnel from the government and universities including private non-profit institutions are conducted every year. This information is completed by data of the German “Stifterverband für die Deutsche Wissenschaft”¹⁶ that collects information about expenditures for R&D of all enterprises in Germany.

In 2007 around 61.5 billion euro were spent for R&D activities. Thereof 30% were spent by the government, universities and private non-profit institutions and 70% by the business sector.¹⁷ The expenditures in R&D activities of the business sector comprise data of all enterprises of the whole economy. Statistical data of the “Stifterverband für die Deutsche Wissenschaft” show that 80% of these expenditures were spent on internal R&D and the remaining 20% were spent on external R&D activities.¹⁸ Internal R&D is executed by an internal section of an enterprise having a main economic activity different from R&D for its own use (ancillary activity), whereas external R&D is conducted by outside companies. These results show, that the share of R&D output covered by structural business statistics in services industries can be suggested as being just a small part of total output.

Another important point to mention is that output measurement for R&D activities is not straight forward. Not all R&D activities directly cause turnover (e.g. basic research) and not all output is traded on the market. To compile a complete picture of the overall output of R&D activities in Germany, figures other than turnover could be taken into account. For that purpose it is important to understand the production process of R&D activities. Enterprises or public institutions execute R&D to find new scientific knowledge or technical inventions. If the research is successful it results in patents or scientific publications. But this is still not the output. The output is the utilisation of the new knowledge called *innovation*. The gain of an *innovation* can be measured as the share of turnover gener-

¹⁵ See: German Federal Ministry of Education and Research (2010): „Bundesbericht Forschung und Innovation 2010“, page 39.

¹⁶ Stifterverband ist the business community’s innovation agency for the German science system.

¹⁷ See: Federal Statistical Office of Germany (2009): “Ausgaben, Einnahmen und Personal der öffentlichen und öffentlich geförderten Einrichtungen für Wissenschaft, Forschung und Entwicklung. Fachserie 14. Reihe 3.6“.

¹⁸ See: Stifterverband für die Deutsche Wissenschaft (2010). „FuE-Datenreport 2010“, page 14.

ated by using new products or as the reduction of production cost realised by new production process.¹⁹

7 National accounts concepts and measurement issues for the area related to GDP measurement²⁰

The results of national accounts (annual and quarterly frequency) are basically calculated taking into account all suitable and available information of continuous survey of economic statistics. Additionally, data from other sources such as administrative data and administrative statistics, annual reports from large enterprises, household surveys and information from associations are used.²¹

In national accounts, the results are broken down and structured using a variety of classifications. Most of them are internationally harmonised. Particularly important is the breakdown by economic activities. Similarly to structural business statistics in services industries it is based on the national classification of economic activity (WZ 2003). Generally, the most detailed breakdown of economic activities available in national accounts is the so called A60 by 60 industries which corresponds to the two-digit level of the classification of economic activity, actually WZ 2003/ NACE Rev. 1.1.

Although structural business statistics data has been available from reference period 2000 onwards the main source for the services industries is still the value added tax statistics. The reasons are first of all the relatively short period of time for which data are available. And secondly, the business register which is not yet functioning fully being the sampling frame and the extrapolation base of structural business statistics. Therefore, the results of structural business statistics for R&D activities are not directly comparable.

The area of R&D generally comprises statistical units from general government including universities, non-profit institutions serving households and non-financial corporations as well as households. Non-financial corporations and households are called “combined ‘enterprise’ sector”. In the national accounts’ results the production of those units whose main economic activity is R&D is included.

According to the results of national accounts R&D accounted for only 0.4% of all domestic production in the year 2000. Table 8 presents some results for the year 2007 broken down by institutional sectors. Around 56% of the totally generated gross value added

¹⁹ German Federal Ministry of Education and Research (2010): „Bundesbericht Forschung und Innovation 2010“.

²⁰ Federal Statistical Office of Germany (2009): National accounts – Gross domestic products in Germany in accordance with ESA 1995 – Methods and sources – New version following revision 2005. Subject-matter series 18. Series 22.

²¹ See: Federal Statistical Office of Germany (2009): „Qualitätsbericht: Volkswirtschaftliche Gesamtrechnung“, page 5.

was generated by the combined enterprise sector. The gross value added of the general government and the non-profit organisations serving households accounts for 12.4% and 31.4%, respectively.

Sector	Output	Gross value added (GVA)	Sectoral share of Gross Value added
	in billion euro		%
Non-financial corporations and households	7.7	4.7	56.2
General government	7.0	1.0	12.4
Non-profit institutions serving households	3.9	2.6	31.4
Total	18.7	8.4	100.0

Table 8: National accounts' results for R&D activities (WZ 73) in the year 2007

To deflate output of R&D activities the national accounts use an index combined of three sub-indices: the price index for labour costs and, as a proxy, the price index for investments in buildings and in machinery as well as in equipment.²² Currently, the methods of price measurement in national accounts for R&D activities are developed further. The aim is to improve the methods towards a more output-oriented approach.

8 Evaluation of comparability of turnover/output data with price index practices

Due to the lack of a legal basis a producer price index for R&D activities is not compiled in Germany.

9 Summary

Information about R&D activities on the enterprise level has been collected on an annual basis from reference period 2000 onwards. Results are broken down and systemised using the classification of economic activities. A breakdown of results by products is not available. Short-term statistics as well as a producer price index for R&D activities do not exist.

The statistical results about R&D activities show that this economic activity is in many respects a special economic activity within the scope of structural business statistics in services industries. On the one hand three different types of institutions are engaged in R&D activities: The government, private non-profit institutions and the business sector (internal and external R&D). Furthermore, a huge amount of R&D activities are conducted as an ancillary activity by companies having another main economic activity than R&D.

²² Federal Statistical Office of Germany (2003): Methods of the Price and Volume Measurement in the national accounts, page 24.

Therefore, just a small part of all R&D activities are captured by structural business statistics in Germany.

Output measurement for R&D activities is not straight forward as not all R&D directly cause turnover and large parts of R&D activities are non-market services. In principle there are other variables to complete the measurement of output for R&D activities. But these are not collected by structural business statistics.

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