Price and Volume Measurement for R&D in German National Accounts

by Liane Ritter, Federal Statistical Office (FSO) Germany

Annex

An extended input method for deflating the compensation of employees

by Peter Kuntze, Federal Statistical Office (FSO) Germany, 2011

1 Introduction

For scientific research and development services (R&D) price measurement is difficult, because these services are unique by nature. According to the European System of Accounts (ESA) 2010 an input method can be used for price and volume measurement of R&D. This means, that deflators of inputs for R&D are calculated and weighted to derive deflators for output of R&D.

2009 the German Federal Statistical Office began research work in the area of price and volume measurement for R&D in German national accounts. At that time a first version of an input method was developed for the industry 73 (NACE Rev. 1.1) 'Scientific research and development' and the basic principles for deflating intermediate consumption were determined already. With the introduction of ESA 2010 that method will have to be extended and modified. The relatively simple input method for deflating the compensation of employees used 2009 was improved by Kuntze 2011.[1] With the introduction of ESA 2010 this improved method will be integrated in the input method used in German national accounts.

2 Methodical backgrounds

ESA 2010 provides some general rules for price and volume measures in national accounts.[2] Details are defined in the Eurostat "Handbook on Price and Volume Measures in National Accounts".[3] The handbook on price and volume measures recommends the following methods for market output, for output for own final use and for non-market output:

> "For marketed output, charge-out rates, or hourly fees should be collected as much as possible … Deflating these by a general measure of inflation, in combination with an index of average wage rates will give a measure in volume terms. The rationale for using a combined inflation and wage rates deflator is that many services use a high proportion of labour and purchased goods and services in the production process, so both affect the output price. …

[1] This method is described in detail in the annex of this paper.
[2] European Union (2013), chapter 10.
[3] Eurostat (2013)

> For in-house production, wage rates and price movements of the goods and services purchased can be collected, and weighted to give a price movement of inputs. This can be used as a proxy for the implied price of the in-house production.
>
> For non-market output, by government or non-profit bodies, the usual methods for producing volume growth estimates of collective services … are to be used."[4]

The unique nature of R&D makes it difficult to collect data for price indices at all. For Germany no data about charge-out rates or hourly fees have been collected yet. Therefore input methods have to be used for all kinds of R&D in Germany. This is in line with the recommendations in the Eurostat handbook on price and volume, because "in situations where price measurement does not seem possible or feasible, input methods can be considered. This may be the case especially for services such as R&D and other special unique products."[5]

German price statistics dealt with price measurement for marketed R&D as well. von Borstel described the difficulties to be faced with.[6] She suggested that contract prices and time based methods can potentially be applied to conduct a producer price index (PPI) for R&D. Time based methods like hourly rate may be appropriate only for R&D on social sciences and humanities in Germany because labor costs are predominant. R&D on natural sciences and engineering are expected to be sold in detailed and very specific contracts. Keeping services constant over time might create problems, if contract price methods are used.[7] von Borstel came to the conclusion:

> "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."[8]

3 The German input method for nonfinancial and financial corporations

In German national accounts output of R&D is calculated for the following sectors:

- Nonfinancial corporations
- Financial corporations
- General government
- Non-profit institutions serving households

About ¾ of the total R&D output is produced in nonfinancial corporations. The R&D output of financial corporations is really unimportant (less than 1%). About 20% of the total R&D output is

[4] Eurostat (2013), p. 148-149.
[5] Eurostat (2013), p. 43.
[6] von Borstel (2010).
[7] von Borstel (2010), p. 6.
[8] von Borstel (2010), p. 7.

produced by the general government and about 4% by the private non-profit institutions serving households.[9]

R&D is produced in nearly every industry in Germany. Much more than half of total R&D output is produced in enterprises belonging to manufacturing. Business enterprises, government and private non-profit institutions serving households belonging to the industry 72 (NACE rev.2) 'Scientific research and development' contribute more than 10% to the whole German R&D output. R&D output of mainly public universities belonging to the industry 85 (NACE Rev.2) 'Education' is important as well.[10]

Table 1 shows the composition of R&D output for nonfinancial and financial corporations by industries.

Table 1: Composition of German R&D output for nonfinancial and financial corporations by industries 2009 [1)]

Industry (NACE Rev.2)	Share of total R&D output
Manufacturing	79.8%
of which: 20 Manufacture of chemical products	6.5%
21 Manufacture of pharmaceutical products	8.4%
26 Manufacture of computer, electronic and optical products	11.9%
28 Manufacturing of machinery and equipment	8.9%
29 Manufacturing of motor vehicles, trailers and semi-trailers	28.9%
Services	19.4%
Other industries	0.8%
Total	100%

1) Federal Statistical Office Germany, Wiesbaden 2014.

Due to this heterogeneity it is not possible to construct only one deflator for R&D. Therefore specific deflators have to be calculated for different sectors and different industries. For the sector 'General government' and the sector 'Non-profit institutions serving households' input-methods have been used already and therefore no new methods have to be developed. The new input method described below will be used for price and volume measures of the sectors 'Nonfinancial and financial corporations' after the introduction of ESA 2010.

[9] Oltmanns (2013).
[10] Oltmanns (2008), p 11.

In German national accounts R&D output of nonfinancial and financial corporations is calculated for industries in the following way[11] based on data of the *Stifterverband*[12]:

Intramural expenditures on R&D
- Capital expenditure on R&D
= Current expenditures for R&D
  of which: Personal expenditures
  Non-personal current expenditures
+ Other taxes on production
- Other subsidies on production
+ Consumption of fixed capital
+ Operating surplus, net
= R&D output including R&D for software
- R&D for software
= R&D output without purchase of R&D for intermediate consumption in the industry A72 (main production R&D)
+ Purchase of R&D from non-financial and financial corporations for intermediate consumption in the industry 72 (NACE Rev. 2)
= R&D output

This procedure shows that the input method is used for the compilation of R&D output. Detailed data for the different kinds of input is provided and it can be regarded as an excellent database for the price and volume measurement of R&D output. Except for industry 72 'Scientific research and development' (NACE Rev. 2) non-personal current expenditures coincide with intermediate consumption. In a first step output of R&D including R&D for software can be split into intermediate consumption and gross value added for every industry. For R&D output of nonfinancial and financial corporations as whole the relation between intermediate consumption and output – the intermediate consumption ratio - is about 35% in the year 2009. This ratio differs much between industries. In most industries it is lower for R&D output than for total output. Table 2 shows that in manufacturing industries with important R&D output the intermediate consumption ratio of R&D output fall much below the intermediate consumption ratio of total output.

[11] Oltmanns (2008), p.10 – 13 and Oltmanns (2013).

[12] The Stifterverband für die Deutsche Wissenschaft („Association of funders for the German science") is a private non-profit institution. Yearly reports about its R&D survey are published by the Wissenschaftsstatistik GmbH.

Table 2: Intermediate consumption ratios 2009 in %

Industry (NACE Rev.2)	Intermediate consumption ratio of	
	F&E output[1)]	total output[2)]
20 Manufacture of chemical products	38.1	69.0
21 Manufacture of pharmaceutical products	47.1	54.4
26 Manufacture of computer, electronic and optical products	29.9	63.6
28 Manufacturing of machinery and equipment	29.1	63.8
29 Manufacturing of motor vehicles, trailers and semi-trailers	39.2	80.1

1) Source: Wissenschaftsstatistik GmbH (2011) and own computation.
2) Source: Federal Statistical Office (2013).

The calculation of R&D output for Germany provides data for the different kinds of primary input. Nevertheless it is not possible to include other taxes on production, other subsidies on production and net operating surplus in the input structure used for volume measures of R&D in Germany for lack of data about the price development. Therefore the calculation of deflators for gross value added includes only compensation of employees and consumption of fixed capital. Compensation of employees is the predominant primary input. For total German R&D output of nonfinancial and financial corporations the relation between compensation of employees and consumption of fixed capital was about 9:1 in the year 2009.

The input method for intermediate consumption is described in chapter 4. The input method for compensation of employees is described in the annex of this paper. The Perpetual Inventory Method (PIM) is applied to calculate consumption of fixed capital in current prices and in prices of the previous year for assets used in the production process for R&D.[13] For R&D the composition of capital formation by kinds of assets is derived from the specific composition of the total capital formation by kinds of assets for each industry.

4 Intermediate consumption

In German national accounts price and volume measurement for intermediate consumption of nonfinancial and financial corporations is based on use tables. Yearly deflators for total intermediate consumption are calculated in a breakdown by industries and product groups. These deflators can be used for deflating intermediate consumption for R&D output as well.

[13] For a general description of this method see: Schmalwasser et al. (2006).

$$DefIC_{j\,R\&D} = \sum_{i=1}^{88} pIC_{ji}\ \beta_{ji\,R\&D} \qquad (1)$$

For every industry *j* the deflator of intermediate consumption for R&D output ($DefIC_{j\,R\&D}$) is a weighted average of the deflators for intermediate consumption of the different product groups *i* (pIC_{ji}).The weight for product group *i* ($\beta_{ji\,R\&D}$) is the share of product group *i* in the total intermediate consumption for R&D output of the industry *j*.

The German use tables distinguish between 64 industries and 88 product groups.[14] For the industry 72 'Scientific research and development' (NACE Rev. 2) the input structure of total intermediate consumption - subdivided by product groups - is representative for the input structure of intermediate consumption for R&D output. Only for this industry the input structure can be taken from the published use tables without any modification. For all other industries the input structure of R&D output may differ from the input structure of total output. But no statistical information about the special input structure of intermediate consumption for R&D output is available. Therefore estimates are necessary. They are based on the following principles developed 2009:

- The structure of intermediate consumption for R&D output can be derived from the structure of total intermediate consumption of the industry which generates the R&D output.

- The structure of intermediate consumption of the whole industry cannot be applied to R&D output without modifying it. In doing so data about the cost structure of the industry 72 'Scientific research and development' (NACE Rev. 2) can serve as reference figures.

Statistical surveys in the R&D industry provide data about the expenditure structure of enterprises with a turnover of 250 000 Euro and more. Data about expenditure on staff and expenditure of material is collected. Table 3 shows that raw material and supplies is much more important in R&D on natural sciences and engineering than in R&D on social sciences and humanities.

[14] See for example Federal Statistical Office (2014).

Table 3: Structure of the material costs of the industry 72 (NACE rev.2) in % 2010 [1)]

Industry (NACE Rev.2)	Total	Raw material and supplies	Other operational expenditure and purchased services not for resale	Goods and services for resale
72.1 R&D on natural sciences and engineering	100	23.4	63.3	13.4
72.2 R&D on social sciences and humanities	100	6.6	81.7	11.7

1) Source: Federal Statistical Office (2012)

Goods for resale are not included in intermediate consumption. In addition the assumption is made that services for resale are not purchased in connection with R&D output in other industries than 72 (NACE Rev. 2). Now an average share of raw material and supplies in intermediate consumption of the other industries can be derived from the statistical surveys in the R&D industry. 2010 it amounts to 27% for R&D on natural sciences and engineering and to 8% for R&D on social sciences and humanities. A precise mapping between the product groups in the use tables and the different kinds of material costs of the R&D industry is not possible. Predominantly raw material and supply include the products of agriculture, forestry and fishing, mining and quarrying as well as manufactured products (CPA 01 – CPA 32). According to the supply table 2010 the product groups CPA 01 – CPA 32 contribute much more than 27% to total intermediate consumption of all industries with important R&D output. Table 4 shows that for manufacturing industries with important output of R&D the inputs of the product groups CPA 01 – CPA 32 have to be reduced considerably in order to gain an appropriate input structure for R&D.

Table 4: Share of CPA 01 – CPA 32 in total intermediate consumption 2010 in %[1)]

Industry (NACE Rev.2)	Share of CPA 01 – CPA 32
20 Manufacture of chemical products	64.6
21 Manufacture of pharmaceutical products	52.3
26 Manufacture of computer, electronic and optical products	65.0
28 Manufacturing of machinery and equipment	75.3
29 Manufacturing of motor vehicles, trailers and semi-trailers	80.1

1) Source: Federal Statistical Office (2014).

Even if the structure of total intermediate consumption published in the use table is a good starting point, it cannot be used for R&D output without modification. The estimation of an appropriate input

structure for intermediate consumption is very important for the quality of the deflators. Usually the price development is different for different product groups. Especially the prices of some kinds of raw materials and supplies fluctuate much from year to year.

Due to the fact that the calculation of the deflators for R&D has not been finished yet, the impact of modified input structures on the results cannot be illustrated here.

5 Deflator for R&D output

For every industry *j* the deflator for R&D output ($Def_{j\,R\&D}$) is the weighted sum of the deflator of gross value added ($DefGVA_{j\,R\&D}$) and the deflator of intermediate consumption ($DefIC_{j\,R\&D}$).

$$Def_{j\,R\&D} = \delta \; DefGVA_{j\,R\&D} + (1-\delta) \; DefIC_{j\,R\&D} \qquad (2)$$

The deflator of gross value added ($DefGVA_{j\,R\&D}$) is the weighted sum of the deflator of compensation of employees ($DefL_{j\,R\&D}$) and the deflator of consumption of fixed capital ($DefC_{j\,R\&D}$).

$$DefGVA_{j\,R\&D} = \alpha \; DefL_{j\,R\&D} + (1-\alpha) \; DefC_{j\,R\&D} \qquad (3)$$

The deflators for R&D output are used to calculate output and gross fixed capital formation of R&D in prices of previous year. No results can be presented here, since the revision work is still in progress.

6 Conclusions

From the national accounts point of view input methods are acceptable methods for price and volume measurement of R&D output in Germany. Producer price indices (PPIs) for R&D could be conducted only for market production, which covers just a small part of total R&D output (2009: 15%)[15]. For this purpose difficult and expensive surveys required for PPIs may not be legitimated. R&D output for own final use is predominant in Germany (2009: 62%)[16]. In principle the input method presented in this paper provides satisfying estimates for "wage rates and price movements of the goods and services purchased"[17] for in-house production of R&D. Nevertheless more information about the specific input structure of intermediate consumption for R&D output is desirable.

[15] Oltmanns (2013).
[16] Oltmanns (2013).
[17] Eurostat (2013), p. 149.

Annex: An extended input method for deflating the compensation of employees

by Peter Kuntze, Federal Statistical Office (FSO) Germany, 2011

1 Complementing the input method presented in a previous study

In the absence of a solid output-method to deflate the output of the industry 72 (NACE Rev. 2) as well as the output of other industries comprising research and development (R&D), input-methods seem to be the alternative to be preferred.

Considerable conceptual contributions to further developing the input method which is presently used were delivered by a previous study 2009, which focused on deflating the intermediate consumption. The next important expense factor in R&D is 'compensation of employees'. In the following, a method to deflate the compensation of employees shall be described; this method allows for taking into account different aspects (similar to the method developed for deflating the intermediate consumption) and is in line with the recommendations of the Frascati Manual. The Frascati Manual recommends for the compensation of employees a break down by qualification levels of the staff, as far as necessary information is available.

The input method presented in this paper delivers price indices for the compensation of employees by industries. These price indices are determined by the development of the gross hourly earnings, which are weighted with their share in the total earnings in a break down by levels of qualifications of the R&D staff. Finally, in each industry, the price development of R&D services will be indicated by the weighted arithmetic average of its index for the intermediate consumption and its index for the compensation of employees. The weighting scheme is given by the respective shares of the intermediate consumption and of the compensation of employees in their sum total.

2 Required and available data, basic assumptions

In order to calculate the price index presented above, following information is needed:

- Staff categories defined by levels of qualification
- Distribution of R&D staff to the staff categories
- Average gross hourly earnings of the staff in each of the staff categories

The first and the second information requirement should pose no problems. The Frascati Manual[18] defines three categories of activities by their level of qualification: researchers, technicians and equivalent staff as well as other supporting staff. Information on distribution of R&D staff to these

[18] OECD (2002), p. 221.

categories is included in the Data Report[19] of the *Stifterverband*[20]. The demands of the third information requirement cannot be met. Average gross hourly earnings of the staff in each of the staff categories can only be calculated indirectly.

Starting point are the results of the quarterly survey of earnings[21]: it comprises on a deep disaggregated level average gross hourly earnings of fulltime employees in the manufacturing industries and in services industries. All establishments with more than ten employees are covered, in some areas the threshold was even set at 5 employees. In each industry, the earnings are presented separately by five so called "performance groups" (PG), which allow to classify employees' activities by levels of qualifications. However, these performance groups do not exactly match the staff categories defined in the Frascati Manual. It has to be noted, that the quarterly survey on earnings covers earnings of the whole staff working in the respective industry. Hence, these data may be used for our purpose here only if we assume that the earnings' evolution for the R&D staff is connected to the general earnings' evolution. Otherwise, the use of the earnings' evolution for specific R&D staff profiles would have to be considered cross over all industries.

Therefore, assuming that the earnings' evolution in a specific R&D staff category would not deviate significantly from the general earnings' evolution for staff classified in the same level of qualification of the respective industry, the quarterly survey on earnings can be used. For this, the gross hourly earnings by the five performance groups have to be reallocated to the three staff categories defined in the Frascati Manual. A quantitative allocation formula has to be generated between the performance groups of the quarterly survey of earnings and the staff categories of the Frascati Manual. Therefore the definitions of the Frascati Manual have to be compared with the definitions used in the quarterly survey of earnings. These definitions are:

a) Frascati Manual (staff categories)[22]
    a. **"Researchers** are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned."
    b. **"Technicians and equivalent staff** are persons whose main tasks require technical knowledge and experience in one or more fields of engineering, physical and life sciences or social sciences and humanities. They participate in R&D by performing scientific and technical tasks involving the application of concepts and operational methods, normally under the supervision of researchers. Equivalent staff performs

[19] Wissenschaftsstatistik GmbH (2009).
[20] The Stifterverband für die Deutsche Wissenschaft („Association of funders for the German science") is a private non-profit institution.
[21] Federal Statistical Office (2009).
[22] OECD (2002), p. 93-94.

the corresponding R&D tasks under the supervision of researchers in the social sciences and humanities."

c. **"Other supporting staff** includes skilled and unskilled craftsmen, secretarial and clerical staff participating in R&D projects or directly associated with such projects."

b) Quarterly earnings survey (performance groups of employees with a similar job qualification profile)[23]

a. **Performance group 1 „ Managing directors "(PG 1):**
Employees with supervision and disposition authority; e.g. salaried managing directors, if their earnings contain partly success independent payments. All employees in bigger leadership areas with disposition and executive duties and employees who need business or technical expertise. Normally the expertise is obtained upon a higher education.

b. **Performance group 2 "Senior skilled workers" (PG 2):**
Employees with very difficult till complex or multifarious activities, for which normally a completed vocational education is not sufficient, but furthermore several years of professional experience and special expertise are required. The activities are carried out predominantly independently. Employees with disposition and executive duties for little responsibility areas are included as well (e.g. foremen/forewomen and masters).

c. **Performance group 3 "Specialised personnel, specialists, skilled staff" (PG 3):**
Employees with difficult specialized activities, for which normally a completed vocational education is required and which is partly connected with professional experience.

d. **Performance group 4 "Semi-skilled workers" (PG 4):**
Employees with predominantly simple activities, for which no vocational education is necessary, but particularly special knowledge and skills are required, which are dependent on the tasks of the industry. Normally the required knowledge and skills can be obtained by a training period up to two years.

e. **Performance group 5 "Unskilled workers" (PG 5):**
Employees with simple, schematic activities or isolated work processes, for which no vocational education is required. The required knowledge and skills can be obtained by a training up to three months.

[23] Federal Statistical Office (2010), p. 14.

3 Compilation method

The staff category 'Researchers' matches rather well with the definition of the performance group 1(PG1). The main criterion is "higher education", which is "normally assumed" for staff in this category. Because of this weak formulation ("normally assumed"), it seems to be advisable to calculate the earnings' evolution of researchers only by 75% from the PG1 and by 25 % from PG2.

The staff category 'Technicians and equivalent staff' matches best the definition of PG3. The PG4 does not fit, because the requirements for technical staff would surpass activities described as "preliminary simple". Because of this, it is assumed that the earnings' evolution for technicians and equivalent staff is generated to 75% from the PG3 and to 25 % from PG2.

The category 'Other supporting staff' is described by the Frascati Manual as very heterogeneous in terms of qualification and earnings. It can be assumed that this group lies below the group 'Technicians and equivalent staff'. The wording "skilled and unskilled craftsmen" seems to refer to PG 3, PG 4 and PG 5. In the absence of any information on the distribution to the performance groups – which would be anyway very different by industries – it is assumed that the earnings' evolution for the group 'Other supporting staff ' can be estimated by the following scheme : PG 3 (40%), PG 4 (40%) and PG5 (20%).

The allocation keys determining the composition of the earnings by staff categories on the basis of information on earnings by performance groups is presented in the following table:

Bridge from staff categories (survey of the *Stifterverband*)
to performance groups (quarterly survey of earnings)

Staff categories	Performance groups				
	PG1	PG2	PG3	PG4	PG5
Researchers	75%	25%			
Technicians and equivalent staff		25%	75%		
Other supporting staff			40%	40%	20%

On the basis of the assigned keys, for each industry and in each reporting year, different hypothetical gross hourly earnings are calculated for each staff category. In the algorithm for the index compilation, these results can be interpreted as price components.[24]

For the weights in compilation of the price index, two pieces of information are needed: the respective shares of the staff categories in the total R&D staff and the wage relation in each staff category. The former are published for industries in the Data Report of the *Stifterverband*. The wage relations are the relations of the hypothetical gross hourly earnings between the different staff categories, which are calculated on the basis of the allocation keys described above. Using these data it is possible to calculate the shares of the staff categories in the total earnings of R&D staff. They can be used as weights in the compilation of the price index.

On the basis of these price components and weights, the index of the compensation of employees is calculated for each industry as a Paasche price chain index:

$$P_{0,t}^{P} = \prod_{s=1}^{t} \left[\sum_{i=W,T,S} \left(\frac{p_s^i}{p_{s-1}^i} \right)^{-1} s_s^i \right]^{-1} \qquad (1)$$

P^W, P^T and P^S describe the gross hourly earnings of the staff categories in the reporting year or in the previous year. s^W, s^T and s^S describe the shares of the staff categories in the total earnings of R&D staff in the reporting year.

The required data is available from the year 2007 onwards by industries. Therefore deflators can be calculated as of the year 2008 only. The price index represents the earnings' evolution of the R&D staff in the industry in question. The following example shows the calculation for the industry 72 'Research and development' (NACE Rev. 2).

The described method can be used for almost all industries. There is only one exception: the survey of earnings does not provide data for the industry A 'Agriculture, hunting, forestry and fishing' (NACE Rev. 2).

[24] At least theoretically changes of the staff structure of the performance groups could have influence on the amount of the average gross hourly earnings, as well. Therefore the change of the average gross hourly earnings need not show exclusively changes of prices.

Example: Deflating compensation of employees for R&D staff of the industry 72 (NACE Rev.2)

Database:

a) Allocation keys

Staff category	Performance group				
	PG 1	PG 2	PG 3	PG 4	PG 5
Researchers	75%	25%			
Technicians and equivalent staff		25%	75%		
Other supporting staff			40%	40%	20%

b) Gross hourly earnings of the performance groups, industry 72 (NACE Rev.2) in Euro

Performance group	2007	2008	2009
PG 1	29.48	30.69	31.08
PG 2	23.10	24.09	24.20
PG 3	16.82	17.40	17.66
PG 4	14.47	13.94	15.41
PG 5	11.51	11.62	12.47

c) Share of the staff categories in the total R&D staff of the industry 72 (NACE Rev.2)

Staff category	2007	2008	2009
Researchers	64%	64%	64%
Technicians and equivalent staff	19%	19%	19%
Other supporting staff	17%	17%	17%

Explanatory note: Shares calculated for the year 2007 are used for the following years as well, because more recent data is not available yet. This simplification is acceptable because the shares seem to be rather constant over time.

Compilation procedure:

Step 1: The hypothetical gross hourly earnings of the different staff categories are calculated by multiplying the shares of the performance groups in each line of database a) with the gross hourly earnings of the respective performance group (PG) of database b) and by aggregating the results of all performance groups afterwards.

d) Hypothetical gross hourly earnings by staff categories in Euro

Staff category	2007	2008	2009
Researchers	27.89	29.04	29.36
Technicians and equivalent staff	18.39	19.07	19.30
Other supporting staff	14.82	14.86	15.72

Step 2: One gets the wage relation by standardization of the gross hour earnings on the value of the staff category 'Researchers'.

e) Wage relation (Researchers = 1)

Staff category	2007	2008	2009
Researchers	1.000	1.000	1.000
Technicians and equivalent staff	0.659	0.657	0.657
Other supporting staff	0.531	0.512	0.535

Step 3: The shares of the staff categories are calculated as follows: At first the shares of the three staff categories in the total R&D staff from c) are multiplied by the accompanying wage relations from e). Then the sum of the shares is standardized on 1. That means that the calculated value of every staff category is divided by the sum total of the calculated values of the three staff categories.

f) Shares of the staff categories in the total earnings of R&D staff (total earnings = 1)

Staff category	2007	2008	2009
Researchers	0.748	0.751	0.748
Technicians and equivalent staff	0.146	0.147	0.146
Other supporting staff	0.106	0.102	0.106

Step 4: The Paasche price chain index is calculated by putting the values from d) and f) into equation (1) above.

g) Deflator for compensation of employees of R&D staff
Paasche price chain index (2007=100)

Industry (NACE Rev.2)	2007	2008	2009
72 Research and development	100	103.7	105.3

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