Division Prices
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PRICE INDEX FOR SERVICES IN RESEARCH AND DEVELOPMENT IN GERMANY

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1. Introduction

To approach R&D two perspectives can be taken. First, you can refer directly to NACE rev. 2, code 72 'Research and Development'. It covers the industry where R&D is generated as primary activity. Since it is based on economic units, NACE rev.2, code 72 also captures all other secondary activities economic units undertake besides R&D.

On the other hand R&D itself is a secondary activity in other industries. Its value even exceeds the output of NACE rev.2, code 72. Although by viewing R&D from the product perspective you get a more general picture of R&D services, statistical information on the service R&D is often scarce. Since a R&D PPI serves better as short-term indicator if it mirrors the price development of all R&D services, the product perspective is preferred in the following. Data on NACE rev.2, code 72 are given additionally.

2. Definition of the Service

According to CPA 2008, Code 72 scientific research and development (R&D) includes research and experimental development on all scientific fields with the exception of market research. It is structured on the second level into R&D on natural sciences and engineering (CPA 2008, Code 72.1) as well as on social sciences and the humanities (CPA 2008, Code 72.2)[1].

Into the definition of R&D fall three kinds of activities originally defined by the Frascati Handbook: *basic research* like "experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without particular application or use in view", *applied research* defined as "original investigation undertaken in order to acquire new knowledge, directed primarily towards a specific practical aim or objective" and finally *experimental development* considered as "systematic work, drawing on existing knowledge gained from research and/or practical experience, directed to producing new materials, products and devices, to installing new processes, systems and services, and to improving substantially those already produced or installed".

3. Pricing Unit of Measure

As in most services the pricing unit for R&D is a matter of convention. This might be an hour or day a customer has a scientist and equipment for his disposal. It might also consist of other characteristics laid down in a contract. At present a pricing unit for R&D is yet to define.

[1] See appendix for details.

4. Market Conditions and Constraints

3.1 Size of Industry

3.1.1 NACE Rev. 2, code 72: Research and Development

The turnover for R&D activities within the business sector according to the German service statistics amounts to 8.9 Bill. EUR[2] turnover in 2007, thereof..

- 8.3 Bill. EUR for R&D on natural sciences and engineering and
- 0.6 Bill. EUR for R&D on social sciences and the humanities.

These figures refer to R&D as a primary economic activity by the industrial sector. They exclude extra-sectoral R&D (as secondary activity) as well as R&D conducted by the state or non-profit institutions serving households (roughly 60% of total R&D turnover in NACE rev. 2, code 72).

Table 1 Expenditure structure of NACE rev. 1, code 73

NACE rev. 1 classification		expenditures			expenditures to turnover rate	share	
		total	thereof			of labor costs to total expenditures	of material costs to total expenditures
			labor costs	material costs			
		1 000 EUR			%		
73	Research and development.....	9 120 168	4 630 027	4 490 142	102.4	50.8	49.2
73.1	Research and experimental development on natural sciences and engineering.....	8 586 647	4 270 935	4 315 712	103.3	49.7	50.3
73.2	Research and experimental development on social sciences and humanities.....	533 521	359 092	174 429	90.6	67.3	32.7

Note: On this level of aggregation, NACE rev.1 code 73 is consistent with NACE rev.2, code 72. Source: Service Statistics 2009.

The expenditure structure (table 1) displays two interesting facts:

First, material costs equal labor costs when it comes to R&D expenditures in natural science. This is in contrast to the widespread assumption of predominant labor costs in R&D services. Only the (relatively marginal) expenditures for R&D in humanities display such a pattern.

Second, total R&D expenditures exceed total R&D turnover. We see this effect only in natural science R&D and not in humanities R&D. The sector is highly subsidized, for natural science R&D makes up 30% of labor costs.

[2] Strukturerhebung im Dienstleistungsbereich - Fachserie 9 Reihe 2 – 2007.

3.1.2 CPA 72: Research and Development

R&D from the product perspective was until recently not in focus of official statistics. The Stifterverband für die deutsche Wissenschaft (Foundation of German Science), however, biannually surveys R&D expenditures of the whole business sector in Germany. In 2007, it measures internal (within firms produced) R&D output to amount to 43 bill. EUR. The business sector contributes about two thirds to all internal R&D produced in Germany[3].

Table 2 R&D expenditures of the business sector 2006 - 2009

NACE rev. 1 classification		R&D expenditures						planned
		2006		2007		2008		2009
		total	thereof internal	total	thereof internal	total	thereof internal	total
		Million €						
A,B	Agriculture, hunting, forestry; fishing	127	82	142	95	148	100	166
C	Mining, quarrying	36	29	37	28	34	28	32
D	Manufacturing	47 299	37 035	47 770	38 159	51 264	41 001	51 346
DA	M. of food products, beverages, tobacco	333	288	373	326	333	283	331
DB, DC	M. of textiles and leather	231	215	218	198	220	200	188
DD, DE	M. of wood, pulp, paper publ., printing	178	147	255	218	255	219	253
DF	M. of coke, refined petrol. prod., nucl. fuel	72	67	101	94	101	94	112
DG	Chemical industry	9 048	7 066	8 064	6 460	8 297	6 646	8 259
24.4	M. of pharm., medic. chem., botan. prod.	5 393	3 648	4 504	3 312	4 666	3 414	4 565
DH	M. of rubber, plastic products	762	717	925	885	939	902	884
DI	M. of other non-metallic mineral products	315	262	293	260	308	276	318
DJ	M. of basic & fabric. metals or products	1 067	887	1 139	983	1 176	1 033	1 229
DK	M. of machinery, equipment n.e.c.	4 673	4 255	5 207	4 763	5 535	5 042	5 486
DL	Manufacture of electrical, optical equipmt	10 554	8 267	10 085	8 157	10 800	8 683	10 395
DM	Manufacture of transport equipment	19 847	14 691	20 884	15 610	23 114	17 458	23 714
34	M. of motor vehicles, (semi-) trailers	16 799	12 392	18 116	13 519	20 042	15 120	20 934
DN	Manufacture n.e.c.	217	172	226	205	185	165	176
E	Electricity, gas, water supply	110	95	202	127	215	131	215
F	Construction	31	27	69	59	65	57	59
I	Transport, storage, communication	303	216	350	249	344	249	343
K	Real estate, renting, business activities	3 760	3 399	4 399	3 934	4 740	4 107	4 663
O	Other community, social, personal s.a.	3	2	16	16	16	16	16
G, H, J, L-N	Other	308	262	462	368	479	385	564
Total		51 980	41 148	53 447	43 035	57 304	46 073	57 404

Note: Total expenditures are external (from other sources) and internal (within the firm) expenditures. Source: Stifterverband Wissenschaftsstatistik 2009.

Table 3 Internal expenditures on basic research, applied research and experimental development

NACE rev. 1 classification	Internal R&D expenditures

[3] FuE-Datenreport 2010 – Analysen und Vergleiche. Bericht über die FuE-Erhebungen 2007 | 2008, p.13.

		Basic research		Applied research		Experimental development	
		thsd. €	%	thsd. €	%	thsd. €	%
A,B	Agriculture, hunting, forestry; fishing	2 998	3.2	29 575	31.4	61 558	65.4
C	Mining, quarrying	834	3.1	6 952	25.9	19 025	71.0
D	Manufacturing	1 778 054	4.7	19 140 628	50.5	17 023 168	44.9
DA	M. of food products, beverages, tobacco	20 993	6.6	130 106	41.0	166 229	52.4
DB, DC	M. of textiles and leather	5 897	4.4	79 381	59.8	47 557	35.8
DD, DE	M. of wood, pulp, paper publ., printing	5 591	2.8	94 393	47.5	98 689	49.7
DF	M. of coke, refined petrol. prod., nucl. fuel	2 294	2.5	78 661	84.3	12 333	13.2
DG	Chemical industry	713 727	11.1	2 822 330	43.7	2 920 153	45.2
DH	M. of rubber, plastic products	61 606	7.1	420 919	48.5	385 386	44.4
DI	M. of other non-metallic mineral products	13 364	5.3	99 047	39.6	137 650	55.1
DJ	M. of basic & fabric. metals or products	49 318	5.2	478 373	50.9	412 827	43.9
DK	M. of machinery, equipment n.e.c.	229 807	4.9	1 996 793	42.2	2 505 942	53.0
DL	Manufacture of electrical, optical equipmt	194 456	2.4	4 757 461	58.4	3 190 322	39.2
DM	Manufacture of transport equipment	471 659	3.0	8 076 674	51.8	7 057 248	45.2
DN	Manufacture n.e.c.	9 343	4.6	106 487	52.0	88 832	43.4
E	Electricity, gas, water supply	1 409	1.2	42 872	36.4	73 521	62.4
F	Construction	1 297	2.2	42 630	73.7	13 938	24.1
I	Transport, storage, communication	.a)	.a)	.a)	.a)	.a)	.a)
K	Real estate, renting, business activities	282 174	7.3	1 162 125	29.9	2 442 577	62.8
O	Other community, social, personal s.a.	.a)	.a)	.a)	.a)	.a)	.a)
G, H, J, L-N	Other	13 719	3.7	152 350	41.4	202 057	54.9
Total		2 090 334	4.9	20 717 745	48.5	19 950 422	46.7

Source: Stifterverband Wissenschaftsstatistik 2009.

As table 3 shows conduct the chemical industry (11.1%) and business activities (including the class R&D) (7.3%) more basic research than the average (4.9%). The latter also conducts less applied research and more experimental development than the other sectors.

In total we see that basic research is only a small fraction of all R&D services. Most R&D services are directed towards applied research and experimental development.

3.2 Special Conditions or Restrictions

The nature of R&D as a non-standardized activity makes it difficult to collect comparable prices between two points in time. Moreover, research results can be seen as unique and, therefore, as not at all comparable. Non-exploitable research results i.e. in basic research eventually have no observable market price. Any method for price collection should be applicable to these characteristics of R&D activities.

The fact that in 2007 as in previous years the expenditures in R&D sector exceed the turnover by 2.4% hints to special conditions of the industry. Whether or not the huge subsidies or other contributing factors affect market conditions and prices cannot be answered.

5. Standard Classification Structure and Details

The CPA, version 2008 structures R&D services as follows:

72 Scientific research and development
- 72.1 Research and experimental development on natural sciences and engineering
  - 72.11 Research and experimental development on biotechnology
  - 72.19 Other research and experimental development on natural sciences and engineering
- 72.2 Research and experimental development on social sciences and humanities
- 72.20 Research and experimental development on social sciences and humanities

Code 72.11 includes R&D services in the application of science and technology to living organisms, alter living or non-living materials for the production of knowledge, goods and services like genomics, DNA sequencing, vaccine/immune stimulants or bio processing as well as any scientific originals in this field conducted on own account.

Code 72.19 includes R&D in natural sciences like physics, chemistry or computer sciences, R&D in engineering other than biotechnology like nanotechnology, R&D in medical sciences, R&D in agricultural sciences as well any scientific originals in this field.

Code 72.2 includes R&D in social sciences like economics, psychology or law, R&D in humanities like literature as well as scientific originals in this field.

6. Evaluation of Standard vs. Definition and Market Conditions

German service statistics show different cost structures for humanities and natural sciences for NACE rev. 2, code 72.1. This finding supports the separation of humanities and natural science.

Germany's most important producers of R&D revealed by the product concept, i.e. chemical industry, manufacturing of machinery and of vehicles, fall all in 72.1 and are only separated on the fifth level. Although the classification is rather complex, it doesn't seem to fit well to Germany's R&D structure. For a potential PPI another classification beneath the second level would be necessary.

7. Discussion of Pricing Methods

Before pricing methods for a PPI for R&D can be discussed, we have to collect more information about specific types of R&D in order to define pricing units. For that a clear R&D classification is needed. As the only way to obtain this information an industry survey should be taken into consideration. Since the service is predominantly produced outside of NACE rev. 2 code 72, R&D should be considered from the goods rather that from the sector perspective.

Since registers are usually arranged according to sector codes, the population of such a survey might be hard to obtain. In Germany, the Stifterverband Wissenschaftsstatistik relies on a databank 'of firms where R&D activities can be assumed'[4]. Similar databases might exist in other countries, too.

The following questions should be addressed in a pilot survey:

i. What is the production method?

ii. Can R&D production be sorted in homogeneous R&D types (i.e. pharmaceutical/chemical R&D, machinery R&D)? How can these types be assigned to NACE codes? (For national account purposes groupings along sector boundaries would be preferred)

iii. What are recurring R&D services? What are their price characteristics?

iv. How are these R&D services distributed within the previously defined R&D types?

v. How can quality changes be addressed?

If the central question v. leads to comparable services, price collection can take place. The assumption has yet to be confirmed, but contract prices and time based methods should be considered as potential price methods. Since our data show the predominance of labor costs in humanities R&D, the latter might be more appropriate for CPA, code 72.2. Provided the necessary resources, time based methods like hourly rate could be collected. For the larger part of CPA, code 72, however, we expect that R&D services are sold in detailed and very specific contracts where keeping services constant over time might create problems.

8. Quality Adjustment and Methodology

[4] FuE-Datenreport 2010 – Analysen und Vergleiche. Bericht über die FuE-Erhebungen 2007 | 2008, p.36.

Although a thorough R&D study might lead to other results, I do not expect quality adjustment to be within reach of a potential R&D PPI. I assume that even R&D firms have no proxies to tackle down quality change.

9. Evaluation of Comparability Regarding Turnover/Output Measures

Turnover measurement is taken along class boundaries. Due to the special characteristic of R&D that most of R&D services are conducted outside of NACE rev. 2, code 72, a PPI based on the CPA 2008, code 72 might not be applicable to NACE, rev. 2, code 72 or secondary activities in other NACE codes. It is therefore necessary to find a way to reattribute R&D services to NACE codes

10. Summary

After considering all information available of R&D sector- and product wise, there is still need for elementary information about R&D production. The development of a PPI for R&D heavily depends on whether or not recurring goods can be identified. These might only be obtained via a thorough industry survey. Despite its costs countries face the problem how to obtain a sample of R&D firms that are scattered over most of NACE codes. Finally, efforts to conduct a PPI for R&D will depend on the acceptance of input methods for R&D deflation which seem far less cost-intensive to compute and might also lead to sufficient results.

Appendix

1. Statistical Classification of Products by Activity in the European Economic Community, 2008 version

Code	Description	This item includes	This item excludes
72	Scientific research and development services		This division excludes: - market research services, see 73.20.11
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	This category includes research and experimental development services in the application of science and technology to living organisms as well as parts, products or models thereof, to alter living or non-living materials for the production of knowledge, goods and services. This includes: - research and experimental development services on DNA (the coding): • genomics, pharmaco-genetics, geneprobes, DNA sequencing/synthesis/amplification, genetic engineering - research and experimental development on proteins and molecules (the functional blocks): • protein/peptide sequencing/synthesis, lipid/protein/glyco engineering, proteomics, hormones and growth factors, cell receptors/signalling/pheromones - research and experimental development on cell and tissue culture and engineering: • cell/tissue culture, tissue engineering, hybridisation, cellular fusion, vaccine/immune stimulants, embryo manipulation - research and experimental development on process biotechnologies: • bioreactors, fermentation, bio processing, bioleaching, bio desulphurisation, bio pulping, bio filtration, bioremediation - research and experimental development on sub-cellular organisms: • gene therapy, viral vectors	
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	This subcategory includes: - scientific originals in biotechnology, i.e. ideas, plans, blueprints, formulas for inventions, products and processes, which can be protected and licensed as industrial property, trade secrets, patents etc. The creation of these original works is done on own account, i.e. their production is intended for sale that is undertaken without either a contract or known buyer in mind.	
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	This subcategory includes: - research and experimental development services on heat, light, electromagnetism, astronomy, etc.	
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	This subcategory includes: - research and experimental development services on physiology and ecology of animals and plants, micro-organisms, etc.	
72.19.19	Research and experimental development services in other natural sciences	This subcategory also includes: - interdisciplinary research and development, predominantly in 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	This subcategory includes: - research and experimental development services on applied science and technology for casting, metal, machinery, electricity, communications, vessels, aircraft, civil engineering, construction etc.	This subcategory excludes: - research and experimental development in environmental and industrial biotech-nology, see 72.11.12
72.19.3	Research and experimental development services in medical sciences		
72.19.30	Research and experimental development services in medical sciences	This subcategory includes: - research and experimental development services on treatment of diseases, preventive hygiene, pharmacy, etc.	This subcategory excludes: - research and experimental development in health biotechnology, see 72.11.11
72.19.4	Research and experimental development services in agricultural sciences		
72.19.40	Research and experimental development services in agricultural sciences	This subcategory includes: - research and experimental development services on agricultural techniques, fruit culture, forestry, stock breeding, fisheries, etc.	This subcategory excludes: - research and experimental development in agricultural biotechnology, see 72.11.13
72.19.5	Research and development originals in natural sciences and engineering, except for biotech-nology		
72.19.50	Research and development originals in natural sciences and engineering, except for biotech-nology	This subcategory includes: - scientific originals in natural sciences and engineering, except for biotechnology, i.e. ideas, plans, blue-prints, formulas for inventions, products and processes, which can be protected and licensed as industrial property, trade secrets, patents etc.	This subcategory excludes: - research and development originals in biotechnology, see 72.11.20

		The creation of these original works is done on own account, i.e. their production is intended for sale that is undertaken without either a contract or known buyer in mind.	
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	This subcategory includes: - research and experimental development services in theories of economics, business management, finance, statistics, etc.	This subcategory excludes: - market research services, see 73.20.11
72.20.12	Research and experimental development services in psychology		
72.20.13	Research and experimental development services in law	This subcategory includes: - research and experimental development services in public law, civil law, etc.	
72.20.19	Research and experimental development services in other social sciences	This subcategory includes: - research and experimental development services in social and cultural anthropology, demography, geography (human, economic and social), political sciences, sociology etc.	
72.20.2	Research and experimental development services in humanities		
72.20.21	Research and experimental development services in languages and literature	This subcategory includes: - research and experimental development services in ancient and modern languages and literature	
72.20.29	Other research and experimental development services in humanities	This subcategory includes: - research and experimental development services in history, philosophy, arts, religion, theology etc.	
72.20.3	Research and development originals in social sciences and humanities		
72.20.30	Research and development originals in social sciences and humanities	This subcategory includes: - scientific originals in social sciences and humanities, i.e. ideas, plans, blueprints, formulas for inventions, products and processes, which can be protected and licensed as industrial property, trade secrets, patents etc. The creation of these original works is done on own account, i.e. their production is intended for sale that is undertaken without either a contract or known buyer in mind.	