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**A Preliminary R&D Satellite Account for Germany**

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(The views expressed in this paper are those of the authors. They do not necessarily reflect the views of the German Federal Statistical Office. The data presented here are preliminary and should be interpreted as illustrative.)

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## **Abstract**

In this paper the outline of an R&D satellite account for Germany is presented. According to the discussion about the revision of the 1993 SNA, R&D activities are treated as capital formation in this satellite account. Both by conceptual discussion and preliminary calculations it is shown,

- how available R&D data are transformed into the concepts of national accounts,
- how R&D output, value added and capital formation are calculated, and
- what is the impact of the capitalisation of R&D on national accounts' aggregates.

Following the opportunities of satellite systems to deviate from the core system, different methods to calculate R&D capital formation presented and discussed.

Particularly with regard to software, the relevance of the experience with the compiling of the R&D for other intangibles is discussed.

Keywords: National Accounts, R&D, Investment, Germany

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# 1 Introduction

In February 2008 the Statistical Commission of the United States has passed Volume 1 of the revised 1993 SNA. One of the issues of the revision process concerned the treatment of research and development (R&D). In contrast to the 1993 SNA expenditure on R&D are now recognised as creating intangible fixed assets. To consider the reservations of some countries concerning the implementation of the new concept of capitalising R&D another decision was made: The countries were requested to test the concept of R&D capital within the framework of R&D satellite accounts.

Some countries have pioneered the work on R&D satellite accounts long before the revision of the 1993 SNA. Other countries began in response to the request of the Statistical Commission to develop R&D satellite accounts. In this paper the first results for a R&D satellite account for Germany are presented. Hereunto, the paper is organised as follows:

To go beyond reporting on the development of an R&D satellite account, in section 2 the presentation is embedded into the general framework of intangible fixed assets. First of all, the *symmetric principle* for the treatment of capital from Corrado, Hulten and Sichel is introduced in brief. Then the treatment of intangible fixed assets in the revised 1993 SNA is presented with the focus set on R&D. The section ends with a conceptual discussion of the R&D asset boundary. The subject of section 3 is the German R&D satellite account itself. The steps to calculate such a satellite account for Germany are explained, especially

- the underlying data sources,
- the steps from R&D expenditures to R&D output and
- the calculation of R&D gross fixed capital formation.

Considerations about the impact of capitalisation R&D on the national accounts' aggregates and a valuation of the results end this section. In section 4 two issues are discussed. At first, based on the experience with the development of the German R&D satellite account the relationship between R&D and computer software is discussed. Then, the scope is extended according to the *symmetry principle* of Corrado, Hulten and Sichel. The paper ends with some general conclusions.

This paper deals with two different conceptual frameworks on statistics: on one hand the national accounts and on the other hand the statistics on R&D. Whereas the national accounts' concept refer to the (revised) 1993 SNA, the Frascati-Manual of the OECD provides guidelines to compile statistics on R&D.<sup>1</sup> All statements in this paper concerning the concepts and definitions of R&D statistics concern to the Frascati-Manual.

## 2 R&D within the framework of intangible fixed assets

### 2.1 The *symmetry principle* for capital

In several papers Corrado, Hulten and Sichel propose a *symmetry principle* for the treatment of tangible and intangible capital.<sup>2</sup> They argue that “*any* use of resources that reduces current consumption in order to increase it in the future qualifies as an investment.” The *symmetry principle* would require that most business expenditures aimed at enhancing the value of a firm and improving its products are treated as an investment. Following their approach capital would not only comprise tangibles but also intangibles like

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<sup>1</sup> OECD (2002)

<sup>2</sup> For instance, see Corrado, Carol, Charles Hulten and Daniel Sichel (2005a and 2005b).

- Computer software
- Computerised databases
- Research and development
- Mineral exploration
- Copyright and licence costs
- Brand equity
- Firm-specific human capital
- Improved organisational structures

Their proposal comes along with estimates on the amount of intangible capital in the United States. For the period from 1998 to 2000 they estimate business expenditures on intangibles of about US-Dollar 1.2 trillion annually, more than 13 percent of GDP.

Corrado, Hulten and Sichel regard their estimates as illustrative, not definitive. But the estimates suggest that the economic importance of intangible fixed assets is not (fully) reflected by the national accounts.

## **2.2 R&D as a new intangible in the SNA**

In addition to tangible fixed assets like buildings, machinery and transport equipment the 1993 SNA comprises some intangible fixed assets:

- Computer software
- Mineral exploration
- Entertainment, literary or artistic originals
- Other intangible fixed assets

When the 1993 SNA was written, it was also discussed to include R&D as an intangible fixed asset. But as a result of the discussions on intangibles, it was decided not to treat R&D as an asset. During the revision process of the 1993 SNA this decision was changed. Volume 2 of the revised 1993 SNA will be presumably adopted by the Statistical Commission of the United Nations in February 2009. Even if it is not yet completed, there is agreement that the intangible fixed assets are supplemented by R&D. In detail it has been agreed that

- R&D should be treated as gross fixed capital formation in the SNA.
- The R&D definition of the Frascati-Manual is adopted: Research and [experimental] development consists of the value of expenditures on creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and use of this stock of knowledge to devise new applications.
- This definition should not be interpreted as including human capital as an asset within the SNA.
- The value of R&D should be determined in terms of the economic benefits it is expected to provide in the future. This includes the provision of public services in the case of R&D acquired by government. In principle, R&D that does not provide an economic benefit to its owner does not constitute a fixed asset and should be treated as intermediate consumption. Unless the market value of the R&D is observed directly, it may, by convention be valued at the sum of costs, including the cost of unsuccessful R&D.

- With the inclusion of R&D expenditure as capital formation, patented entities no longer feature as assets in the System. The patent agreement is to be seen instead as the legal agreement concerning the terms on which access to the R&D is granted.<sup>1</sup>

Several countries had reservations how to implement R&D as GFCF in their national accounts. Therefore, the Statistical Commission of the United Nations decided in February 2007:

- In principle, research and development expenditure should be recognized as part of capital formation. However, there are a number of difficulties to be overcome before the objective can be reached. Satellite accounts will provide a useful way of working towards solutions that give the appropriate level of confidence in the resulting measures and practical guidance on implementation will help to ensure international comparability.<sup>2</sup>

As a result many countries began to develop satellite accounts for R&D. In section 3 the experiences with the German satellite account are described. Before, an important conceptual issue concerning the capitalisation of R&D is discussed.

### 2.3 R&D as an intangible fixed asset

If a new kind of intangible fixed assets is introduced it should be clarified that it fits for the concepts of the national accounts. Therefore, two questions should be answered: Is R&D an intangible fixed asset? And, if yes, should all R&D be treated as GFCF or is there some R&D that furthermore should be regarded as intermediate consumption?<sup>3</sup>

In the revised 1993 SNA an asset is defined as “a store of value representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time. It is a means of transferring value from one accounting period to another.” Additionally, it is stressed that only economic assets are recognised as assets in the SNA. Assets that are not economic in nature and which can be described with attributes like reputation or skill are explicitly excluded from the asset boundary.<sup>4</sup> To constitute *fixed* assets, they have to be the output of production processes that fall within the production boundary of the SNA and they have to be used repeatedly or continuously in production processes for more than one year.<sup>5</sup> Summing up a (intangible) fixed asset has to satisfy four requirements:

- (Legal or economic) ownership can be assigned
- (Economic) benefits are intended
- Use in production processes for more than one year
- Output of a production process.

The latter item can be dropped, as R&D is an economic activity by definition. Applying the other three requirements to R&D it is obvious that there are many R&D activities that should be treated as fixed assets.<sup>6</sup> But to find an answer to the second question is not straightforward. To illustrate this, some selected issues concerning the capitalisation of R&D are discussed below.

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<sup>1</sup> See United Nations (2008b), para. 10.104/10.105 and Aspden, Charles (2007), p. 4.

<sup>2</sup> See United Nations (2006), para. 30.

<sup>3</sup> In the following only some selected issues are reconsidered. At present, the OECD task force on Intellectual Property Rights is discussing the R&D asset boundary to a broader extent.

<sup>4</sup> See United Nations (2008a), para 3.30 and 3.31

<sup>5</sup> See United Nations (2008a), para 10.9 to 10.11.

<sup>6</sup> Strictly spoken, it is not necessary to discuss this question as the SNA 2008 recognises intellectual property products (including R&D) explicitly as fixed assets. See United Nations (2008a), para 10.9 to 10.11.

If market producers conduct R&D or purchase R&D results, it can be generally assumed that this R&D should be treated as GFCF. They use R&D on results in the production process and they intend to gain economic benefits. Ownership can often be assigned by patenting. But some possible exceptions should be discussed here:

- Basic research conducted by market producers
- Unsuccessful R&D.
- R&D conducted due to *strategic* reasons

By definition, basic research does not lead to new production processes or the development of new products. So, there is no direct link to production. The results of basic research cannot be patented. This suggests excluding basic research from GFCF, even if conducted by market producers. On the other hand, today the distinction between basic research, applied research and experimental development is not as clear as it was, when the Frascati-Manual introduced this distinction in 1963. Even if not in general, results of basic research can definitely lead to economic benefits.<sup>1</sup> Additionally, market producers can try to enforce ownership by contracts that oblige R&D personal to confidentiality. Therefore, R&D of market producers should be treated as GFCF rather than as intermediate consumption.

It is part of the nature of R&D that the results to be gained in the future are uncertain. This leads to the question how to treat unsuccessful R&D.<sup>2</sup> It could be argued that unsuccessful R&D should be excluded from GFCF. It is not used in production processes and benefits cannot be gained. But the picture of an R&D project that is conducted over years and then is terminated with a complete failure may not reflect the reality of modern (industrial) research. Often R&D coincides with the use of the results in production processes. During the R&D project there is an incremental change both in R&D as well as in production processes. In this case R&D fulfils the requirements of a fixed asset and it should be included in GFCF. And then, the termination of an R&D project should be reflected by its service life.

The point of departure for *strategic* R&D is given by the following: R&D results are produced and economic benefits are expected for the future. To internalise the benefits, the producer has protected the R&D results by a patent. However, the patent is not only yielding the right to use R&D results. It is also a source of information for other producers. Without infringing the patent these producers will try to benefit from the R&D which is documented by the patent. Anticipating these benefits the owner is conducting *strategic* R&D. The only purpose of this R&D is to generate patents that prevent others from benefits, but not to generate own benefits.

How to treat this case? The R&D owner does not use the R&D to generate direct economic benefits. But the R&D owner is avoiding economic benefits of his competitors, and this improves his relative economic position what can be interpreted as an indirect economic benefit. If the criterion is “direct economic benefits”, “strategic” R&D should not be recorded as GFCF, but if it is “economic benefits, either direct or indirect, it should be recorded as GFCF. As the SNA does not distinguish direct and indirect benefits the requirement of benefits is not straightforward to apply. The requirement of ownership is fulfilled, but the R&D is not used in production processes. Therefore, *strategic* R&D should not be treated as GFCF.

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<sup>1</sup> Meanwhile, the Frascati-Manual has recognised this fact by introducing the distinction between pure basic research and oriented basic research.

<sup>2</sup> Here the focus is set on R&D projects that fail as a whole. In the case of conducting experimental series, the failure of tests is an integral part of successful R&D.

Another issue concerns non-market producers, conducting R&D in the field of humanities. The R&D results in economics, sociology, history etc. cannot be protected by a patent. But when the results are published in a scientific journal, the author respectively the producer of the R&D has the right to claim the origin or copyright on this publication. Everybody can use this R&D for the production of further R&D and is only obliged to cite the source. The requirement of ownership is satisfied, but it is ownership of the copyright, not the R&D. Likewise, the producer can generate economic benefits from the copyright, not from R&D. Therefore, this kind of R&D that has to be published to claim ownership and constitutes a copyright should not be treated as GFCF.

### 3 The development of the German R&D satellite account

#### 3.1 The data sources

The R&D satellite account for Germany is based on several data sources. The data are collected according to the definitions of the Frascati-Manual and the different surveys refer to the (domestic) sectors defined by this manual:

- Business enterprises
- Government
- Private non-profit institutions
- Higher education

For the business sector data are taken from two sources: the survey of the *Stifterverband für die Deutsche Wissenschaft* and the cost structure survey for the manufacturing industry of the Federal Statistical Office.<sup>1</sup>

The survey of the *Stifterverband* provides data for the business sector, including enterprises and cooperative research institutes serving these enterprises. But these survey data cannot be used in a direct manner, because they have some shortcomings:

- The statistical units are not classified according to national accounts standards.
- The survey is not based on the official business register.

In the national accounts statistical units are classified according to their main economic activity. Hence, research institutes should be classified into the branch “73 Research and Development” (ISIC, Rev. 3.1). In the R&D survey research institutes are only part of this branch if they conduct R&D for more than one branch. If they conduct R&D for one single branch, they are assigned to this branch. Therefore, the *Stifterverband* carried out a special evaluation of the survey data, reclassified the research institutes to the R&D branch and provided these data according to the two-digit level of the ISIC.<sup>2</sup>

The business register of the Federal Statistical Office contains information about nearly 3.5 million enterprises. This register is used as a sampling frame for official surveys in Germany, but it is not used for the R&D survey of the *Stifterverband*. For reasons of secrecy there is no access to the register for users from outside the official statistics. Therefore, the *Stifterverband* uses a business register, which is compiled by a private supplier. This register contains 1.3 million enterprises what leads to the assumption, that the data from this survey underreport the R&D expenditures of the business sector.

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<sup>1</sup> The *Stifterverband für die Deutsche Wissenschaft* („Association of funders for the German science”) is a private non-profit institution.

<sup>2</sup> Due to reasons of confidentiality data for some of the 60 branches were not provided by the *Stifterverband*.



For mining and quarrying and for manufacturing it was possible to confirm this assumption. Since 1999 the cost structure survey for these branches is asking for R&D expenditures. This survey provides a considerable higher amount of intramural R&D expenditures than the survey from the *Stifterverband*. As the cost structure survey is used in general as a basis for the compilation of national accounts, the R&D data from this survey seem to be more consistent with the national accounts than the data from the *Stifterverband*. For this reason, both data sources are combined. Data from the cost structure survey are used as a benchmark, and the data from the *Stifterverband* are used to calculate R&D expenditures by type of expenditure. The cost structure survey includes enterprises with 20 employees and more. To recognise R&D activities of small enterprises, a mark up on the data is added. Because of the lack of appropriate information, for the branches outside mining and quarrying and manufacturing only the data from the *Stifterverband* are used.<sup>1</sup>

Data for R&D expenditure of the government and private non-profit institutions are provided by a sole survey. The data are published by the Federal Statistical Office.<sup>2</sup> For higher education there is another data source available.<sup>3</sup>

### 3.2 Bridging data from FM sectors to SNA sectors

The next step is to convert the R&D data which are available by sectors of the Frascati-Manual into the sectors of the national accounts. The details of the conversion are shown in Table 1.

The largest share of business enterprises and all cooperative research institutes are assigned to the non-financial corporations. These are supplemented by university hospitals and clinics exclusive of the subject area “human medicine”. Since the data for business enterprises are provided on the two-digit level, it is possible to separate the enterprises in the branch financial intermediation and assign them to the financial corporations. Public research institutes and public higher education institutions are assigned to the general government, public funded research institutes and private higher education institutions are assigned to the private non-profit institutions.

<b>Table 1: Assigning domestic FM sectors to SNA sectors</b>		
FM sector	Linking subsector	SNA sector
Business enterprises	Business enterprises out of the branch “financial intermediation”	Non-financial corporations
Business enterprises	Cooperative research institutes	Non-financial corporations
Higher education	University hospitals and clinics exclusive of subject area „humane medicine”	Non-financial corporations
Business enterprises	Business enterprises in the branch “financial intermediation”	Financial corporations
Government	Public research institutes	General government
Higher education	Public higher education institutions incl. subject area “humane medicine”	General government
Higher education	Publicly funded research institutes	Private non-profit institutions
Higher education	Private higher education institutions incl. subject area humane medicine	Private non-profit institutions

<sup>1</sup> For further details see Federal Statistical Office (2008)

<sup>2</sup> See Federal Statistical Office (2005a)

<sup>3</sup> See Federal Statistical Office (2005b)

### 3.3 R&D output

To obtain figures on R&D output a second conversion is necessary. The R&D expenditures according to the Frascati-Manual have to be translated into the costs of R&D production in the national accounts. The steps of the translation are shown in the following scheme:

- Intramural expenditure on R&D (Frascati-Manual)
- Capital expenditure on R&D
- + Other taxes less other subsidies on production
- + Net operating surplus
- + Consumption of fixed capital
- Overlap with Software
- = R&D output (National accounts)

Intramural expenditures on R&D are the starting point. According to the Frascati-Manual they include expenditure on wages and salaries, other current expenditure and capital expenditure. The latter do not belong to the cost of production and are subtracted from intramural expenditure. More precisely, they are replaced by the consumption of fixed capital. As consumption of fixed capital is part of the cost of production but no part of R&D expenditure, consumption of fixed capital has to be added to wages and salaries and other current expenditure on R&D.

The next adjustment concerns other taxes less other subsidies on production. Other taxes on production are at least partially included in R&D expenditures, for instance payroll taxes as part of the labour costs.<sup>1</sup> But they are not explicitly included. To measure R&D output at basic prices an adjustment for other taxes on production is necessary. On the other hand, the Frascati-Manual recommends to report *gross* expenditure, even when the actual costs are reduced because of remissions, rebates or post-performance grants.<sup>2</sup> Therefore, subsidies have to be subtracted.

As a last cost component an estimate for net operating surplus is added. The cost of capital comprise consumption of fixed capital as well as the opportunity costs of holding this capital. And to consider the opportunity costs a net operating surplus is introduced for market producers. For non-market producers no net operating surplus is assumed.<sup>3</sup>

The final adjustment concerns a problem of overlapping or double counting: the treatment of software. There is a close relationship between R&D and software: R&D is undertaken to produce software and software is used to conduct R&D. In the National Accounts software is already recognised as an intangible asset. Therefore, the introduction of R&D as another intangible fixed asset would lead to a double counting.

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<sup>1</sup> See OECD (2002), p. 109, para. 361.

<sup>2</sup> See OECD (2002), p. 115, para. 401.

<sup>3</sup> For a discussion of adding net operation surplus to own-account R&D see Statistics Canada (2008), p. 14.

**Table 2: Bridge table for R&D output by branches. Germany 2003**

ISIC Rev.3	Branches	Intra-mural expenditures on R&D	Capital expenditures on R&D and software	Other taxes on production less subsidies	Net operating surplus	Consumption of fixed capital	R&D Output
		(1)	(2)	(3)	(4)	(5)	(6)
		Mill. EUR					
A to B	<b>Agriculture, hunting and forestry; fishing .....</b>	66	6	-2	15	12	85
C to F	<b>Industry, incl. energy and construction .....</b>	42 799	3 871	-1 155	9 137	7 670	54 581
C to E	Industry, incl. Energy .....	42 769	3 849	-1 154	9 130	7 664	54 561
C	Mining and quarrying .....	22	1	-0	3	2	26
10 to 12	Mining and quarrying of energy producing materials .....	14	1	-0	2	2	16
13/14	Mining and quarrying, except of energy producing materials .....	8	0	-0	1	1	10
D	Manufacturing .....	42 674	3 830	-1 152	9 112	7 650	54 454
15/16	Manufacture of food products, beverages and tobacco .....	265	31	-8	61	51	338
17/18	Manufacture of textiles and textile products .....	116	15	-3	24	20	143
19	Manufacture of leather and leather products .....	5	3	-0	1	1	4
20	Manufacture of wood and wood products .....	18	3	-1	4	3	21
21/22	M. of pulp, paper and paper products, publishing and printing ....	83	59	-1	8	7	39
23	M. of coke, refined petroleum products and nuclear fuel .....	85	9	-2	18	15	107
24	M. of chemicals, chemical products and man-made fibres .....	6 495	627	-151	1 195	1 003	7 915
25	Manufacture of rubber and plastic products .....	736	95	-21	163	137	919
26	Manufacture of other non-metallic mineral products .....	276	35	-7	57	48	338
27/28	Manufacture of basic metals and fabricated metal products .....	954	139	-28	218	183	1 189
29	Manufacture of machinery and equipment n.e.c. ....	5 608	575	-161	1 277	1 072	7 220
30 to 33	Manufacture of electrical and optical equipment .....	10 918	945	-327	2 590	2 175	14 410
34 to 35	Manufacture of transport equipment .....	16 889	1 273	-435	3 443	2 890	21 513
36 to 37	Manufacturing n.e.c. ....	227	20	-7	54	45	299
E	Electricity, gas and water supply .....	73	17	-2	14	12	80
F	Construction .....	30	22	-1	7	6	20
G to P	<b>Services .....</b>	21 025	2 971	-573	1 306	3 061	21 848
G to I	Trade, transport and communications .....	556	127	-18	139	117	667
G	Wholesale and retail trade; repair .....	86	36	-3	21	17	85
H	Hotels and restaurants .....	-	-	-	-	-	-
I	Transport, storage and communication .....	470	91	-15	118	99	582
J to K	Financial, real estate, renting and business activities .....	10 993	2 101	-292	916	1 615	11 132
J	Financial intermediation .....	101	47	-3	26	23	99
K	Real estate, renting and business activities .....	10 892	2 054	-288	890	1 593	11 033
73	of which Research and development .....	9 333	1 264	-243	531	1 292	9 649
L to P	Public and private services .....	9 475	743	-264	252	1 329	10 049
L	Public administration and defence; compulsory social security .....	-	-	-	-	-	-
M	Education .....	7 902	523	-227	-	1 092	8 244
N	Health and social work .....	1 302	159	-32	251	211	1 573
O	Other community, social and personal activities .....	271	60	-5	1	26	232
P	Private households with employed persons .....	-	-	-	-	-	-
A to P	<b>Total .....</b>	63 889	6 847	-1 730	10 458	10 743	76 513

Table 2 shows the bridge table for R&D output by branches. For reasons to be explained below capital expenditures and the overlapping expenditures for software are combined in one column. To calculate the data for the columns (3) to (5) no survey data were available. Instead, some mark ups were used. The data for other taxes less other subsidies on production and the consumption of fixed capital are derived from data of the R&D branch. For the former the ratio between the other taxes less other subsidies on production and the compensation of employees is used as a mark up. For the latter it is the ration between consumption of fixed capital and net value added in the R&D branch.<sup>1</sup>

For net operating surplus the data from the R&D branch are not be used. A net operating surplus is only assumed for market producers. On the other hand, the R&D branch comprises research

<sup>1</sup> The use of mark ups or “premiums” is also applied in other studies. For instance, see Gysting, Ch. (2006), p. 26 or Statistics Canada (2008), p. 14 – 15.

units from the government sector and non-profit institutions. A mark up derived from the R&D branch would underestimate the net operating surplus. Instead, the relationship between net operating surplus and compensation of employees for (non-financial and financial) corporations is taken as an estimate for net operating surplus of corporations (in all branches). Table 3 shows the corresponding results for institutional sectors.

**Table 3: Bridge table for R&D output by institutional sectors. Germany 2003**

Item	Total economy	Non-financial	Financial	Government	Private nonprofit institutions
	corporations				
	S.1	S.11	S.12	S.13	S.15
	Mill. EUR				
Intramural expenditures on R&D	63 889	48 579	101	8 760	6 450
- Capital expenditures on R&D and software	6 847	5 156	47	624	1 020
+ Other taxes on production less subsidies	-1 730	-1 318	- 3	- 251	- 157
+ Net operating surplus	10 458	10 432	26	-	-
+ Consumption of fixed capital	10 743	8 757	23	1 209	755
= R&D Output	76 513	61 293	99	9 094	6 027

Even clear from a conception point of view, the deduction of overlapping software involves a problem. In some branches no R&D expenditures are reported. In other branches the overlapping software expenditures exceed the R&D output. Both leads to a negative R&D output after deducting overlapping software. There are two possible reasons for this problem:

- R&D of these branches is underreported by the survey data.
- R&D software is overreported.

It was mentioned, that the R&D survey in the German business sector may not cover all R&D activities of business enterprises. To consider this, the R&D expenditures for mining and quarrying and for manufacturing were benchmarked with the results of the cost structure survey. And for all branches mark ups were introduced to consider R&D expenditures of small enterprises. By now, it is not investigated if the mark ups for branches other than the two mentioned above are appropriate. But as a negative R&D output is only calculated in the branches outside from mining and quarrying and from manufacturing, there is evidence to suggest.

For software there is no special survey in Germany that comprises all branches.<sup>1</sup> Data on software are mainly based on model calculations for purchased software and own-account software. These data are part of the published figures on intangible GFCF and capital. But because of their model based character, it is difficult to evaluate the quality of these data.<sup>2</sup> For this reason it is assumed that a constant share of software is regarded as R&D software to be deducted from the R&D output. This may be the source of overreporting.

As there is no obvious solution for this problem, a very simple method is chosen to handle the problem. In that cases where a negative R&D output is calculated, the R&D output of these

<sup>1</sup> Since 2000 there is a yearly survey in the service sector that covers purchased software in the branches “Real estate, renting and business activities” and “Real estate, renting and business activities”.

<sup>2</sup> For a description of the German method to calculate software see Schulz, I. (2002).

branches is set to zero. This may be a very rough method. Otherwise, it is rather a conceptual shortcoming. The quantitative impact of this problem is very slight.<sup>1</sup>

### 3.4 Capitalisation of R&D output

In section 2 was reconsidered which R&D expenditures should be included in GFCF and which should be treated as intermediate consumption furthermore. The international discussion on this topic is not yet completed. Even if the revised 1993 SNA provides general requirements to constitute fixed assets, there are still some open questions that have to be clarified in the near future.

To get some evidence for the impact of R&D capital on national accounts' aggregates three scenarios are proposed. Even if these scenarios are inspired by the discussion about the R&D asset boundary, the scenarios are determined by the available data sources on R&D. The three scenarios differ in the extent of R&D capitalisation:

- scenario 1: *extensive* R&D capitalisation
- scenario 2: *medium extend* of R&D capitalisation
- scenario 3: *restrictive extend* of R&D capitalisation

In the first scenario, which is called *extensive*, R&D output of all sectors respectively all branches is included in GFCF. The advantage of the *extensive* scenario is the simplicity. Once the bridge tables for the R&D output are calculated, R&D investment is available. On the other side, this approach is far away from the current discussion on the R&D asset boundary. The only purpose of the extensive scenario is to provide an upper limit for the extend of R&D capitalisation and for the impact on GDP.

The second scenario is regarded as a *medium* option. Based on conceptual considerations some R&D activities are included in GFCF, others are excluded. For the *medium* scenario the R&D output to be capitalised was selected by institutional sectors. Included in R&D capital are corporations as well as the biggest share of public research institutes and publicly funded research institutes. Excluded are R&D activities of public and publicly funded libraries and museums and the institutions of the higher education sector.

The second scenario is based on a *restrictive extend* of R&D capitalisation. Concerning the impact of R&D capitalisation this scenario can be regarded as a lower limit. Only R&D activities of corporations are included. R&D activities of cooperative research institutes are excluded as well the R&D of all other institutional sectors. The available data would allow to be more restrictive by excluding basic research of corporations additionally. But this would be contrary to the conceptual discussion on section 2. Appropriate to this discussion would it be to exclude pure basic research. But due to the lack of data this is not feasible.

In the next section the results for the three scenarios are used to show possible impacts on the national accounts' aggregates.

### 3.5 Quantitative impact on national accounts aggregates

Basically, the capitalisation of R&D expenditures has an impact on structure, level and growth rate of GDP. As R&D expenditures do not fluctuate strongly in the course of time, it can be expected that the impact on GDP growth rates is negligible. But there will be a significant impact

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<sup>1</sup> The share of *negative* R&D output does not exceed 0.5% of the R&D output.

on the level of GDP that may correlate with the measure “gross domestic expenditure on R&D (GERD) as a percentage of GDP”.<sup>1</sup>

The quantitative impact on GDP and the change of its components is a result of several modifications:

- Value added and GFCF of corporations will increase according to the amount of own account production of R&D output.
- Purchases of R&D services by the corporate sector are reclassified from intermediate consumption to GFCF.
- Own account production of R&D by non-market producers (government and private non-profit institutions) is rearranged from consumption expenditures to GFCF.
- Purchases of R&D services by non-market producers are rearranged from government consumption to GFCF.
- Consumption of fixed capital will increase due to the R&D capitalised and cumulated in former periods.

Summing up, there is a direct and an indirect impact on GDP: GDP will directly increase by the capitalised R&D of market producers. And indirectly the GDP will increase by additional consumption of fixed capital.

Table 4 shows the quantitative impacts for the three scenarios as described above. For every scenario the change in output is equal. Intermediate consumption is only impacted by changes for market producers. As R&D output of market producer is capitalised in each of the scenarios, these changes are equal, as well. The change in consumption of fixed capital exceeds slightly the increase in gross fixed capital formation. The impact on GDP ranges from 2.8% for the *restrictive* scenario to 3.5% for the *extensive* scenario. Following these figures the difference of 0.9% reflects the indirect impact on GDP due to the capitalisation non-market producers’ R&D.

**Table 4: Quantitative impact of R&D capitalisation on economic indicators for Germany 2003**

Item	Scenario 1: <i>extensive</i> approach	Scenario 2: <i>medium</i> approach	Scenario 3: <i>restrictive</i> approach
	%		
Output	2,0	2,0	2,0
Intermediate consumption	-0,5	-0,5	-0,5
Gross value added	3,9	3,4	3,1
Gross domestic product	3,5	3,1	2,8
Consumption expenditures	-0,9	-0,4	0,0
Gross fixed capital formation	19,8	17,6	15,9
Consumption of fixed capital	20,7	18,0	16,4

### 3.6 Appraisal of results

The results in Table 4 suggest a considerable impact of R&D capitalisation on the level of GDP. To discuss the reliability of these results, they can be compared with the ratio GERD to GDP. For some conceptual reasons it should be expected that the impact on GDP is a little bit lesser than the

<sup>1</sup> In 2006 the ratio for OECD member countries varied from about 0.6 for Poland to 3.8% for Sweden. For Germany the ratio was 2.5% in that year. See OECD, 2008, p. 18. Countries outside the OECD may deviate from this range. For instance, Israel has exceptional high expenditures on R&D. In 2001 the ratio accounted for almost 5% of GDP. See Peleg, Soli (2004), p. 2.

GERD to GDP ratio suggests.<sup>1</sup> In 2003 this ratio accounted for 2.5%. Already the impact of the *restrictive* scenario exceeds this ratio. This suggests that the results for R&D capital are overestimated for all three scenarios.

To find reasons for this issue is not straightforward. But two possible reasons should be reconsidered here: the underlying data sources and the assumptions used to calculate R&D output.

As explained in section 3 for mining and quarrying and for manufacturing the R&D data of the German cost structure survey were used. These data exceed the data surveyed by the *Stifterverband* considerably. Additionally, several mark ups were introduced to consider that in some branches R&D is presumably not covered by the surveys. So, the R&D data used to compile the R&D satellite account exceed the published data on GERD. If the ratio GERD to GDP would be calculated with the former, the ratio would account for 3.0%. In this case the results for the impact on GDP are still high, but more plausible as before.

To compile the bridge table for R&D output some assumptions were introduced. Some of them refer to the structure of production in the R&D branch concerning the estimation of other taxes less other subsidies on production and consumption of fixed capital. In Germany national accounts' data of the corporation sector are compiled based on data for enterprises, not for kind of activity units. So, the R&D branch is relative small, as it only includes enterprises that conduct R&D as a principal activity. The structure of production of these R&D enterprises may differ from the structure of R&D production of enterprises outside the R&D branch. This would lead to a misspecification of the assumptions respectively mark ups used to calculate the bridge tables. By now, it is not possible to assess the amount of the misspecification. For this, it would be useful to examine R&D activities at the firm level.

#### **4 Implications for the framework of intangibles**

From the experience of developing the German R&D satellite account some conclusions can be drawn:

In section 3 it was shown, that the software data used to overcome the overlap with R&D in some branches exceeded their R&D expenditures. In Germany the data on computer software are mainly based on model calculations, whereas the R&D data are based on surveys. This implies that model based data control empirical data. Even if there are some doubts about the reliability of the R&D data, especially for corporations, empirical data should control model based data. Therefore, it should be considered to resign the software overlap in the bridge tables for R&D output and to introduce an R&D overlap in the calculation of software instead.

The discussion of the R&D asset boundary in section 2 has shown, that it can be essential in some cases to distinguish between direct and indirect (economic) benefits. Even if the requirements for fixed assets suggest that only direct benefits constitute fixed assets, the revised 1993 SNA makes no explicit statement. For conceptual discussion about other intangibles such a clarification would be very useful.

Finally, to take up again the *symmetry approach* of Corrado, Hulten and Sichel a further conclusion can be drawn: During the work on the German R&D satellite account the overlap with software was investigated. Possible overlaps with other intangibles were not taken into account. But the conceptual considerations in section 2 have shown that there is also a possible overlap

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<sup>1</sup> See Aspden, Charles (2007), p. 5.

with copyrights. As there may be other conceptual overlaps, it follows that intangible assets should not only be treated *symmetric* but also *integrated*.

With regards to the experiences made in Germany with the calculation of intangibles in the past the approach of Corrado, Hulten and Sichel should not be seen as a request to introduce all intangibles into the core system of national accounts. But their approach is a very useful basis for the compilation of satellite system, either by statistical offices or research institutes. So, they propose that “statistical agencies and the broader research community should construct satellite accounts for as many of the categories of intangible investment as possible. Satellite accounts would illuminate the data hurdles and information needs and position researcher to suggest improved techniques and data sources.”<sup>1</sup>

## 5 Conclusion

In this paper the first draft of a German R&D satellite account was presented. The results concerning the calculation of R&D output and R&D capital can give first hints on possible impacts on national accounts’ aggregates, if R&D is treated as a fixed asset. Because of the preliminary character of the calculations the results should not be overstated.

To improve the quality of the R&D satellite account several steps are necessary in the future:

- The underlying data sources, especially for the corporation sector, should be improved.
- The assumptions used for the calculations of R&D output should be refined or replaced by empirical data.
- Currently, the calculations for the R&D satellite system are concentrated on the year 2003. To apply the perpetual inventory method on the capitalised R&D output, the calculations have to be extended to the past as far as possible.
- The yearly data in current prices should be supplement by price-adjusted data and quarterly data.

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<sup>1</sup> Corrado, Carol, Charles Hulten and Daniel Sichel (2005b), p. 38.



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