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SEMINAR ON MEASURING CAPITAL – BEYOND THE TRADITIONAL MEASURES
SESSION II

The Capital Boundary in the 1993 SNA, Rev. 1 – Challenges for National Statistical Offices [1]

Submitted by Federal Statistical Office (FSO), Switzerland

EXECUTIVE SUMMARY

The aim of this paper is to describe the main challenges that national statistical offices face when they want to implement the changes in the capital boundary proposed in the current revision of the system of National Accounts (SNA 1993). The challenges are illustrated with the example of Research and Development (R&D). The proposal made by the international community is to consider these expenditures as investments (gross fixed capital formation (GFCF)). Estimates were made for the first time for Switzerland. The paper documents the various stages of the implementation process and presents provisional results for the period 1990-2004. For the Swiss Federal Statistical Office (FSO), these results represent only a first step, the ultimate goal being the full integration of the conceptual changes proposed by the international community in the national accounts. The exercise shows the difficulties of the whole process and stresses the following points for discussion:

[1] This paper has been prepared at the invitation of the secretariat.

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(a) Some countries are pioneers in the R&D capitalization, but most of members of OECD are only followers. Thus a manual and a guide of best practices are needed but are they sufficient to insure a wide diffusion of knowledge and skills of this new theme?

(b) How to insure in the R&D framework the homogeneity of measures on an international level? National statistical offices are facing a dilemma: Measuring the complex reality of their economy versus applying a more standardized and simplified methodology allowing international comparisons. How these two objectives can be balanced?

Finally, the use of an R&D satellite account is a right way to work out the new methodologies. Nevertheless, the real aim is its full integration in the national accounts. Is this aim completely agreed by all countries? If it is not the case, how can we convince them?

INTRODUCTION: CAN USER NEEDS, THE STATISTICAL BURDEN AND THE QUEST FOR PERFECTION EVER BE BALANCED?

1. Statistical offices are a breed of a special kind: payrolls and research tend to be financed mainly by the taxpayer, demands for data are increasing in all fields of analyses and parliaments are often deaf to pleas for more funding. Moreover, production processes have to be planned years in advance while financial support is provided on an annual basis. Finally, data should always be up to date with current social, economic or political issues, regardless of the difficulties inherent to the collection process.

2. Besides, major efforts are made by the international community to set rules by which statistics must abide in order to have a given quality. Time and human power are also devoted to provide harmonized results. At the same time, national users feel that attention should focus mainly on their statistical needs. Finally, data providers resist what they perceive as an ever-increasing and never-ending statistical burden. Response rates sometimes decline, and statistical offices consider steps to implement their surveys into a binding legal framework.

3. Statistical offices are therefore quite a unique specie, and their directors have to come up with institutional, legal, methodological and technical solutions. Simplifying options are limited, but worth exploring, as they can help in the balancing exercise between statistical perfection, user needs and provider reservations. In this context, standardized methodologies, harmonized statistics and coordinated revisions are major inputs provided by international organizations. This international support –however precious it may be- is nevertheless not sufficient to square the situation. Two additional options are also investigated by statistical offices: on the one hand, production processes are scrutinized and initiatives are launched to integrate processes and outputs more systematically. This provides a horizontal framework which, by nature, is applicable across most fields of official statistics. On the other hand existing data is reshuffled so as to widen its use to new fields of analysis. Here, the thrush is more of a vertical nature, addressing issues which are related, but not identical.

4. This paper was written with this last element in mind. The option is important, as statistical

structures can never integrate all needs, let alone needs which were not voiced at the initial, conceptual stage. The world would be a gloomy planet if statistical shortcomings of existing data were systematically used as an excuse not to investigate new issues. Statistical offices don't live in a perfect world, and perfection thus is an illusion. At the very least, existing data should be used as proxies and tested. Based on the results of the investigations, initiatives can be launched to collect additional information and/or the conceptual framework can be reorganized.

5. The revision process of the SNA 1993 came up with various proposals which widen the capital boundary. The most important elements are the integration of Research and development (R&D), of originals and copies, of databases, of patented entities, and of purchased goodwill. While arguments for the integration of these elements into the capital boundary are sound and convincing, statistical offices are faced with the challenge of the implementation in the context sketched above. This paper argues that first estimates based on existing data are possible, but also that recommendations of "best-practices" and in-depth assessments with partners are indeed not only welcome but a necessity. The document will focus on the issue of R&D, as statistical data is partly available in Switzerland.

6. A last point should be mentioned here: all data provided in this document is provisional and has not yet an official character. The Conference of European Statisticians (CES) actually gave the impulse for first estimates in this field of work, which is new to the FSO. Results will therefore be revised, and inputs of the experts at the conference are most welcome.

I. THE USE OF EXISTING DATA: THE EXAMPLE OF R&D EXPENDITURES AND THEIR CAPITALIZATION

7. As indicated in the previous section, using existing data is a first step in the process of setting up new statistical information. Obviously a major prerequisite is that data was collected on a systematic and coordinated basis in the past. In this context, R&D is a good example that illustrates not only of what can be done, but also the challenges which statistical offices face when they want to implement the proposals put forward in the revision of the SNA 1993. As a reminder, the revised SNA 1993 proposes that R&D should be capitalized, that is that it should be considered as a part of gross fixed capital formation (GFCF) and not an element of intermediate consumption.

8. In this context, R&D benefits from two elements:

(a) R&D surveys were launched many years ago, which implies that methods are robust, results have been scrutinized, and international comparability is rather good.

(b) "Capitalization" is not a strange planet which still needs to be explored, but a world where many studies were conducted in the past. The capitalization process of R&D thus benefits from the accumulated experience. While various methods are indeed possible (econometrics for example) to set up a capital stock, international practice suggests that the Perpetual Inventory Method (PIM) is a good vehicle. Experiences collected in the non-financial capital stock make it possible to identify the elements which are needed, namely basically data about GFCF, parameters for mortality functions, information about lifetime and finally a set of deflators.

9. Ingredients are thus available for a first try. Two points can be made at this point: first,

during the consultation of the recommendations of the SNA revision process, some countries voiced reservations regarding the difficulties of working with accounting and survey-based data. These concerns will not be dealt with here. The document rather focuses on bridging difficulties between existing data and the framework of national accounts. Another point is the difficulties of working with data which are not collected on a yearly basis. As a matter of fact, in Switzerland, R&D surveys of private enterprises are made every fourth year, and no estimates were provided for the intermediate period. Thus, in order to deal with the lack of data, hypotheses have to be made to “bridge” the years of the surveys. These do have significant impacts on results. Thus, in the next two subsections, difficulties and hypotheses chosen for the estimation of R&D capital stock in Switzerland are not only presented, but the impacts of the different hypotheses are also discussed.

A. Challenges for First Estimates of Gross Fixed Capital Formation: the Case of “Freely Available R&D”, the Pitfalls of Interpolations and the Construction of Long Time Series.

10. To estimate a capital stock with the help of the PIM, the first step is to obtain GFCF in R&D. Primary data used comes from data collected according to the prescriptions of the Frascati Manual (FM). In this manual, an important aggregate is gross domestic expenditures on R&D (GERD). This aggregate constitutes the starting point of the calculations. However, three hurdles must then be overcome:

11. Criterions for distinguishing R&D activities are not the same between the FM and the SNA. Actually, we may refer to Salem & Sidiqqi (2006, p. 8) when they state: “The precise range of activities or expenditures that constitute R&D capital is one of the key conceptual issues”. Adjustments to the results collected according to the FM are thus needed.

12. In the recommendation put forward to the international community, only R&D expenditure that is sold or that is expected to bring a benefit in the future to its owner can be included within the asset boundary. This raises the question of R&D which brings no economic benefit discernable at the time of its completion and the issue of R&D provided by government.

13. As stated before, R&D surveys are not conducted on a yearly basis in Switzerland. The “bridging problem” must still be overcome.

14. Adjustments to the FM results are not detailed here, as they don’t constitute the main focus of the research. Appendix 1 gives the architecture of these adjustments for the interested reader. The two last points need further developments and are dealt with in the following parts.

<u>The issue of R&D which does not generate economic benefits</u>

15. The definition and delimitation of R&D is an important issue. Various options are possible. On the one hand, in the FM, R&D activities are defined as a creative work undertaken on a systematic basis in order to increase the stock of knowledge (OECD, 2002). On the other hand, in the 1993 SNA, the definition of an economic asset if an entity functioning as a store of value from which economic benefits may be derived by their owners by holding them or using them over a period of time. One can see that the impact on the productivity of an economic process of an R&D activity is not a selecting criterion of the FM, while it is a central concern in

the logic of the SNA.

16. This conceptual difference is extremely important. With the SNA's criterion, most of basic R&D activities should not be included in GFCF, as it is not possible to link these activities to productivity improvements. Consequently, it was argued in the SNA revision process that R&D "made freely available to the public" should not be capitalized. The main argument is that knowledge produced by this R&D activity does not provide any competitive advantage to its owner. This is due to the fact that knowledge is provided freely to the public. Such an activity should thus not be considered as an asset in the economic sense (de Haan & Rooijen-Horston, 2004).

17. In 2005, the Advisory Expert Group on National Accounts (AEG), which is a central actor in the revision process of the SNA, came up with the following wording for a solution: "In principle, freely available R&D should not be included as capital formation but in practice it may not be possible to exclude it. The assumption is that including freely available R&D would not lead to significant error." In the ensuing discussions, the questions of the definition of "freely available R&D" and of the magnitude of the phenomena were raised. To answer these questions, Aspden (2006b) came up with the following solution:

(c) Basic research expenditures of government and higher education institutions should be excluded.
(d) Parts of the R&D expenditures of private non-profit institutions should also be excluded.

18. In both cases, the argument is that there is no strategy in place to capture future economic benefits.

19. In parallel, Aspden proposes to take into account basic research of business enterprises. As a matter of fact, these units expect future incomes derived from this basic research, even if the results are published or made available to a wider audience. Aspden also proposes to include applied research and experimental development realized by the government and by higher education institutions, because he considers that these activities are undertaken with the intention of obtaining specific benefits for the R&D performers. His proposition has generated many responses and the debate is not closed (Aspden 2006c).

20. To answer the question about the magnitude of freely available R&D, Aspden published the (unweighted) average of R&D expenditure across 29 countries, by institutional sector and by type of R&D. Findings show that aggregated basic research of Government and higher education institutions represents almost 18% of the total R&D expenditures. Nevertheless, as stressed by the author, substantial variations between countries lie behind the average.

21. Aspden's proposals were used as a guideline for the calculations made in Switzerland. Total R&D expenditures and the "adjusted" R&D expenditure (i.e. freely available R&D) were tested in various scenarios in order to estimate their impact on Swiss R&D capitalization. Results are presented and commented in part 2.3 below.

Interpolated data and long time series

22. Primary data for the GFCF in R&D can be found in various surveys, focusing on business enterprises, on government and on higher education institutions. The Swiss federal statistical office was confronted with two problems:

(a) Data is not available on a yearly basis.

(b) Surveys are not coordinated. As a matter of fact, in Switzerland, R&D expenditures are covered every four years for business enterprises, every two years for the government, and every year (but unpublished) for higher education institutions. The R&D expenditures of private non-profit institutions are estimated every four years.

23. The PIM needs annual GFCF in order to estimate R&D capital stock. Interpolations must thus be made, in order to obtain coherent and reliable series of data. The interpolation was made in two steps. In a first phase, the R&D expenditures were interpolated by institutional sectors (private enterprises, government, etc.). The next move was to interpolate expenditures by type of research, for each institutional sector.

24. In order to interpolate the various periods, the growth rate of an indicator was used. It was constrained in the sense that the average annual growth rates of the indicator were adjusted in order to correspond to the average annual growth rate of R&D expenditure measured during the analyzed period (for more details about the interpolation of data, see appendix 2). The indicator variable is Gross Domestic product (GDP) at current prices, with a positive lag of one year. The lag mirrors the anticipations of the various economic actors regarding economic growth. One should point out the fact that this is a rather strong assumption, as it means that we consider that the R&D expenditures pattern is linked with the GDP growth rate of the following year. Further research will be launched at the FSO to test alternatives to this indicator, but results presented below were conducted on the basis of this assumption.

25. With the help of interpolation, R&D GFCF can be estimated on an annual basis. A question remains, namely the availability of long time series. It is a well-known characteristic of the PIM that long time series are needed. In Switzerland, coherent R&D expenditures are available since 1981. Surveys were conducted earlier, but the conceptual framework was different. Thus, it is impossible to link the data of earlier periods to the present time series. Consequently, availability of R&D capital stock estimation is limited in time.

B. Well-known Concepts for a New Dimension: the Choice of Mortality Functions, Lifetimes and Deflators of R&D

26. As such, the PIM is a well-known process. The concept is mature and many researchers use this method. However, the standard process can generate some critical interrogations in the R&D framework. Some parameters such as lifetimes, mortality functions or deflators can impact significantly on final results and must be assessed with caution.

Mortality functions

27. In Switzerland, due to the lack of data, there is currently no differentiation of mortality function between industries. Thus, all GFCF use the same mortality function. A bell-shaped distribution estimated by a log-normal density function was chosen. This choice is justified by the fact that the Swiss non-financial capital stock uses a log-normal distribution for every category of fixed asset (Rais & Sollberger, 2006). For that reason, to insure coherence between R&D and the other fixed assets in the national account framework, the same density function is used in the case of R&D expenditures.

Lifetime

28. In order to measure a capital stock with the PIM, service lifetimes must be estimated, which is quite a daunting task in the case of R&D. As pointed out by De Haan et al. (2006), there are only few empirical analyses on this theme. In the various studies, annual depreciation rates go from 11% to 25%, corresponding to an average service life ranging from 5 to 10 years. For example, the BEA (Bureau of Economic Analysis) uses a depreciation rate of 15% in its primary scenario (Okubo et al., 2006), which corresponds to a lifetime of about 7 years. The Australian Bureau of Statistics (ABS) uses a median lifetime of 9 years. In a study published in 1996, Nadiri and Prucha already realized such comparisons. Depreciation rates were set within the framework of a factor demand model, and the results are consistent with studies with an average survival time of approximately 7 years.

29. These examples illustrate the difficulty to estimate average or median lifetimes for R&D GFCF. There is a real necessity that analysts continue empirical researches and improve knowledge in this area, as lifetimes have a tremendous impact on the level of the R&D capital stock. That is why, in the next subsection, hypotheses on lifetimes are tested, illustrating the impacts of two different lifetimes on the stock of the Swiss R&D capital. The two lifetime used for the scenario are based on the paper of De Haan et al. (2006), with a duration of 5 and 10 years. A more extended duration could be investigated; however, due to a lack of historical data in Switzerland, it is quite impossible – at present – to realize a third scenario involving a longer lifetime.

Deflators of R&D

30. Capital stocks are usually estimated on the basis of GFCF at constant prices. Most of the time, R&D data is at current prices. Therefore, deflators are needed to get to GFCF at constant prices.

31. The optimal solution is to calculate special R&D deflators based on weights and prices that are specific to R&D. Nevertheless, the complexity of the task and its cost make this exercise hardly achievable. In the absence of a full set of R&D deflators, the use of the implicit GDP deflator is tolerable (OECD, 2002). The GDP deflator provides an approximate measure of the average real “opportunity cost” of carrying out the R&D.

32. However, as mentioned in the FM : “In general, over the long term, it is reasonable to suppose that the implicit GDP deflator (output) would tend to increase less rapidly than a “true” R&D deflator (input) because of productivity increases.” The FM thus recommends using a more common approach by using weights derived from R&D surveys combined with proxy prices. Unfortunately, in Switzerland as in many other countries, there is no data that can be used to construct a specific R&D deflator. Therefore, the implicit GDP deflator was used for the results presented in the next subsection.

C. Setting the scenarios for analysis, or how capital stock fluctuates depending on the assumptions

33. As seen before, R&D capitalization requires strong assumptions to close the gaps linked to the lack of information. We decided to focus on two major assumptions and to cross each other in order to obtain four scenarios. A benchmark is then realized in order to analyze how capital stocks fluctuate depending on the assumptions.

Scenarios

34. The first dimension used for the definition of the scenarios is the extension of the capital boundary of R&D. One may choose between a large and a limited option. The first option considers all R&D expenditures to estimate the R&D capital stock while the second one excludes freely available R&D.

35. The second dimension is the lifetime of R&D “output”. As it is not yet a mature subject and more research will be conducted in the future, two lifetimes were selected for the creation of the scenarios, namely 5 and 10 years.

36. By crossing the two main assumptions, we have the following scenario matrix:

Table 1: Scenario matrix

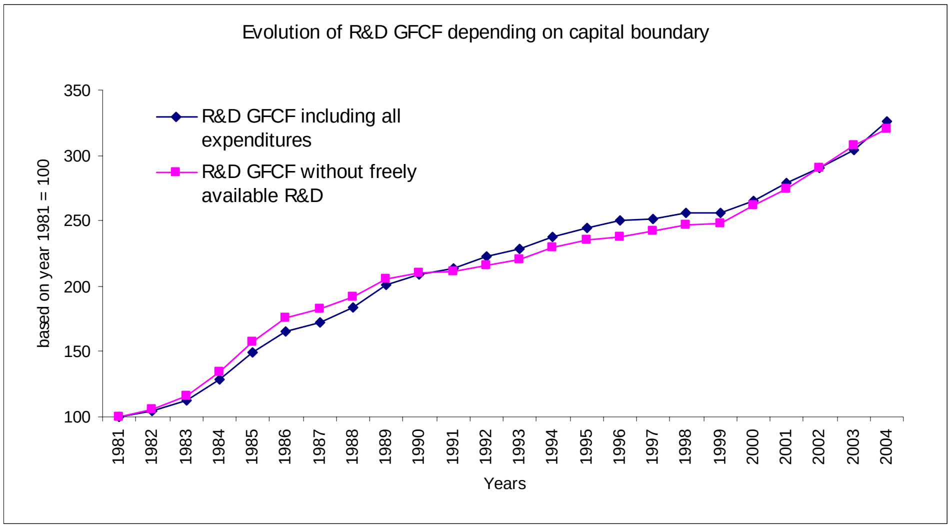
	Including all R&D expenditures	**Excluding freely available R&D**
Lifetime = 5 years	Scenario 1	Scenario 2
Lifetime = 10 years	Scenario 3	Scenario 4

Scenario 0 is the initial situation, that is the results before considering R&D expenditures in the Swiss non-financial capital stock.

Findings and comments

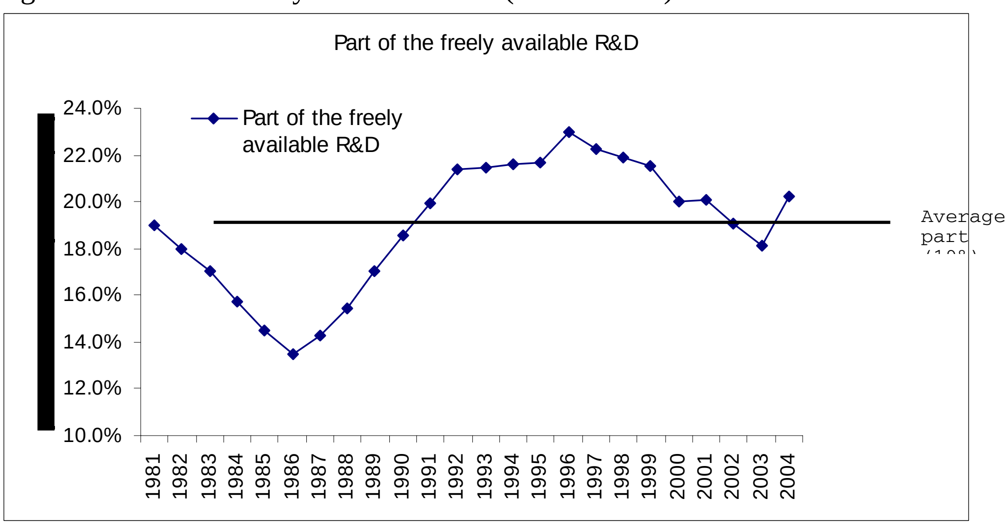
37. In a first step, estimates of R&D GFCF are made with and without the freely available R&D. Evolutions are illustrated in figure 1 below. The two series have been indexed on the year 1981 = 100.

Figure 1: Evolution of R&D GFCF (source: SFO)



38. On average, basic research which can be excluded represents about 19% of total of R&D expenditures. This result is very similar to the findings of Aspden (2006b) mentioned above. Quite logically, series including all R&D expenditures are the highest.

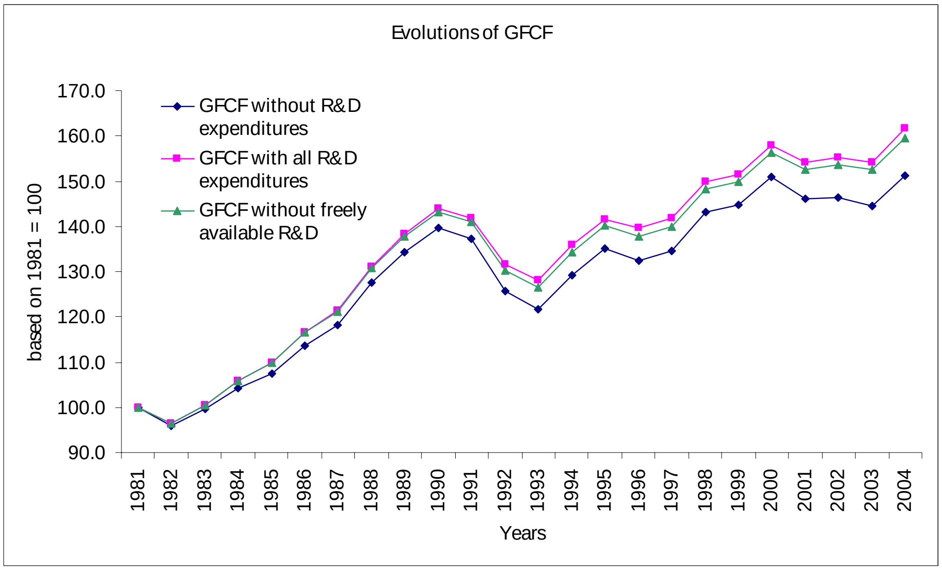
Figure 2 Part of the freely available R&D (source: SFO)



39. In the first half of the 1980s, the part of freely available R&D declined steadily from 19.0% to 13.5%. This was followed by a continuous increase from 1986 to 1996, the latter being the maximum reached so far (23.0% of Total R&D). The last years are more stable, with a spread of freely available R&D varying between 18.0% and 22.0% of total R&D.

40. When the two new series are included in the initial GFCF data (figure 3), the profile changes over time. As a matter of fact, the aggregate with the R&D is more dynamic than the traditional aggregate of the National accounts.

Figure 3: Evolutions of GFCF depending on scenarios (source: SFO)



41. These differences have direct impacts on the evolution of the amount of the capital stock. As shown in the following table (table 2), fluctuations of capital stock vary depending on the scenario.

Table 2: Swiss non-financial capital stock depending on scenarios, index based on scenario 0 of the studied year.

Year	Scenario 0	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2001	100.0	102.6	102.0	104.8	103.8
2002	100.0	102.6	102.1	104.8	103.8
2003	100.0	102.6	102.1	104.9	103.9
2004	100.0	102.7	102.2	105.0	104.0

42. The impact of R&D capitalization on the Swiss non-financial stock is thus significant. With a lifetime of 5 years (scenario 1 &2), the impact on capital stock for the year 2001 is comprised between 2.0% and 2.6% depending on the inclusion or not of freely available R&D. Considering a lifetime of 10 years (scenarios 3 & 4), for the same year, the impact almost doubles, with an increase of the capital stock comprised between 3.8% and 4.8%. The impacts on the Swiss capital stock are more marked for scenarios 3 & 4 because of the intrinsic characteristics of the PIM, based on an accumulation of GFCF. These impacts cumulate slowly over time, with a total impact for the year 2004 ranging between 2.2% and 2.7% for scenarios 1 & 2 and between 4.0% and 5.0% for scenarios 3 & 4. These increases are mainly due to the fact that R&D GFCF grow more rapidly than GFCF of other categories of asset.

43. As could be expected, growth rates of capital stock were affected by inclusion of R&D GFCF. The question now is if the evolution of capital stock changes significantly depending on the scenario.

Table 3: Annual growth rate of the Swiss non-financial capital stock depending on scenarios

Year	Scenario 0	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2002	1.98%	2.00%	2.02%	2.02%	2.02%
2003	1.78%	1.83%	1.84%	1.84%	1.84%
2004	1.85%	1.92%	1.91%	1.93%	1.92%

44. Table 3 shows that there are no huge changes in the evolution of the annual growth rates. Still, it is interesting to observe that the inclusion of R&D has a systematically positive impact on the evolution of the total capital stock. That means that R&D GFCF grows faster than the other type of categories, thus increasing annual growth rates.

45. To have the full picture, the contributions of each scenario to the capital stock growth rate are assessed (table 4).

Table 4: Contributions to the capital stock growth rate depending on scenarios

Year	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2002	0.08%	0.08%	0.13%	0.11%
2003	0.09%	0.09%	0.14%	0.13%
2004	0.12%	0.10%	0.17%	0.14%

46. While its contribution is not really impressive, R&D capitalization contributes positively to the growth of the Swiss non-financial capital stock. Besides, it seems fair to say that R&D will play a growing role in the evolution of the capital stock. Table 4 shows that the contribution of each scenario is increasing with time. Hence, it may not be surprising that R&D contributions will increase in the near future.

II. THE LANDSCAPE, THE ROAD, AND THE BUMPS: MAIN PROVISIONAL CONCLUSIONS

47. Henry Kissinger said: “If you don't know where you are going, every road will get you nowhere”. Fortunately, in the case of R&D capitalization, researchers know where they are going. Even if the road is already set in a well-known landscape called System of National Accounts, the way is still thorny and bumpy. In this chapter, provisional conclusions will be discussed, and the methodological and conceptual bumps which spread over the road leading to the R&D capital stock will be analyzed.

A. Methodological Challenges: From the Problem of Interpolation to the Estimation of Deflators

48. The previous chapter showed the pitfalls which had to be overcome in order to present first estimates for Switzerland. Among the various problems which were discussed, data availability is central. Even when it is possible to obtain time series which are sufficiently long for R&D expenditures, data provided by surveys are often conducted every second, third or even fourth year. To use the PIM, GFCF for every year is needed. Therefore, there is a necessity to

interpolate data in order to estimate R&D capital stock.

49. For the current exercise, R&D expenditures have been interpolated with the help of GDP as indicator, with a positive lag of one year between the variation of GFCF and the one of GDP. The underlying assumption is based on a neo-classical approach. However, this choice is debatable. Is GDP the best indicator to interpolate R&D expenditure? It is difficult to answer the question. In Switzerland, research is under way to evaluate alternative indicators like for example the evolution of the number of patents.

50. Besides, one must keep in mind that data was calibrated in order to fulfill the requirements of the System of National accounts. While a number of papers was already published on this subject, most notably on the bridge tables, it is important to remember that this kind of adjustments can become complex. A harmonized process should be elaborated and widely published to help statistical offices to face this problem.

51. Finally, another recurring methodological problem mentioned by various studies is the production of a deflator. It appears that only few countries have appropriate R&D deflators. A large number of countries have proxies like the implicit deflator of GDP. In this context, one must keep in mind the warning of the Frascati Manual namely that, over the long term, the implicit GDP deflator increases less rapidly than appropriate R&D deflators. Even if this "B-solution" is acceptable for the moment, measures have to be taken in order to estimate properly a set of R&D deflators.

B. Conceptual Issues: from Capital Boundary to Lifetime and Mortality Functions

52. Besides methodological problems, the analyst is faced with conceptual issues. The first one is the problem of the capital boundary, or more precisely, the issue of "freely available" R&D. There is a rather broad consensus that R&D which cannot be protected by property rights should not be considered as an economic asset. Still, it is not easy to define "freely available R&D". Basic research undertaken by government and private non-profit institutions is an option chosen by many, but it is not the only one. In addition, it is quite difficult to estimate the part of the R&D expenditures of the private non-profit institutions which has to be included in the process of capitalization.

53. Other important conceptual issue is the choice of the density function with the PIM. Weibull or log-normal density distributions are often used to estimate the mortality function of a specific vintage of a capital asset. These choices are often justified by operational reasons and less frequently by scientific motives. Recommendations agreed upon by a majority of states would be welcome for countries which have no information whatsoever.

54. As seen above, lifetimes greatly influence the level of capital stocks. Nevertheless, only few empirical studies have been made to provide inputs. Results are currently converging to an interval comprised between 5 and 15 years. Nevertheless, as shown in this paper, fluctuations generated by lifetime are really significant and more efforts should be make to acquire knowledge about R&D lifetime.

55. Finally, a persistent difficulty is the question of historical data series. Repeated observations are needed to set up an approximation of the capital of a fixed asset. The issue may be more important for R&D than for other asset categories, as this type of expenditures has not a really long history in statistical terms. Consequently, it is quite difficult to take into account R&D in the capital over a long period.

III. THE FUTURE LIES AHEAD

56. When the 1993 SNA was drafted, the idea to consider R&D expenditure as a gross fixed capital formation was already in many minds. Methodological and conceptual issues then stalled the inclusion, and R&D was integrated only as intermediate consumption, thus as an item which diminishes value-added.

57. Nowadays, a convergence of opinions leads to the acceptance of the capitalization of R&D. While difficulties and uncertainties should not be underestimated, breakthroughs were achieved and various countries recently published first estimates of an R&D capital stock.

58. It is now time to define, to explain and to agree on R&D capitalization in the framework of the system of national accounts. Of course, it is too early to include R&D capital stock directly in the national accounts, but a process should be launched in order to find data and work out pragmatic solutions.

A. How to Find a Smoother Road with a Satellite Map

59. The road is still long up to a complete integration of R&D capitalization in the system of the national accounts. Methodologies are not yet consolidated and tested on a grand scale, and satellite accounts seem to be appropriate tools for testing the solidity of hypothesis which are needed to set up such a construct.

60. As outlined by Okubo et al. (2006): “While this satellite account does not affect national official measures of GDP, it provides an opportunity to work out new methodologies that may be incorporated into the accounts in the futures.”

61. The realization of a R&D satellite account is one of the main short term objectives for the Swiss federal statistical office. This paper can actually be considered as the first step in the implementation process.

B. Conclusions: Of the Importance of a Manual and the Key Role of OECD

62. The previous sections show that Switzerland has used instruments developed elsewhere to cope with data shortcomings and methodological difficulties. Many countries face the same situation, and the danger now seems to be that statistical offices develop tailor-made solutions only on the basis of national concerns. This might lead to heterogeneous solutions if assumptions were to differ. In order to realize international comparisons, it is crucial to know assumptions on which the work was carried out.

63. In order to insure minimal coherence, a manual should be published describing the major

concepts with the main recommendations, and describing “best practices”. In this context, the OECD seems to be the perfect “editor” and work is under way to provide statistical offices with guidelines. By operationalizing the concepts, the OECD would actively participate to a better understanding of the concepts related to the capitalization of R&D expenditures. Such a manual would help to disseminate concepts and improve knowledge, skills could become more specific and surveys could be reshuffled to cover the various needs of the users. By helping producers and users of statistical information to find a common ground, the OECDE would act again as a facilitator and provide the international community with resources which are central to the mission of statistical offices, namely efficiency of processes, integrity of data and comparability of results.

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List of abbreviations
FM : Frascati Manual
FSO : Federal Statistical Office
GFCF : Gross Fixed Capital Formation
OECD : Organization for Economic Co-operation and Development
R&D : Research and Development
SNA : System of National Accounts

APPENDICES

Appendix I: From GERD of the Frascati Manual to the R&D FBCF of the National Accounts

Data from derived of the Gross Expenditures in Research and Development (GERD) provided by the Frascati Manual (FM) and data relative to the R&D output defined by the System of national accounts (SNA 93) are not directly comparable. Based a process sketched by Peleg (2006), data from the Frascati Manual would need the following adjustments in order to be "SNA compatible":

GERD (from FM)
+ acquisition of R&D used as input in R&D production
+ depreciation of capital goods owned by R&D producers and used in R&D production
+ net operating surplus contained in R&D output measured at basic prices
+ other taxes less other subsidies on production
- capital expenditures__________________
= R&D output by SNA 93 definition.

Appendix II: Interpolation of R&D expenditures

1. In Switzerland, R&D expenditures of private businesses are recorded every four years. In order to interpolate data for the lacking three years, a growth rate of another indicator variable is used with a constraint. The constraint is that the average annual growth rate of the indicator variable must be adjusted in order to correspond to the average annual growth rate of R&D expenditure measured during the analyzed period. This is done by the following formula:

$$RD_{h,i} = RD_h \times \sqrt[n]{x^i} \times \frac{S_{h,i}}{S_h \times \sqrt[n]{Z^i}}$$

Where,

$RD_{h,i}$ is the amount of expenditures in R&D of the i^{th} year after the observed year h,

RD_h is the amount of expenditures in R&D for the first observed year.

$\sqrt[n]{x} = \sqrt[n]{\frac{RD_{h+1}}{RD_h}}$ is the average annual growth rate of R&D expenditures between two observed years (there are *n* years between these two observations),

$S_{h,i}$ is the indicator variable – available each year – of the i^{th} year after the observed year h,

$\sqrt[n]{Z} = \sqrt[n]{\frac{S_{h+1}}{S_h}}$ is the average annual growth rate of the indicator variable between the two observed years relative to R&D survey.

2. The indicator variable used to interpolate R&D data is Gross Domestic Product (GDP), with a positive lag of one year. That is to say that to estimate the annual growth rate of R&D expenditures of the year t, the annual growth rate of GDP of the year t+1 has been used. This choice can be explained by the fact that enterprises decide to invest or not, by anticipating the forecasted evolution of the demand (neo-classical approach of the investment theory).

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