



**Economic and Social
Council**

Distr.
GENERAL

ECE/CES/GE.20/2008/14
18 March 2008

ENGLISH ONLY

ECONOMIC COMMISSION FOR EUROPE

CONFERENCE OF EUROPEAN STATISTICIANS

Joint UNECE/Eurostat/OECD Meeting on National Accounts

Ninth Meeting

Geneva, 21-24 April 2008

Item 4 of the provisional agenda

MEASUREMENT OF RESEARCH AND DEVELOPMENT IN NATIONAL ACCOUNTS

RESEARCH AND DEVELOPMENT IN THE NORWEGIAN NATIONAL ACCOUNTS
A PROGRESS REPORT

Note by Statistics Norway¹

Summary

Following the new treatment of intellectual property products in the revised System of National Accounts (SNA) 1993, Statistics Norway is developing a satellite account for Research and Development (R&D). The aim of the project is to analyse the available data, collected in accordance with the Frascati Manual, and to identify possible gaps and needs of further information. It will also explore the consequences of the new treatment of R&D on gross domestic product (GDP), capital formation and saving. The paper presents the progress achieved up to date.

¹ Prepared by Knut Ø. Sørensen, Statistics Norway

I. BACKGROUND AND INTRODUCTION

1. As many other statistical agencies, Statistics Norway is working to establish satellite accounts for Research and Development (R&D). The data and the concept of R&D are based on the Frascati manual of OECD (OECD2002a), and the data collection that has been organized in that context. Data has been collected along these lines for a long time in Norway. Most time series data goes back to 1991, some to 1970.

2. This satellite accounts project in Norway still is a project in progress. Part of the project is to study the existing data and reveal gaps and needs for further information on R&D. It is also the intention to do a test implementation of a satellite system, exploring the consequences of the revised SNA treatment of R&D on GDP, capital formation and saving. Finally, Statistics Norway has an in-house Research Department looking for data to analyze productivity development. The project has received financial support from Eurostat.

II. GENERAL APPROACH IN NORWAY

3. The definition for what counts as Research and Development (R&D) follows the Frascati manual. Following the revised SNA, expenditures for R&D are mainly expenditures for fixed capital formation, building fixed immaterial capital (R&D capital).

4. The R&D statistics report on expenditures for own R&D work (intramural R&D) and R&D acquired from others (extramural R&D). These expenditures are transformed to production of R&D services according to the bridge tables that have been developed by OECD. It is necessary to use this R&D statistics, as this statistics is the one that gives special attention to whether an activity/transaction qualify as R&D according to the Frascati criteria.

5. While the bridge tables leading to estimates of production of R&D services are fairly agreed upon, there are more difficulties with the uses of R&D production.

- (a) We still need more discussion of what is to count as intermediate and final consumption under the revised SNA. Our own preliminary assumptions for Norway could be changed in view of this discussion.
- (b) There are some gaps in the statistics showing transactions in R&D services. This is why we so far do not have results for investment of R&D services by detailed industry, even though we give estimates of production of R&D services.

6. The time development of this capital stock depends not only on capital formation, but on consumption of capital as well. On this point, we have tried to apply the same model of capital consumption for R&D capital as we do for most other types of capital. This is a perpetual inventory (PIM) model.

7. It is not sufficient to give R&D estimates in current prices; we need volume estimates as well. In general it is hard to define good price indexes for R&D products. We have used input price indexes now defined for activities of the industry NACE73, producing business services of R&D. Output price indexes for R&D does not exist for Norway.

III. MAIN RESULTS

8. Even though there are some missing parts and unsettled questions of the satellite accounts for R&D, we are able to give a preliminary estimate of the impact on GDP and GNI from the revised treatment of R&D in the national accounts. The increase in GDP is a result of reclassification of R&D services from intermediate consumption to fixed gross investment in market activities, including own account investment work. Reclassifying R&D services in non-market activities to investment does not increase GDP per se, as these services already are included in final consumption. However, the R&D capital stock in non-market activities will give rise to increased capital consumption, which in turn causes a corresponding increase in their final consumption. Together, this gives an increase of GDP of 1% in 2004 and 1.1% in 2005. For GNI we have to take into account the increased consumption of fixed capital from the R&D capital stock. For 2004 and 2005 the increase in capital consumption was somewhat larger than the increase in GDP, giving the surprising result that GNI would slightly decrease as a result of the change in the treatment of research and development. There is a small increase in the volume growth of GDP from 2004 to 2005. We end the paper with a preliminary discussion of some exhaustiveness questions with the R&D statistics of Norway.

**Table 1. Present NA and test satellite figures for Norway treating R&D as investment
Million NOK**

<u>Figures at current prices</u>	2004	2005
Present GDP of Norway	1743041	1945716
Increased investment in market activities ¹	9957	13185
Increased capital consumption, non-market act.	7929	8611
Revised level of GDP (test version)	1760927	1967511
Increase in GDP, per cent	1.0%	1.1%
Change in volume growth of GDP		+0.2%
Present Gross National Income (1)	1511301	1711277
Increase in GDP (2)	17886	21795
Increase in consumption of capital (3)	21126	22201
Revised level of GNI (test version) (= (1)+(2)-(3))	1508061	1710871
Increase in GNI, per cent	-0.02	-0.00

Note 1: including own account investments

IV. R&D DATA FOR NORWAY

9. The official statistics for R&D in Norway is the shared responsibility of the non-profit institution NIFU STEP (see <http://English.nifustep.no>) and Statistics Norway. There are three separate surveys collecting data for R&D expenditures. Each survey collects data for a specific 'sector'. There is a sector for 'research institutes', one for higher education, and finally one for 'industrial sector'. The collection of statistics for the 'industrial' or business sector has been the responsibility of Statistics Norway since 1991. Collecting data for research institutes as a separate sector is not usual internationally. Usually, research institutes mainly doing market activities would be classified as business enterprises, while research institutes mainly serving General Government would be included in the government R&D sector.

10. The data are collected every second year. For the business sector, there is a yearly survey since 2001. To be integrated in the National Accounts, annual figures are needed. So far we have interpolated the figures for fixed capital formation in order to calculate capital stocks using the PIM method.

11. Data for purchases of R&D services are collected for the business sector and for research institutes. Data for sales of R&D services have been collected for the business sector for 2005 and 2006. This fragmentary data makes it difficult to estimate R&D capital by detailed industry.

12. Another complication with the distribution by industry is the fact that the data for the sector research institutes is difficult to distribute by industry in a way corresponding to the industry classification used in the National Accounts. Generally, these units belong to the industry NACE 73. There are, however, some exceptions. For instance, the research departments of Statistics Norway and Bank of Norway both are units in the research institution sector of the R&D statistics. In the National accounts these research departments are not counted as separate units, but included in General Government (government administration) and financial institutions, respectively. The National Accounts will need a distribution by institutional sector as well. We are still working to overcome this type of complications.

V. R&D SERVICES FOR CONSUMPTION

13. The idea of the revised SNA is that R&D services normally are used for capital formation, not for consumption. There are, however, two exceptions to this, which we need to implement in order to get estimates for investments.

14. The first exception is the one mentioned in the revised SNA §10.100: "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." The second category of expenditures to be included in intermediate consumption is acquired R&D to be used as input of R&D output.

A. R&D that do not provide an economic benefit to its owner

15. We need to discuss how these R&D expenditures could be identified. Our preliminary figures, as presented in the tables in this paper, have ignored this problem and counted all final domestic use of R&D as investments.

16. We would suggest that R&D done by market producers should be classified as investment. The idea is the simple one, that if a market producer chooses to undertake R&D, or to buy R&D services, he would do so only if he expects to derive some benefit from it.

17. Non-market units are mainly found in the statistical category "Higher education" of the R&D statistics. Using the concepts of the Frascati manual, their research can be classified as 'basic research', 'applied research' or 'experimental development'. We have discussed whether the category 'basic research' could be selected as relevant for consumption. This is because we would expect that the results of such research to be published and made available to the general public. If anyone is free to learn and apply the results of the R&D, it seems that it is difficult to profit from the ownership of the R&D. Close to 50 per cent of the R&D expenditures in Higher education are basic research. For the two remaining R&D categories, it is not so clear whether the universities have economic benefits from it or not. It seems possible that external units would pay for such R&D, and if it can be sold, it seems that this is a relevant economic benefit.

18. In principle, universities and the like, have to demonstrate their excellence by publishing R&D results. This gives benefits in terms of continued or expanded government funding, increased future student numbers etc. Such benefits derive from publishing results. These types of economic benefits are perhaps more like goodwill and marketing assets for the institution.

19. As can be expected, private businesses do not have much expenditure for producing basic research. Some units in the research institutes sector do, however, have some basic research. This category of the R&D statistics also includes non-profit organizations and even some few government units. Ideally, we should to treat basic research in the non-market units within research institutes in the same way as basic research in higher education. So far there are some practical data problems with this.

20. The consequences for GDP of treating basic research in higher education as consumption are modest. Because the stock of R&D capital in non-market activities would be smaller, consumption of capital is smaller, so the level of GDP increases by 0.9 and 1.0 per cent in 2004 and 2005 respectively, instead of 1.0 and 1.1 per cent. In this case, the volume growth rate would be the same as in the present national accounts.

B. R&D acquired to be used as input of R&D output

21. Private businesses and research institutes are asked about purchases of R&D. The private businesses are asked about total purchases, we don't know what part of the R&D that is used as input of R&D output, and what is for fixed capital formation. No questions of purchases are asked to units in higher education.

22. Discussing what part of purchased R&D that should be for intermediate consumption is somewhat similar to the discussions of capitalization of software. The OECD task force concluded that the software to include in intermediate consumption was software embedded in other products for sale and expenditures for subcontracting (OECD 2002b, Ch5, step 4: avoiding double counting). We think this can be applied in the case of acquired R&D as well. The idea is that the value of such purchases of R&D is integrated into the value of the final R&D services when they are sold. It follows from this that the value of the R&D that is sold is an upper limit to the R&D acquired to be used as input of R&D output. When the R&D output for sale also incorporates own work and other expenses, the R&D acquired from others for intermediate consumption should be smaller than this upper limit.

23. What if the R&D output is not sold, but invested on own account? In this case the total expenditures, including the purchased R&D should be capitalized. The purchases of R&D are then acquired for fixed capital formation, and we suggest that they should be classified directly as investment in fixed capital, not as part of own account investment work.

24. Unfortunately, R&D statistics giving direct information of sales of R&D only exists for the industrial sector for 2005 and 2006. What we can find is the way R&D expenditures are financed. Our assumption is that R&D financed from abroad, by other private units or by general government (other than subsidies) can be used as an indicator of the development of R&D sales. Private businesses purchased R&D amounting to 4.1 billion NOK in 2005, while the sales, on our assumptions, were 3,5 billion NOK. Some of these sales should be the value of own R&D expenditures. Assuming the same proportion of purchases to total expenditures in the sold projects as for other R&D, purchased R&D to be used as input of R&D output corresponds to 23% of the sales, that is 0,8 billion NOK. This leaves 3,3 billion NOK that is acquired by private businesses for fixed capital formation.

25. In our view it is reasonable to assume that also research institutes and universities purchase R&D in order to use it as input of their R&D output. We have had access to such data for research institutes for 2005. As for the industrial sector data showing the financing of their R&D expenditures are available. This is used as an indicator for the development of the sales from the research institutes, and we have assumed a constant ratio of purchases for intermediate consumption to sales. We have further assumed that this ratio also is the same for higher education as for research institutes. These estimates are quite small, 0.2 billion for research institutes, 0.1 billion for higher education.

VI. OVERLAPPING ESTIMATES OF OWN ACCOUNT INVESTMENT

26. We assume that figures for own-account investment of software are also included in the reported R&D figures. This amounts to 2 billion NOK in 2005. This figure is, however, drawn from the existing National accounts, not from the R&D statistics. It seems reasonable to assume that there are own account investments of software that are not of the R&D type. This could perhaps be studied in more detail for industries where own-account investment of software is important.

27. It is also in the present National accounts some R&D services that are delivered to oil exploration. This had some importance around 1990, but is now almost negligible.

VII. WORK IN PROGRESS

28. Starting from 2004, the Norwegian National Accounts has estimates of work in progress for several types of services. We have assumed that the figures that are entered in the present National accounts for work in progress of research and development services show a category of use of the R&D services of the preliminary satellite accounts. These figures actually refer to the services that are produced in the industry 'Research and development' (NACE 73), which do not necessarily meet the Frascati criteria of R&D. The present data in the National accounts partly reflects the problems of balancing supply and uses for the output of NACE 73. With better data for production and uses of R&D, this part of the data for work in progress can be revised.

VIII. EXPORTS AND IMPORTS OF RESEARCH AND DEVELOPMENT

29. Norwegian Trade statistics has long specified R&D in imports and exports. The figures used to be drawn from the payment statistics of the Bank of Norway. R&D was a separate category of this statistics. This payment statistics has now been stopped, and the data for 2005 is based on a general sample of service producing firms. The R&D statistics has its own estimate for imports of R&D, and R&D financed from abroad also can be specified. The level of national accounts data and the R&D statistics are not too different for 2005 and for the first part of 1990ies, but the national accounts data seem to be low for the intermediate period. So far, we have kept the existing National accounts figures. Almost all imports are assumed to be imported by the industrial sector. The research institutes had some purchases from abroad in their data for 2005, and we have assumed that they purchased the same proportion of imports for the other years.

30. It is possible to compare the figures for exports and imports reported in the R&D survey with figures reported for R&D services in the general survey for foreign trade in services. This can be done for many of the largest enterprises performing R&D. Such a comparison has been done for 2005 and 2006. The analyses of the results of the comparison are, however, not yet finished. Preliminary results show some large discrepancies between the data reported to R&D statistics and data reported to the foreign trade survey for some of the enterprises.

IX. THE BRIDGE TABLE FROM GERD TO PRODUCTION OF R&D SERVICES

31. In Table 2, we have entered elements from the simplified bridge tables from GERD to National accounts figures, following Robbins (2006).

Table 2. Assessment of production of R&D services 2004 – 2005
Million NOK

2005	R&D expenditures GERD	Purch. of R&D for intermed. consumption	Corr. for software and oil exploration	Investm. for capital used for R&D prod.	Consump. of capital for prod. of R&D	Operating surplus	Other taxes on prod.	Production of R&D (National Accounts concept)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total	29643	2160	2090	2072	1202	-794		28046
Businesses	13640	587	2090	920	555	-794		10975
Research institutes	6907	1213		246	290	0 ¹		8164
Higher education	9096	360		906	357	0		8907
2004								
Total	27786	2121	4250	2272	1138	741		25264
Businesses	12941	613	4250	972	534	485		9351
Research institutes	6620	1179		300	282	256		8037
Higher education	8225	329		1000	322	0		7876

Note: (8) = (1) + (2) - (3) - (4) + (5) + (6) + (7)

1: Though NACE73 had negative operating surplus for 2005, the accounting statistics for the research institutions showed a positive operating surplus. That is why we did not apply the negative rate of operating surplus to these institutions.

32. The estimate of consumption of capital here is using figures for NACE73 industry (consumption of capital in relation to the sum of compensation of employees and intermediate consumption). For operation surplus, the NACE73 ratio of operating surplus to consumption of capital is used. Nothing is known about other taxes on production that may be relevant for R&D activities. The zero for operating surplus of Higher education is entered because these institutions are totally dominated by non-market activities in Norway.

33. Table 2 can be a starting point for figures by industry as well. The industrial sector can be specified by industry. Higher education covers the industries education and health. Research institutions largely correspond to the industry NACE73, as most of the large units belong there. There are however units from other industries as well.

X. TOTAL SUPPLY AND USES OF R&D SERVICES

34. Total supply of R&D services comes from domestic production and imports. This equals total uses of R&D. The uses are dominated by fixed capital formation. We have assumed that all exports are exported from the industrial sector. Further, we have the R&D purchased as intermediate consumption to be used in the R&D production. The amounts on the uses side are equal to the amounts on the supply side, defining total production. We also have entered changes in inventories (work in process) according to the present National Accounts. The results are given in Table 3.

Table 3. Supply and uses of R&D services in Norway Preliminary results 1989-2005
Mill NOK

Year	Domestic production	Imports	Total supply =total uses	Fixed capital formation	Exports	Change in inventories (work in progress)	Intermediate consumption.
2005	26988	1547	28535	24643	2053	737	1102
2004	24274	873	25147	20424	1346	2246	1131
2003	23245	730	23975	21896	1062		1017
2002	24763	753	25516	23408	1229		879
2001	24532	936	25468	23082	1192		1194
1999	21414	888	22302	19616	1090		1596
1997	21447	841	22288	20049	1000		1239
1995	17716	664	18380	16881	733		766
1993	15904	506	16410	15116	487		807
1991	13134	214	13348	12090	329		929
1989	11717	165	11882	11008	173		701

XI. SUPPLY AND USE OF R&D SERVICES BY INDUSTRY

35. For production of R&D services, the figures in Table 2 above can be regarded as being close to a split by broad categories of industry. In order to move to a detailed table by industry, we would want a better classification of the research institutes by industry.

36. To split the uses of R&D services by detailed industry seems to be harder. This is because there is little data of regular transactions in R&D services. The surveys ask for purchases of R&D by businesses, but not always for their sales. For the other two surveys, there are no data for sales or purchases of R&D services. There are, however, data for financing. Our preliminary figures assumes that R&D expenditures financed by other private units, by government units (except the Research council and 'Skattefunn', which is scheme for tax exemption) or by foreign units is an indicator of R&D that are sold. Based on these (and some few other) assumptions, it is possible to give a distribution of uses by the broad categories of users. It is possible to extend this method to give a detailed breakdown by industry.

37. In the table of uses, we have introduced a further category of users, which is General Government (outside education and hospitals). This category of users does not produce own R&D services (if we succeed in splitting up the research institutions according to industry, this would change). The General Government units are supposed to buy R&D services from the other categories of users for fixed capital formation.

38. From the R&D survey, we know how much 'businesses' bought from research institutions and Higher education combined. We have allocated these purchases to the two groups according to the financing from businesses of each group. We have assumed that businesses do not sell R&D services to research institutions or Higher education. The sales to General government are assumed to correspond to financing from Government units other than the research council or the tax scheme. The purchases of R&D services by Government are transactions that should be identified in the intermediate consumption of the present National accounts. Unfortunately, the government accounts, in particular the accounts for Central government, do not give much product details about their intermediate consumption.

**Table 4. Uses of R&D services by broad categories of industries. Mill NOK.
Preliminary estimates**

Broad category of industry	Production and imports	Net domestic purchases	Total use	Purchases for intermediate consumption	Changes products in progress	Exports	Gross fixed capital formation
2005							
Total	28535	0	28535	1102	737	2053	24643
Businesses	12674	388	13062	797		2053	10212
Research institutes	7244	-3299	3945	235	737		2973
Universities, colleges	8617	-793	7824	70			7754
Other General Government	0	3704	3704	0			3704
2004							
Total	25147	0	25147	1131	2246	1346	20424
Businesses	10417	268	10685	839		1346	8500
Research institutes	7119	-3188	3931	228	2246		1457
Universities, colleges	7611	-708	6903	64			6839
Other General Government	0	3628	3628	0			3628

39. From Table 4 we see that private businesses had 44 per cent of total gross fixed capital formation from R&D services in 2005. This group also was the largest producer and exporter of R&D services. Research institutions and universities / colleges had a comparable amount of production of R&D services, but the research institutions, as a result of net sales to other users, had much smaller part of domestic uses than of domestic production. The figures for R&D work

in progress are the present National account figures, allocating this production to NACE 73 (research and development). With a better handling of production of R&D, a revised industry distribution of work in progress should be expected. Fixed capital formation in R&D is less important for the research institutions. Especially for 2004 we have small investments in R&D, partly as a result of large increase in work in progress.

40. In this test of a satellite account for R&D, R&D services are treated as other regular products that can be purchased or sold. When there are transactions in R&D services, we have assumed that if the producer sells the R&D services to someone else, it should be recorded as investments for the final user, and not for the producer. This accounting does not perhaps take the special nature of R&D into account. The results of the R&D project will still be with the producer, even if the project is sold to some other unit. Counting the R&D expenditures as investment for the producer as well as for the buyer would however be a double counting.

XII. STOCKS OF R&D CAPITAL AND CAPITAL CONSUMPTION

41. Based on the preliminary results from Table 3, we have tested the consequences of applying the regular PIM method that we use for other types of capital in Norway to this time series of gross fixed capital formation. Figures for the missing years have been interpolated from the investment figures in the table. Average lifetime of R&D capital is set at 10 years. This is not based on our own research, but rather an ad hoc assumption that seems to be in line with assumptions that are used in other countries. Further assumptions in our PIM method are the same as for other types of assets with a 10-year average lifetime.

42. We have assumed that the price index of these services follows the price index of production in the market segment of the industry NACE 73 (Research and development). This price index is an input price index, weighing together increases in compensation of employees and price increases in intermediate consumption in the industry.

43. In addition to the compilation of total R&D capital stocks, we also have made estimates for non-market units, defined as the sum of capital stocks for the categories Higher education and other general government. This has a special interest, as the consumption of capital of these units will contribute to the increase in GDP caused by the new treatment of R&D. The data is found by compiling Table 6 for the same years as are given in Table 3. These data are more uncertain than the data for the total stock of R&D capital.

**Table 7. Stocks of R&D capital and consumption of fixed capital
Mill NOK, preliminary figures**

	Figures at current prices		Volume growth
	2005	2004	2004 - 2005
Total			
Stocks of fixed R&D capital	151355	145682	1.6
Consumption of fixed capital	22201	21126	2.8
Non-market activities ¹			
Stocks of fixed R&D capital	62188	58053	4.8
Consumption of fixed capital	8611	7929	6.2

Note¹: Sum for the categories Higher education and other General government.

44. We note that the growth in stocks of R&D capital and consumption of fixed capital was much larger in non-market activities than in the national totals for Norway. Please note that these are preliminary figures that are likely to be revised before the project is finalized.

XIII. SOME EXHAUSTIVENESS QUESTIONS

45. The design of the R&D survey for businesses has been changed several times. The most important changes took place in 2006 and 1995. Before 1995 only large companies were asked about R&D. In the period 1995 to 2005 the R&D survey covered corporations with 10 or more employees. For 2006, there was an extra sample of units of 5-9 employees. The own expenditures for R&D were 17 per cent higher than the expenditures in the part of the sample that were comparable with the previous survey. In 2006, the expenditures in the sample of small units were estimated at 7 per cent of total expenditures for own R&D. The Norwegian tax exemption scheme for R&D expenditures clearly favour small units. It is therefore possible that expenditures in small units now is more important than what used to be the case before this tax plan was implemented. Please note that the figures presented in the paper are not yet adjusted to take the activity in the small units into account.

46. The extended coverage in 1995 was quite important. The significant extension of the survey makes 1995 to a natural starting point for the time series giving detailed industry figures.

47. In addition to the question of cut-off limits, it is a fact that not all industries are covered in the Norwegian R&D statistics. We shall have to accept that these are industries that probably do not have significant expenditures for own R&D. Even so, there is a possibility that units that

are not covered could buy R&D from R&D producers. This is clearly the case or general government.

48. Comparing the figures from the structural business statistics for NACE73 to the R&D expenditures for the research institutes, it is evident that the units in this industry had a total production much higher than our estimate based on the R&D statistics. Probably that this is because the firms in this industry produce services that are not classified as R&D services. Comparing turnover according to the structural business statistics to R&D expenditures according to the R&D statistics, we find that R&D expenditures are a bit higher than turnover for the units that are responding to both surveys. In several cases there are large differences, however. We hope to be able to study this question and the related question of balancing supply and uses further in the National accounts.

REFERENCES

OECD (2002a): Frascati Manual 2002, OECD (Paris)

OECD (2002b): Software task force report OECD, Paris

C.A.Robbins (2006) R&D expenditures for the US: A Frascati System of National Accounts Application to US data. U.S. Bureau of Economic Analyses, WP2006-02, March 17, 2006, Washington DC. Paper to the Joint Expert Meeting Canberra II Group and NESTI - Capitalisation of R&D Berlin 31 May to 1 June 2006

* * * * *