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EXTENDING THE ASSET BOUNDARY TO INCLUDE RESEARCH AND DEVELOPMENT

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Executive summary

1. Expenditures on research and development (R&D) are not treated as capital formation in the 1993 SNA even though it is acknowledged that they are inherently investment in nature. The reasons that are usually cited, which are essentially technical in nature, are given in paragraph 6.163.

2. Over the last few years a task force set up by the OECD Working Party of National Experts on Science and Technology Indicators (NESTI) has been systematically addressing all the difficulties of using data compiled in the Frascati[1] system to support the inclusion of R&D assets in the national accounts. This task force has also participated in the Canberra II Group on the Measurement of Non-financial Assets and aided the Group in its work. The issues addressed include:

a) The scope of R&D capital formation

b) The definition of R&D

c) The measurement of R&D capital formation and other R&D statistics in the national accounts

d) The avoidance of double counting R&D output

e) Constant price estimation of R&D output

f) The measurement of R&D capital stock, capital services and consumption of fixed capital (CFC)

3. The Canberra II Group believes that the obstacles to incorporating R&D assets in the national accounts can be overcome reasonably well, and now we can proceed to remedy what has long been seen as a shortcoming in the SNA. In fact, the evidence is there that one can expect better estimates of R&D capital formation and related statistics than those relating to some existing assets. With the R&D data collected in the Frascati system, many countries are in a strong position to implement this proposal, and they are almost certainly in a stronger position than they were, and maybe still are, with respect to other intangible fixed assets. It would be a mistake to demand higher standards of R&D statistics than is the case for existing assets. Accordingly, the Canberra II Group makes the following recommendations:

1. The 1993 SNA should be changed to recognise the outputs of R&D as assets, and the acquisition, disposal and depreciation of R&D fixed assets should be treated in the same way as other fixed assets.
2. All R&D output should be treated as an asset, irrespective of its nature or whether it is made freely available. In the latter case, the asset should be recorded on the balance sheet of the owner of the original and be regarded as providing a free service until it becomes obsolete.
3. The definition of an asset should be reviewed to ensure it covers the assets of non-market producers adequately.
4. The definition of R&D given in the Frascati Manual (FM) should be adopted in the SNA.

[1] *Frascati Manual, Proposed Standard Practice for Surveys on Research and Experimental Development*, OECD, 2002. Available on the OECD website www.oecd.org

5. The Frascati system provides the best source of data for deriving estimates of R&D statistics, principally gross fixed capital formation (GFCF). However, there are shortcomings in the Frascati data and the FM should be amended to better support the needs of the SNA. (NESTI has indicated a willingness to do this.)
6. Most R&D output is produced over several periods and the SNA recommendations for the production of other assets should apply. Most R&D production is on own account, which implies recording it as GFCF as it occurs under the current recommendations.
7. Patented entities should no longer be recognised as assets in the system.

Issues for discussion

4. It is suggested that the AEG consider each of the recommendations in turn, drawing on the relevant parts of the main body of the paper as needed.

Background

5. Expenditures on R&D output are not treated as capital formation in the 1993 SNA even though it is acknowledged that they are inherently investment in nature. Paragraph 6.163 gives the explanation:

> Research and development are undertaken with the objective of improving efficiency or productivity or deriving other future benefits so that they are inherently investment – rather than consumption-type activities. However, other activities, such as staff training, market research or environmental protection, may have similar characteristics. In order to classify such activities as investment type it would be necessary to have clear criteria for delineating them from other activities, to be able to identify and classify the assets produced, to be able to value such assets in an economically meaningful way and to know the rate at which they depreciate over time. In practice it is difficult to meet all these requirements. By convention, therefore, all the outputs produced by research and development, staff training, market research and similar activities are treated as being consumed as intermediate inputs even though some of them may bring future benefits.

This paper only deals with the question of whether R&D should be regarded as investment. The ISWGNA has decided already that there should be no consideration given in the update as to whether human capital should be classified as an asset in the system, and by implication staff training. Market research and similar activities have been considered as part of issue 22, Purchased Goodwill and Marketing Assets in the SNA.

6. In fact, as Anne Harrison reports in her paper (Harrison, 2002), a decision was almost taken to treat expenditure on R&D output as capital formation during the preparation of the 1993 SNA. It was only late in the piece that concerns about where the boundary should lie led to the final decision not go ahead with this change. The upshot is that according to the 1993 SNA, R&D activity does not lead to the creation of assets.

7. This recommendation creates a difficulty – what to do with the outputs of R&D that generate income for their owners over a considerable period of time? The SNA solution is to recognise assets called 'patented entities' that are non-produced and just appear via the other changes in assets account. So, in effect, the SNA recognises those assets created by R&D which generate an income flow between units, while denying their connection with R&D production, and does not recognise at all those R&D assets whose services are consumed by their owners.

8. Although the 1993 SNA maintained the recommendation of the 1968 SNA to treat all R&D expenditures as consumption and to recognise patented entities as non-produced assets, it did change the 1968 SNA recommendation to record the income flows associated with patented entities from property income to the sale and use of services. Clearly the authors of the 1993 SNA felt that patented entities were really produced assets and the payments for the services they produce should be recorded accordingly, but it did leave the anomaly – in the context of the SNA - of non-produced assets producing services.

9. This was a disappointing outcome for many national accountants, not least for some of those involved in the preparation of the 1993 SNA. Indeed, this was recognized at the time the 1993 SNA was completed and so further work on the treatment of R&D figures prominently in the chapter of the manual devoted to the future research agenda.

10. Even though R&D output was not classified as an asset in the national accounts, the importance of measuring R&D activities explicitly was recognized, and the SNA notes that *"When research and development is carried out on a significant scale, within an enterprise, it would be desirable to identify a separate establishment for it"* (paragraph 6.164). However, this is not always the treatment in practice, and own account R&D (being an important part of total R&D) is in many cases treated as an ancillary activity in the national accounts. Also R&D activities in universities or other institutions of higher education have not been separated, in practice, from teaching activities in the national accounts compiled by countries, as suggested by the 1993 SNA. *"In principle, the two activities ought to be distinguished from each other …although there may be considerable practical difficulties when the same staff divide their time between both activities. There may be also interaction between teaching and research, which makes it difficult to separate them, even conceptually, in some cases."* (paragraph 6.142). As a consequence, a significant part of all generated R&D is not accounted for as R&D output in the national accounts.

11. Since the promulgation of the 1993 SNA there has been increased interest in what contributes to economic growth and why some countries have enjoyed more rapid growth than others. There is a widespread belief that R&D contributes to future growth in output. The knowledge gained from R&D is reflected in technological innovation, new products and better ways of doing things. While the 1993 SNA promotes the development of R&D satellite accounts as a way of meeting this analytical need, few countries have done so. In any case, occasional satellite accounts are a poor substitute for a full and frequent articulation that is necessary to support analysis of such an important economic phenomenon. So the question is, are we now sufficiently confident that the obstacles described in paragraph 6.163 of the SNA can be adequately overcome? The Canberra II Group has considered all the obstacles identified in this paragraph plus some others that are not, and has come to the conclusion that they can be dealt with sufficiently well to warrant changing the SNA recommendation on the treatment of R&D expenditure.

R&D facts and figures

12. The most important source of R&D data is the R&D accounts prepared according to the Frascati Manual (FM). Many countries conduct regular surveys of R&D expenditure according to the recommendations of the FM: the OECD R&D database holds FM data for over 30 countries and a database on the UNESCO website holds R&D expenditure data for 89 countries, with annual data for recent years for the majority. One of the main objectives of the FM is to measure the total expenditure on intramural R&D activities (i.e. all expenditures for R&D performed within a statistical unit or sector of the economy during a specific period, whatever the source of funds). While gross domestic expenditure on research and development (GERD) does not correspond to a national accounts measure of expenditure on R&D (the differences are discussed below) it provides an excellent indicator of the magnitude of R&D activity. The FM recommends that GERD be obtained by component, that data be collected for different types of R&D, that they be obtained for each institutional sector that undertook the R&D and also by which sector financed it.

13. Table 1 in Appendix I presents GERD as a percentage of GDP for OECD member countries and eight non-OECD countries. The OECD average is about 2.2% of GDP, but there is significant variation between the lowest and highest ratios: Sweden and Finland have the highest ratios and some eastern European countries have the lowest. The USA and Japan both have ratios higher than the OECD average, and because of the large size of their economies they lift the average up somewhat. The ratios for the eight non-OECD countries also vary greatly, ranging from 0.4% for Argentina and Romania to about 5% for Israel.

14. The FM identifies three principal components of R&D and defines them thus:

a) Basic research, defined to be experimental or theoretical work undertaken primarily to acquire new knowledge or the underlying foundation of phenomena and observable facts without any particular application or use in view.

b) Applied research, defined to be original investigation undertaken in order to acquire new knowledge… directed primarily towards a specific practical aim or objective.

c) Experimental development, defined to be systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

15. Many countries (including Australia, Czech Republic, France, Hungary, Japan, Slovak Republic, South Korea, Poland, Spain, Switzerland, USA, Argentina, Chile, China, Romania, Russian Federation, Singapore, Slovenia and Chinese Taipei) are able to provide a breakdown of expenditure by the three above categories. For the year 2000 the distribution is: Basic research 18%; Applied research 23%; and Experimental development 59%. Of the total R&D expenditure by these countries 52% and 19% was spent by the USA and Japan, respectively. Note that the data for many of the countries, but not the USA, used to produce these proportions include capital expenditures as well as current expenditures (other than consumption of fixed capital). The distribution of the three kinds of R&D for the USA is 21: 21: 59.

Should all expenditures on R&D output be recorded as capital formation?

16. Identifying the scope of R&D assets is probably the most controversial issue to deal with. It certainly was the principal reason that a recommendation not to include any output of R&D in the asset boundary was made in the 1993 SNA. According to Harrison (2002) and the 1993 SNA itself, the major concerns were in regard to the inclusion of basic research and the inclusion of all research in the social sciences. Within the Canberra II Group the principal concern has been whether R&D output that is made freely available should be regarded as an asset.

<u>Should R&D output made freely available be recorded as an asset?</u>

17. This question has posed the greatest difficulty for the Canberra II Group and it has in fact led to a significant split between its members. The majority view is that all expenditures on R&D output should be recorded as capital formation, but there is a minority that questions whether all R&D output meets the definition of an asset. The difference of opinion centres on the question of whether R&D output that is disseminated freely meets the SNA asset criteria. This principally concerns R&D output produced or financed by non-market sector producers. The asset criteria given in paragraph 10.2 of the 1993 SNA are as follows:

> The assets recorded in the balance sheets of the System are economic assets. These are defined as entities:
>
> a) Over which ownership rights are enforced by institutional units, individually or collectively; and
>
> b) From which economic benefits may be derived by their owners by holding them, or using them, over a period of time.

18. Those opposed to treating all expenditure on R&D as capital formation argue that if there is no exclusive ownership or control of the knowledge gained from R&D output then it fails to meet the definition of an asset. It is often, if not generally, the case that governments and non-profit institutions (NPIs) give unrestricted access to the knowledge gained from the R&D output they have either undertaken or sponsored. This implies ownership rights are not being enforced and there is no direct economic benefit

to the institutions disseminating the knowledge. While the knowledge may bring general benefits it is not owned by any particular institutional unit once it has been disseminated.

19. Those in favour of treating all expenditure on R&D output as capital formation argue that the fact that ownership is not enforced does not change the asset nature of such R&D. The registration of such R&D is important for the analysis of production processes of the whole economy, even though it may not be possible to allocate the capital services derived from the R&D between units in the economy. Such R&D should at least be registered as assets under a separate heading, even if it means changing the guidelines for registration of assets in the SNA. They argue that there is a parallel with public assets, such as roads, the services of which are provided free of charge yet they are considered as assets owned by government on behalf of the community at large. Such assets provide a service to the community collectively which contributes to its production and welfare. If this is accepted for public assets, such as roads, why is not accepted for R&D output?

20. Each of the two sides to the debate has further arguments and counter arguments and these are summarized in Appendix II. In order to determine what major users thought, Canberra II members were asked to consult them and the outcome is presented in Appendix III (Aspden, 2004b).

21. Very recently Sveikauskas (2005) has posted a paper on the Canberra II EDG in which he argues that market sector R&D expenditures should be recorded as capital formation because firms commit resources in the hope that they will lead to greater profits in the future. But he also argues that R&D differs from other forms of capital in that it is a non-rival good which provides benefits to other firms and customers, as well as the firm that owns the R&D asset. Because of this feature it would be a mistake to be too strongly committed to the 'private asset' view of R&D, and we need to take a broader view of R&D in order to capture the role of R&D in productivity growth.

22. He gives two examples that demonstrate the importance of the diffusion of knowledge from firms undertaking research to the broader community. One concerns statins, a new class of anti-cholesterol drug which has contributed to the decline of heart disease. A major pharmaceutical firm introduced the first statin in 1987, and conducted pioneering research demonstrating that statins were safe, lowered cholesterol, and successfully reduced the death rate from heart disease. Since 1987, several firms have introduced new and improved statins. A different firm now produces a new and greatly improved statin that has become the market leader. Sveikauskas argues that even though the second firm dominates the market we cannot ignore the R&D undertaken by the first firm, which is still relevant to the industry and provides substantial social returns, even though the second firm is gaining most of the private returns. Sveikauskas's second example concerns the production of semiconductors. In this case market competition has meant that the consumer has obtained most of the benefits of the R&D undertaken.

23. His survey of innovation studies suggests that the social return to R&D is very large, and exceeds the return to all firms by more than 40 per cent. Furthermore, he quotes research findings that imply that some of the benefits of successful R&D undertaken by one firm in an industry quickly spread to its competitors, both in its home country and in other countries, as in the two examples, above.

24. Sveikauskus does not support the recognition of R&D capital formation undertaken by government and NPIs on the grounds that there is little evidence that it contributes to the growth in market sector output. But this is not the appropriate criterion for its recognition in the national accounts. The goal of much R&D undertaken by the non-market sector is to improve the welfare of people - such as health, the environment, education and on defence to improve security. The benefits are not reflected in private sector output, but in the output of the non-market sector which, by convention, is measured by summing inputs.

25. Some of those opposed to treating all expenditure on R&D as capital formation acknowledge that it would be difficult in practice to separate R&D output that was made freely available by a unit from that which was protected in some way. Accordingly, they have proposed that R&D expenditure undertaken by general government and NPIs be treated as consumption and that undertaken by private and public enterprises be treated as capital formation (de Haan, 2004).

26. While acknowledging that excluding R&D output produced by non-market producers is a practical solution, the majority of Canberra II members think it is a rather crude one because not all the results of R&D are given away by government and NPIs: some of them are protected by patents and in the case of defence they are kept secret. Also, it has become commonplace in many countries for units in the non-business sector to receive funding from business sector units which are often in the form of joint projects, although this is usually small: often around 5-10% of non-market GERD. It is also the case that government provides funding for R&D undertaken by private enterprises. It therefore appears to be the case that there are large spillovers from practically all R&D, but they are relatively greater in the non-market sector than they are in the market sector.

27. In quite a few countries (USA, Japan, Ireland, Korea, Switzerland) over 70% of GERD is undertaken by the business sector, but there are others where the proportion is much less: Australia 47%, Greece 32%, Hungary 36%, Italy 49% and Mexico 20%. Thus, if R&D undertaken by non-business units were not recorded as GFCF only a minor proportion of R&D output in these countries would be recorded as GFCF.

<u>Should the output of 'esoteric' R&D be recorded as an asset?</u>

28. Most members of the Canberra II Group hold the view that, in principle, only those expenditures on R&D that are undertaken with the aim of increasing production in the future should be recorded as capital formation. Thus, research into dead languages, for example, does not qualify. However, the Group noted that expenditures of this type account for only a very small proportion of total R&D expenditures, and any attempt to exclude them would be costly and probably lead to less accuracy and a reduction in international comparability. Therefore, on practical grounds, the Group believes that it is better not to attempt to exclude them, and to record all expenditure on R&D as capital formation.

<u>Should the output of research that has no particular goal be recorded as an asset?</u>

29. As already noted, the FM identifies three principal components of R&D: basic research, applied research and experimental development. It also distinguishes between two types of basic research (paragraph 243 of the FM):

a) Pure basic research is carried out for the advancement of knowledge, without seeking long-term economic or social benefits or making any effort to apply the results to practical problems or to transfer the results to sectors responsible for their application.

b) Oriented basic research is carried out with the expectation that it will produce a broad base of knowledge likely to form the basis of the solution to recognised or expected, current or future problems or possibilities.

30. Without basic research technological progress would be severely reduced. It would appear that with only applied research and experimental development technological progress would be restricted to improving existing technologies, and technological leaps (such as the invention of the transistor) would occur only by chance. Clearly, those who finance basic research do so in the belief that it will benefit themselves or those they represent in the long run, even though they know that some of the output of basic research will become available to others. They accept that many projects will not lead to any economic benefit, but they expect that some projects will lead to such a large benefit that it makes the expenditure for all basic research worthwhile.

31. It appears that few countries publish a breakdown of basic research into the two components. The difficulty to separate basic R&D from other R&D reported by many countries may indicate that basic R&D often is closely linked to other types of R&D, and that the separation in some cases may be artificial.

32. *Conclusion 1 All R&D output should be treated as an asset, irrespective of its nature or whether it is made freely available. The definition of an asset should be reviewed to ensure it covers non-market sector assets adequately.*

Definition of R&D

33. The FM defines '*research and experimental development to comprise 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.*' The 1993 SNA does not give an explicit definition of R&D and the closest it comes to doing so is in paragraph 6.163 '*research and development are undertaken with the objective of improving efficiency or productivity or deriving other future benefits so that they are inherently investment – rather than consumption – type activities'*. However, various paragraphs in the 1993 SNA that mention R&D imply a definition that is somewhat broader and more akin to the FM's definition and coverage of market and non-market activities, including, for example, R&D activities that are mixed with education (paragraph 9.89).

34. Peleg (2003c) reports on the various definitions of R&D given in business accounting standards of a number of OECD countries. The definition of R&D in the UK is given in SSAP13.

> R&D is the process by which new scientific and technological information is discovered, gathered and used involving theoretical conjecture, observation, experiment, measurement and deduction. It is research that aims to break new ground or to resolve scientific or technological uncertainties. The key theme is that to be R&D activities must be creative or innovative work in the fields of science or technology and undertaken with a view to the extension of knowledge. R&D is characterised by work that contains an appreciable element of innovation and breaks new ground or aims to resolve scientific or technological uncertainties. Such work can range from "blue skies" research in areas that are purely theoretical, to applied research and experimental development directed towards a practical aim or product. R&D can include the development of prototypes and pilot plant to test the R&D, but commercial development without such scientific or technological investigation, or after the resolution of such uncertainties, is not R&D for tax purposes.

35. Japan's Business Accounting Deliberation Council gives the following definition (1997):

> "Research" is "a planned search and exploration for discovering new knowledge," and "development" is "a process of translation of research findings and other knowledge into a plan or design for new products, services, and processes (hereafter, collectively "products") or a plan or design for bringing significant improvements on the existing products."

36. Australian tax legislation has the following definition: Section 73B(1) "Research and development activities" means:

a) systematic, investigative and experimental activities that involve innovation or high levels of technical risk and are carried on for the purpose of:
   i. acquiring new knowledge (whether or not that knowledge will have a specific practical application);
   ii. or creating new or improved materials, products, devices, processes or services;
b) or other activities that are carried on for a purpose directly related to the carrying on of activities of the kind referred to in paragraph (a).

37. The USA accounting standard SFAS 2 defines research and development as follows:

a) Research: is planned search or critical investigation aimed at discovery of new knowledge with the hope that such knowledge will be useful in developing a new product or service or a new process or technique or in bringing about a significant improvement to an existing product or process.
b) Development: is the translation of research findings or other knowledge into a plan or design for a new product or process or for a significant improvement to an existing product or process whether intended for sale or use.

38. The UK, Japanese and Australian definitions accord quite closely with the FM with regard to basic research, while the USA definition is more akin to paragraph 6.133. The International Accounting Standards Board issued a standard - IAS 38 - in 1998 that concerned all intangible assets, including R&D and replaced the IAS 9 on which many of the current national standards are based[2]. The definition of R&D in IAS 38 is given as follows:

a) Research is original and planned investigation undertaken with the prospect of gaining new scientific or technical knowledge and understanding.

b) Development: is the application of research findings or other knowledge to a plan or design for the production of new or substantially improved materials, devices, products, processes, systems or services prior to the commencement of commercial production or use.

This definition is quite consistent with that of the FM when one takes account of the fact this is a business standard and is therefore focussed on scientific and technological R&D and is not very concerned with the social sciences.

39. Clearly, the 1993 SNA is deficient in its definition of R&D. By contrast, the FM definition seems most appropriate and is consistent with modern business accounting standards.

40. *Conclusion 2 The FM definition of R&D expenditure should be adopted in the SNA.*

The measurement of expenditure on R&D output using input data

41. Gross fixed capital formation is the value of the acquisition (less disposal) of fixed assets by producing units. R&D output is either purchased from another unit (including cases where the second unit undertakes R&D under contract to the first unit) or is undertaken on own account. In the former case the R&D output should be valued at the price paid by the first unit to the second unit. In the latter case the 1993 SNA recommends that fixed assets should be valued at their estimated basic prices, or by their cost of production when it is not possible to make a satisfactory estimate at basic prices.

42. For R&D output that is not sold outright by its producer the services produced by R&D output are either used by it or they are sold in return for royalty payments. In the latter case, another possible way of estimating the value of an R&D asset presents itself, and that is if the owner of an R&D asset could estimate the net present value of the future income the asset will generate. There are two factors that make this approach difficult. First, a reasonably accurate estimate may only be able to be made quite a long time after the R&D production occurred. Second, if it were possible to produce adequate, timely estimates how could these be combined with estimates of the remainder of R&D, based on input costs, without omission or double counting? This would not be easy and presumably would entail asking producers of R&D output to identify what proportion of their output was intended for rental on the one hand and what proportion was intended for own account consumption or produced on contract for another unit on the other hand. The first part would be excluded from estimates of R&D GFCF and replaced by estimates of the net present value of future rentals. One wonders how accurate estimates of R&D GFCF derived in this way would be.

43. Given that most R&D is undertaken on own account and the owner uses the services of the R&D internally, then, following the current recommendations in the 1993 SNA, the bulk of R&D capital formation in practice would be made by summing the cost of inputs. These should include estimates of capital services from non-financial assets owned by the producer that are being used to produce R&D output. This should certainly apply to market production and also non-market production if the Canberra II Group proposal to replace consumption of fixed capital with capital services when measuring non-market production by summing costs is incorporated in the updated SNA.

[2] According to IAS 38 research should be expensed, while development may be capitalized under certain conditions. But from a special report prepared by the Financial Accounting Standard Board (FASB) in 2001, it seems that changes in the treatment are being considered.

44. This solution is not without its objections, most of which stem directly from the fact that inputs are being used to value outputs. Three major ones are:

a) Not all R&D is successful.

b) R&D production can span many years before there is worthwhile output.

c) R&D output is fluid.

45. Some people might argue that only successful R&D activity should be treated as capital formation. Large organisations that finance or undertake many R&D projects understand that the success of any particular project is not assured, but they expect that enough will be successful to cover the costs of both the successful and unsuccessful projects. Organisations that only finance or undertake a few R&D projects must expect that the benefits of a successful outcome will exceed the costs by a significant margin, given the uncertainty of success. Otherwise, in the long run, if the benefits did not exceed the costs such R&D would not be undertaken, at least by market producers. Hence, if only expenditure on successful R&D projects were recorded as capital formation there would be a (more) serious understatement of R&D capital formation. This line of reasoning led to the recommendation in the 1993 SNA to record all mineral exploration, whether successful or unsuccessful, as capital formation.

46. It takes time to complete a R&D project, and while work is proceeding there is an accumulation of work in progress in inventories. In concept, once the project is complete the inventory should be run down and transferred to fixed capital formation. Two types of lags have been identified: gestation lags and application lags. The gestation lag is the time taken to undertake a R&D project, and the application lag is the time taken from the completion of the R&D project to its initial commercial use. In the report of its construction of a R&D satellite account, the BEA (1994) notes that survey-based research has found that gestation lags range from 1 to 2 years and that application lags range from less than 1 year to more than 2 years. For the purpose of deriving capital formation of R&D only (half) the gestation lag needs to be considered, and the BEA used a one year lag.

47. R&D assets are knowledge assets. So, one can argue that as soon as a quantum of knowledge has been gained then it can be said that there is fixed capital formation. This means that one does not necessarily have to wait until a project has been completed before GFCF can be recognised. There can well be readily identifiable intermediate steps in an R&D project where fixed capital formation can be recorded. This line of reasoning implies that R&D output need not be very long in inventory before it can be legitimately viewed as a fixed asset – an asset that contributes to further R&D production or some other output.

48. R&D output is not alone in requiring more than one accounting period to be produced. It shares this characteristic with many other assets, such as major construction projects and the manufacture of large pieces of equipment, such as ships, and it should be dealt with in a consistent way. The bulk of it is undertaken on own account, which implies recording R&D output as GFCF as it occurs. That which is being undertaken under a sale contract or is intended to be sold should be recorded as work-in-progress of the producer. Note that the 1993 SNA recommendations in this regard are the subject of review by the Canberra II Group as part of the issue, Classification and terminology of non-financial assets (issue 27),

49. As already mentioned, there is a good deal of information transfer from units engaged in R&D that crosses unit and country boundaries as well as through time. Such imported information can contribute to the output of R&D, as well as other outputs, by a unit. There are also substantial benefits for the consumer. The upshot is that most of the benefits flow to units other than the one undertaking or financing the R&D. Nevertheless, the total benefits from R&D exceed the costs by such a large margin that units expect to make an adequate return on their R&D expenditures, sufficient to cover their costs and the substantial risk inherent in undertaking R&D. Market forces are likely to ensure that, overall, the benefits of undertaking R&D that accrue to the producing units will correspond to the costs they incur plus a risk premium. A risk premium will always be present for investment in tangible and intangible assets when there is risk, and the

greater the risk the greater the premium. One would expect substantial risk premiums for software development and mineral exploration, for example.

50. *Conclusion 3 Using input data to measure R&D output should produce acceptable estimates, overall.*

51. *Conclusion 4 Most R&D output is produced over several years and the SNA recommendations concerning other produced assets should apply. Most R&D is produced on own account, which, under the current recommendations, means that fixed capital formation should be recorded as the R&D is produced.*

Using R&D collected as per the Frascati Manual

52. As already noted, the most important source for R&D data is the R&D accounts prepared according to the FM. These accounts have been compiled by many countries for many years, and they are well established. There is no other comparable existing source of data, hence it follows that we should look very closely at the FM data and assess their suitability for deriving estimates of capital formation of R&D and other R&D statistics.

53. One of the main objectives of the FM is to measure the total expenditure on intramural R&D activities. It thus differs in several respects from what is required for deriving capital formation of R&D. First, the FM intramural measure of R&D expenditure needs to be augmented by a measure of extramural expenditures in order to get an estimate of total R&D capital formation by a unit. To avoid double counting, sales or transfers of R&D from the donor unit need to be subtracted from its intramural R&D expenditures to obtain its capital formation of R&D. Second, the FM's measure of 'total expenditure' comprises the following:

Labour costs

Other current costs

Capital expenditures (including land)

Subsidies *less* taxes on production

54. Annex 3 of the FM systematically describes the differences between GERD and the 1993 SNA measure of R&D output. In brief, the FM measure of labour costs is very similar to compensation of employees. Other current costs correspond to intermediate consumption, with the principal difference being that changes in inventories of inputs are not taken account of. Capital expenditures need to be replaced by estimates of capital services (principally consumption of fixed capital (CFC) and a return to capital) for market producers and CFC for non-market producers[3]. This requires using the perpetual inventory method (PIM) to derive estimates of capital services and CFC using the capital expenditure data relating to fixed assets collected in FM surveys. Also, taxes on production should be included and subsidies excluded in GFCF. The institutional sectoring in the FM differs from that in the SNA.

55. A task force was established in the framework of the NESTI group of OECD, and its purpose was to (Mandler and Peleg (2003)):

a) examine the methodological issues raised by an accounting of R&D in a SNA framework, to investigate the needed adaptation of data constructed in the Frascati framework, and estimate their impact on R&D figures;

b) empirically explore the utilization of the FM data as a starting point to generate the R&D data required by the SNA, considering issues of coverage and valuation of production of R&D, as well

[3] If the Canberra II recommendation on the measurement of non-market production is accepted then the treatment would be the same as for market producers.

as adjustments needed to put R&D in a supply and use framework. The needed adjustments and additions will be analyzed and implemented as far as possible;

c) investigate methods for the preparation of estimates at constant prices, and at international prices (PPP); and

d) investigate the possibility of estimating R&D depreciation, obsolescence, and stocks under various assumptions in the framework of satellite accounts.

56. In a subsequent report (Mandler and Peleg, 2004a) to NESTI, the task force concluded that it is feasible to construct bridge tables between the Frascati system and the national accounts and that most of the additional data are obtainable from R&D surveys. The task force (Mandler and Peleg, 2004b) also recommended that future revisions to the FM should include features to overcome the few significant shortcomings. At its meeting in June 2004, NESTI welcomed the report and expressed its support for the notion of linking the Frascati system to the national accounts. In a letter to the chair of the Canberra II Group, the NESTI chairman invited the Canberra II Group to submit a proposal for changes to the FM that would aid the construction of bridge tables to the national accounts and proposed that the most important changes be trialled by a few NESTI members. Subsequently, a paper was sent from the Canberra II chair to his NESTI counterpart (Aspden, Lopez-Bassols Reyes, Mandler, Peleg, 2005).

57. The main changes to the FM mentioned in the paper were requirements for refined classifications of the data collected in the R&D surveys: a classification of data on sources of funds for the performance of intramural expenditures between R&D sales to domestic producers and to those abroad (i.e. exports), and transfers received. Similarly, a classification of extramural expenditure between acquisition of R&D performed by other units (separating acquisitions from domestic and from foreign producers) and grants and other types of transfers. A sub-classification of the institutional units within the higher education sector and the business sector according to the SNA/ESA institutional classifications was also proposed. In addition, it was proposed to add recommendations to use national accounts data and methods in order to estimate the operating surplus and net taxes on R&D production needed in the bridge tables.

58. Since the FM has recently been updated and a new revision can only be expected after a number of years, the paper also outlined some intermediate estimation methods that would be feasible in the short term before the changes in the FM manual and in R&D surveys are implemented. The R&D estimates thus obtained would be of a reasonable reliability, and would satisfy the most urgent needs for the national accounts.

59. Making changes to the FM will address many of the problems, but national statistical offices will also need to play their part. First, they will need to undertake the additional work required to meet the revised recommendations in the FM. Second, they will need to ensure that their R&D surveys are adequately integrated with the business surveys used to support the national accounts, such as using the same business register and designing their R&D surveys to produce adequate estimates by sector and industry of activity at the required level of detail.

60. *Conclusion 5 The Frascati system provides the best means of deriving estimates of R&D GFCF. However, there are shortcomings in the Frascati data and the FM should be should be amended to better support the needs of the SNA. National statistical offices will need to integrate their R&D and business surveys.*

Boundary issues with current expenditure and GFCF of other fixed assets

61. There are two types of boundary issue in measuring R&D. The first is to discriminate between expenditure on R&D activity and current expenditure, and the second is to discriminate between expenditure on R&D and other fixed assets. Chapter 2 of the FM addresses the more difficult cases in detail. The second boundary issue is most serious in respect of own account software production, and Section 2.4.1 of the FM is devoted to it.

62. Given that we can obtain estimates of software R&D excluding software production, how can we make sure that the estimates of software GFCF exclude software R&D? Aspden (2004c) notes that the OECD software taskforce (2002) recommended that expenditure on software R&D should be included in estimates of own account software GFCF. The rationale being that software R&D is presently treated as an expense and if it contributes to the production of software it should be included along with all the other input costs in estimating the value of own account software GFCF at basic prices. Hence, countries following this recommendation are already including current expenditures on software R&D in their estimates of software GFCF. This suggests that double counting can be avoided by simply subtracting expenditure on software R&D from the existing estimates of software GFCF. However, the capital service flows from the stock of software R&D should be included in the own account GFCF of software. The upshot is that the proposed estimates of own account GFCF of software would equal estimates compiled under the 1993 SNA *plus* the value of capital services from the stock of software R&D *less* the GFCF of software R&D in the current period. A similar approach could be adopted for mineral exploration, which is another field where double counting could occur.

63. *Conclusion 6 The boundary between R&D GFCF and current expenses can be resolved satisfactorily by following the FM guidelines. Significant double counting of GFCF of R&D can be readily avoided.*

Constant price estimates

64. The task of deriving volume estimates of R&D output or capital formation is for the most part just the same as that faced with any non-market output. Irrespective of the fact that the current price estimates of R&D output may be derived using the cost of inputs, the volume estimates should reflect the growth in output. If there are no satisfactory indicators of output - which is generally the case with R&D - then deflation of the inputs is the next best solution. This should be done at the most detailed level possible, using price and wage rate indexes that relate to the purchase prices of the inputs being deflated.

65. Annex 9 of the FM discusses the derivation of constant price estimates in some detail. However, the NESTI task force has recommended some improvements (Peleg, 2003).

66. *Conclusion 7 Detailed input price indexes, corresponding to the constituents of the estimates should be used to derive constant price estimates of R&D output and GFCF.*

Measures of capital

67. Estimates of the capital stock of R&D have been derived using econometric methods as well as the perpetual inventory method (PIM)[4]. The latter is the method most commonly used to derive estimates of tangible fixed assets for national accounts purposes and it can be used to derive estimates of R&D capital stock in just the same way. In order to do so, constant price estimates have to be derived of R&D capital formation to allow the aggregation of different vintages, and the service lives of assets, asset-life distribution functions, age-efficiency functions and depreciation rates (or age-price functions) – which are all inter-related - have to be specified. Undoubtedly, the most important of these is the service life.

68. In equilibrium, the value of an asset is equal to the net present value of expected future benefits. Hence, the value of an asset declines over time unless the value of the benefits do not decline, such as can be the case for natural assets like land. Like other intangible assets, R&D is not subject to wear and tear. It can be subject to obsolescence in the way that software is, and for R&D that is given away freely it is the rate at which it becomes obsolete that determines the decline in its 'value'[5]. For an R&D asset that is

[4] For a comprehensive description of the application of the PIM and the estimation of capital measures refer to the OECD manual *Measuring Capital, Measurement of Capital Stocks, Consumption of Fixed Capital and Capital Services*, OECD, 2001. Available on the OECD website www.oecd.org

[5] As noted above, some would argue that something that is given away freely has no value. To avoid argument, 'value' can be taken to mean to be of benefit to the community at large.

protected in such a way that the owner has a monopoly over its use then the benefits decline in value as the asset becomes obsolete or as the owner loses its monopoly – whichever is the predominant factor.

69. Researchers have employed two different approaches to estimating depreciation rates and asset service lives for R&D output: the patent renewal method and econometric methods. The patent renewal approach uses data from patent offices which show for how long particular patents have been renewed – for a fee – by their owners. Pakes and Schankerman (1986) have used patent renewal data to not only estimate depreciation rates but also to estimate the value of patents for a number of European countries (France, Germany and UK). Using data from 1955-81, their preferred model led to estimated average annual depreciation rates of 15% for Germany and 24% for the UK. They also found that the estimated annual depreciation rates declined over the period and in the 1970s were 11% for Germany and 17% for the UK. These estimates were closer to their estimate for France (10%) for which they only had data from 1970-81. An annual depreciation rate of 11% corresponds to an asset life of 21 years if it is assumed that an R&D asset is obsolete when annual revenues fall to less then 10 per cent of the initial revenue, and 17 years if the assumption is 15 per cent. Pakes and Schankerman also found that their estimates of the value of patents, while substantial, were much less than estimates of the expenditure on R&D. The Australian Bureau of Statistics (ABS, 2004) used patent renewal data to determine that the median period for which patents are renewed in Australia is 9 years. However, Pakes and Schankerman found the length of patent renewals was very skewed, with the more successful and valuable patents having much longer renewal periods than the less successful patents. This implies that the mean patent renewal life of all patents in terms of value might well exceed the median renewal period substantially, depending in part on the structure of the renewal fee schedule. It must be remembered that the values of R&D inputs are used only as a means of estimating the values of R&D outputs, and so it is the depreciation rates and service lives of outputs that are required.

70. Researchers have used econometric models in which the decline in the value of R&D assets is linked to future output or revenue, or a production function is estimated in which one of the inputs is the capital service flow from the stock of R&D. In their survey of the literature, Rosa and Rose (2004) report annual rates of depreciation that vary by between 10% and 20% across industries.

71. In his review of the various attempts to estimate the lives of R&D assets, Diewert (2005) rightly notes that the limitation of the patent renewals method is that it does not cover all R&D. His review of some of the econometric methods (reported by Rosa and Rose) that have been used to derive R&D depreciation rates reveals severe shortcomings that led him to write “our conclusion at this point is that none of the suggested econometric methods for estimating the effects of R&D investments are completely satisfactory” and “.. the econometric evidence on this question seems, at least to this reader of the evidence, to be unreliable and inconclusive.” In the case of the work of Nadiri and Prucha (1996:48) he finds that their model attributes all growth in multifactor productivity to R&D – ignoring the contributions of other factors, such as economies of scale and better working practices. Hence, their estimate of an annual 12% depreciation rate is very likely understated and the associated service life is considerably less than 20 years.

72. All of the studies referred to above are concerned with market producers, and we are unaware of estimates of asset service lives for non-market producers. In these circumstances, it seems the best option is to assume that they have the same length as the R&D assets of the market producers they most closely resemble.

73. Although it is not possible at the present time to give definitive advice on what asset lives to use in the PIM or how to estimate lives for non-patented assets, there are prospects for improving the quality of estimates derived by econometric models, as Diewert (2005) shows. In reality, the situation is no worse than for most tangible assets.

74. *Conclusion 8 Measures of R&D capital can be derived in the same way as other fixed assets. In concept, an R&D asset made freely available should be recorded on the balance sheet of the owner of the*

original and be regarded as providing a free service until it becomes obsolete. For an R&D asset that is protected in some way the service life is determined by obsolescence or when the owner loses the protection, whichever is predominant. There are difficulties in determining rates of depreciation and asset service lives, and it is clear that more work needs to be done. Nevertheless, for the bulk of R&D assets the situation is no worse than it is for most other fixed assets.

Practicality of extending the asset boundary to include R&D

75. Over the last ten years, or so, members of national statistical offices (most of whom are members of the Canberra II Group) have compiled estimates of R&D GFCF, capital stocks, depreciation and related statistics. They include:

a) BEA (1994) a detailed satellite account for the USA.

b) Fraumeni and Okubo (2002) undertook an analysis that included estimating the contribution of R&D to to the growth in US output.

c) Peleg (2003b) compiled supply and use tables and capital stock estimates of R&D for Israel.

d) Peleg (2005) undertook a study to evaluate the impact of capitalising R&D for Israel.

e) De Haan and van Rooijen-Horsten (2004) compiled a set of R&D accounts for the Netherlands

f) ABS (2004) compiled a set of R&D accounts for Australia.

The last four of these projects have been undertaken to determine the practicality of compiling accounts with R&D capital formation, the size of the impact on major aggregates, identifying problem areas, and determining the seriousness of various data deficiencies. This work has led the Canberra II Group to conclude that it is practical to incorporate the capital formation of R&D in the accounts, and the information gleaned has provided the Group with a sound basis for making a request to NESTI for changes to R&D surveys to better support its implementation.

76. *Conclusion 9 The work of these national accountants amply demonstrates the practicality of incorporating R&D assets in the national accounts.*

Recommendations

77. The following recommendations are made:

1. The 1993 SNA should be changed to recognise the outputs of R&D as assets, and the acquisition, disposal and depreciation of R&D fixed assets should be treated in the same way as other fixed assets.
2. All R&D output should be treated as an asset, irrespective of its nature or whether it is made freely available. In the latter case, the asset should be recorded on the balance sheet of the owner of the original and be regarded as providing a free service until it becomes obsolete.
3. The definition of an asset should be reviewed to ensure it covers the assets of non-market producers adequately.
4. The definition of R&D given in the Frascati Manual (FM) should be adopted in the SNA.
5. The Frascati system provides the best means of deriving estimates of R&D statistics, principally gross fixed capital formation (GFCF). However, there are shortcomings in the Frascati data and the FM should be amended to better support the needs of the SNA. (NESTI has indicated a willingness to do this.)
6. Most R&D output is produced over several periods and the SNA recommendations for the production of other assets should apply. Most R&D production is on own account, which implies recording it as GFCF as it occurs under the current recommendations.

7. Patented entities should no longer be recognised as assets in the system.

Impact on the accounts

78. If the recommendation to recognise capital formation of R&D were accepted then it would have a number of implications for the accounts. Intangible fixed assets would have a new member. The values of own account GFCF of existing fixed assets, particularly software, would differ by the value of capital services from the stock of R&D *less* the current costs of R&D included in the existing estimates. Total GFCF, GOS, output, GVA, GDP, saving and net worth would all be larger. The output of market producers would be greater, mostly due to the increase in their output of R&D for own use. The output of non-market producers would be greater by their CFC[6] of R&D: expenditures on R&D are already included in their output but the capital service flow from their stock of R&D assets would now be added. The GDP of OECD member countries as whole would probably be about 2 per cent larger. Most of the studies listed above (paragraph 76) indicate little impact on the growth of GDP. An exception is a recent study for Israel (Peleg, 2005) which shows a significant impact – up to 0.5% - for some years. This is in part due to the recognition of work in progress by R&D producers that should have been included in the estimates already.

79. Patented entities would cease to be recognised as assets in the national accounts. Hence, the value of non-produced assets would be reduced on the balance sheet - at least in theory. (One wonders how many national statistical offices actually record patented entities in their accounts. The lack of such data in country national accounts is testimony to the weakness of the current recommendations.) The value of R&D assets would exceed sum of the value of patented entities currently recorded, because not all R&D output is patented. Hence, the total value of assets on the balance sheet would be greater and net worth would be greater.

80. Even though patented entities are classified as non-produced assets in the 1993 SNA, payments for their use are treated as the sale and purchase of services. These flows would remain unchanged.

81. Many of the accounts are affected by the proposed changes, but in a fairly straightforward way. For simplicity only the affected entries are shown for the whole economy. Entries as they are shown in Annex V of the 1993 SNA are made using a normal font while proposed changes are made using italics. The differences are shown in the end column and explanations are given in brackets.

[6] They would be larger by the value of capital services if the Canberra II recommendation with respect to measuring non-market output were accepted.

Impact on the accounts for the total economy

Account 0: Goods and services account	Old/*New*	Diff.
<u>Resources</u>		
P.1 Output	3604 *3636*	32
P.12 Output for own use	171	30
(Increased by GFCF of R&D produced on own account)	*201*	
P.13 Other non-market output	376	2
(Output increased by R&D CFC)	*378*	
<u>Uses</u>		
P2. Intermediate consumption	1883	-2
(Reduced to the extent of purchases of R&D assets)	*1881*	
P.51 Gross fixed capital formation	376 *410*	34
P.511 Acquisitions less disposals of tangible fixed assets	303	1
(For own account capital formation: differs by the value of capital services from the producer's stock of R&D *less* the current costs of R&D included in the existing estimates.)	*304*	
P.512 Acquisitions less disposals of intangible fixed assets	51 *84*	33
P.5121 Acquisitions of new intangible fixed assets	53 *86*	33
Software	40	-2
(For own account capital formation: differs by the value of capital services from the producer's stock of R&D *less* the current costs of R&D included in the existing estimates.)	*38*	
Mineral exploration	8	-1
(As for software)	*7*	
R&D	0 *36*	36
P.5122 Acquisitions of existing fixed intangible assets	6	0
(Could be different)	*6*	
P.5123 Disposals of existing fixed intangible assets	-8	0
(Could be different)	*-8*	
P.5132 Cost of ownership transfer of non-produced non-financial assets	17	0
(Could be different with the removal of non-patented entities)	*17*	

Account I: Production account	Old/*New*	Diff.
Uses		
P.2 Intermediate consumption	1883 *1881*	-2

B.1*g Gross domestic product	1854 *1888*	34
K.1 Consumption of fixed capital	222 *230*	-8
B.1*n Net domestic product	1632 *1658*	26
Resources		
P.1 Output	3604 *3636*	32
P.11 Output for own final use	171 *201*	30
Other non-market output	376 *378*	2

Account II.1.1 Generation of income account	Old/*New*	Diff.
Uses		
B.2 Net operating surplus	247 *267*	20
B.3 Net mixed income	432 *438*	6
Resources		
B.1*n Net domestic product	1632 *1658*	26

Account II.1.2 Allocation of primary income account	Old/*New*	Diff.
Uses		
B.5* Net national income	1661 *1687*	26
Resources		
B.2 Net operating surplus	247 *267*	20
B.3 Net mixed income	432 *438*	6

Account II.2: Secondary distribution of income account	Old/*New*	Diff.
Uses		
Net disposable income	1632	26
	1658	
Resources		
B.5* Net national income	1661	26
	1687	

Account II.4.1 Use of disposable income account	Old/*New*	Diff.
Uses		
B.8 Net saving	233	26
	259	
Resources		
B.6 Net disposable income	1632	26
	1658	

Account III.1: Capital account	Old/*New*	Diff.
Changes in assets		
P.51 Gross fixed capital formation	376	34
	410	
P.511 Acquisitions less disposals of tangible fixed assets	303	1
(For own account capital formation: differs by the value of capital services from the producer's stock of R&D *less* the current costs of R&D included in the existing estimates.)	*304*	
P.512 Acquisitions less disposals of intangible fixed assets	51	33
	84	
P.5121 Acquisitions of new intangible fixed assets	53	33
	86	
Software	40	-2
(For own account capital formation: differs by the value of capital services from the producer's stock of R&D *less* the current costs of R&D included in the existing estimates.)	*38*	
Mineral exploration	8	-1
(As for software)	*7*	
R&D	0	36
	36	
P.5122 Acquisitions of existing fixed intangible assets	6	0
(Could be different)	*6*	
P.5123 Disposals of existing fixed intangible assets	-8	0
(Could be different)	*-8*	

P.5132 Cost of ownership transfer of non-produced non-financial assets	17	0
(Could be different with the removal of non-patented entities)	*17*	
K.1 Consumption of fixed capital	-222	-8
	-230	
K.22 Acquisitions less disposals of intangible non-produced assets	0	0
(Patented entities no longer included.)	*0*	
B.9 Net lending/Net borrowing	38	0
	38	
Changes in liabilities and net worth		
B.8n Saving, net	233	26
	259	
B.10.1 Changes in net worth due to saving and capital transfers	230	26
	256	

Account III.3.1: Other changes in volume of assets account	Old/*New*	Diff.
Changes in assets		
K.3 Economic appearance of non-produced assets	24	0
(Could be different due to absence of patented entities)	*24*	
K.62 Other disappearance of non-produced assets	-1	0
(Could be different due to absence of patented entities)	*-1*	

Account 111.3.2: Revaluation account	Old/*New*	Diff.
Changes in assets		
AN Non-financial assets	198	3
	201	
AN.11 Fixed assets	111	3
(R&D now included in this item)	*114*	
Changes in liabilities and net worth		
B.10.3 Changes in net worth due to nominal holding gains/losses	288	3
	291	

Account IV.1: Opening balance sheet	Old/*New*	Diff.
Assets		
AN Non-financial assets	9922	90
	10012	
AN.1 Produced assets	6047	100
	6147	
AN.11 Fixed assets	5 544	100
(R&D now included in this item)	*5 644*	
AN.2 Non-produced assets	3875	-10
	3865	
AN.22 Intangible non-produced assets	66	-10

(Patented entities now excluded from this item)	*56*	
<u>Liabilities and net worth</u>		
B.90 Net worth	10416	90
	10506	

Account IV.2: Changes in balance sheet	Old/*New*	Diff.
<u>Total changes in assets</u>		
AN Non-financial assets	482	29
	511	
AN.1 Produced assets	289	29
	318	
AN.11 Fixed assets	239	29
(R&D now included in this item)	*268*	
AN.2 Non-produced assets	193	0
	193	
AN.22 Intangible non-produced assets	2	0
(Patented entities now excluded from this item)	*2*	
Changes in net worth	535	29
	554	

Account IV.3: Closing balance sheet	Old/*New*	Diff.
<u>Assets</u>		
AN Non-financial assets	10404	117
	10523	
AN.1 Produced assets	6336	139
	6465	
AN.11 Fixed assets	5 783	129
(R&D now included in this item)	*5 912*	
AN.2 Non-produced assets	4068	-10
	4058	
AN.22 Intangible non-produced assets	68	-10
(Patented entities now excluded from this item)	58	
<u>Liabilities and net worth</u>		
B.90 Net worth	10951	109
	11060	

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Appendix I

Table 1 GERD as a percentage of GDP

	2000		2001		2002		2003	
Australia	1.54		..		..		..	
Austria	1.95	c	2.07	c	2.19	c	2.19	c,p
Belgium	2.04		2.17		2.24	p	2.33	p
Canada	1.92		2.03		1.90	p	1.87	p
Czech Republic	1.33		1.30		1.30		1.34	
Denmark	..		2.40		2.52		..	
Finland	3.40		3.41		3.46		..	
France	2.18	a	2.23		2.26		..	
Germany	2.49		2.51		2.53		2.50	c
Greece	..		0.65		..		..	
Hungary	0.80	d	0.95	d	1.02	d	0.95	d
Iceland	2.75	c	3.06		3.09	c	..	
Ireland	1.15	c	1.13	c	..		..	
Italy	1.07		1.11		..		..	
Japan	2.99		3.07		3.12		..	
Korea	2.39	g	2.59	g	2.53	g	2.64	g
Luxembourg	1.71		..		..		..	
Mexico	0.37		0.39		..		..	
Netherlands	1.90		1.88		..		..	
New Zealand	..		1.16	a	..		..	
Norway	..		1.60		1.67		..	
Poland	0.66		0.64		0.59		..	
Portugal	0.80	c	0.85		0.94	c	..	
Slovak Republic	0.65	m	0.64	m	0.58	m	0.59	m
Spain	0.94		0.95		1.03		..	
Sweden	..		4.27	m	..		..	
Switzerland	2.57		..		..		..	
Turkey	0.64		0.72		0.66		..	
United Kingdom	1.85		1.86		1.87		..	
United States	2.72	j	2.73	j	2.66	j,p	2.60	b,j, p
Japan (adj.)	..		..		..		..	
Total OECD	2.23	b	2.28	b	2.26	b,p	..	
EU-25	1.80	b	1.83	b	1.86	b,p	..	
EU-15	1.89	b	1.92	b	1.95	b	..	
European Commission	..		..		..		..	
Argentina	0.44		0.42		0.39		0.41	
China	1.00	a	1.07		1.22		..	
Israel	4.70	d	5.04	d,p	5.08	d,p	4.90	d,p
Romania	0.37		0.39		0.38		..	
Russian Federation	1.05		1.18		1.25		1.28	
Singapore	1.88		2.10		2.15		..	
Slovenia	1.44		1.56		1.53		..	
Chinese Taipei	2.05	d	2.16	d	2.30	a	..	

STANDARD FOOTNOTES

Information on the quality and international comparability of the data are included. As concerns the standard footnotes, the following cases are noted in the data file:

a) Break in series with previous year for which data is available.

b) Secretariat estimate or projection based on national sources.

c) National estimate or projection adjusted, if necessary, by the Secretariat to meet OECD norms.

d) Defence excluded (all or mostly)

e) National results adjusted by the Secretariat to meet OECD norms.

f) Including R&D in the social sciences and humanities.

g) Excluding R&D in the social sciences and humanities.

h) Federal or central government only.

i) Excludes data for the R&D content of general payment to the Higher Education sector for combined education and research (public GUF).

j) Excludes most or all capital expenditure.

k) Total intramural R&D expenditure instead of current intramural R&D expenditure.

l) Overestimated or based on overestimated data.

m) Underestimated or based on underestimated data.

n) Included elsewhere.

o) Includes other classes.

p) Provisional.

q) At current exchange rate and not at current purchasing power parities.

r) (note not currently used)

s) Unrevised breakdown not adding to the revised total.

t) Do not correspond exactly to the OECD recommendations.

u) University graduates instead of researchers.

v) The sum of the breakdown does not add to the total (see General Methodology).

w) Including extramural R&D expenditure.

*) Pre-EMU euro should not be used to form area aggregates or to carry out cross-country comparisons.

Appendix II

The arguments for and against capitalizing R&D disseminated freely[7]

While all, or nearly all, Canberra II members are in favour of capitalizing R&D there is disagreement about the scope. The majority favours capitalizing all R&D expenditure, but there is a significant minority who feel that some R&D does not result in new assets. The disagreement centres around whether the definition of an asset, quoted above, includes an entity where ownership rights are not enforced and the benefits are not derived by its owner, but accrue to an economy, or may be to mankind at large, without direct cost to the beneficiaries.

Against: Those opposed to capitalizing all of R&D argue that if there is no exclusive ownership or control of the knowledge gained from R&D then it fails to meet the definition of an asset. It is often, if not generally, the case that governments and non-profit institutions give unrestricted access to the knowledge gained from the R&D they have either undertaken or sponsored. This implies ownership rights are not being enforced and there is no direct economic benefit to the institutions disseminating the knowledge. While the knowledge may bring general benefits it is not owned by any particular institutional unit once it has been disseminated.

For: Those in favour of capitalizing all of R&D argue that there is a parallel with public assets, such as roads, the services of which are provided free of charge yet they are considered as assets owned by government on behalf of the community at large. Such assets provide a service to the community collectively which contributes to its production and welfare. If this is accepted for public assets, such as roads, why is not accepted for R&D?

Against: Public assets, such as roads, are still owned by the public sector and could be sold if so desired. By contrast, once the results of R&D have been disseminated they are of no further value to the original owners and ownership no longer resides with the original owners. Furthermore, roads provide a service only in the territory in which they are located, whereas disseminated R&D output is available to all.

For: Governments do not charge for the use of suburban roads and they have no expectation of doing so. Nor do they have any expectation of selling them in the future. Hence, it could be argued that they have no economic value to the government. But the government considers that one of its functions is to provide road services. In effect the community has created an asset to provide services for itself. In just the same way, the community, via its government, undertakes R&D to provide services for itself, such as medical research, cultural and social research, space research, as well as industrial R&D.

Against: Public assets, such as roads, provide services over many years. In the case of roads, there is a capacity constraint as more traffic requires more roads, and there is a current cost to providing the roads each year of their service life. Providing the services of the roads each period includes the costs of the decline in value of the roads from usage and decreased services life plus the costs of current maintenance, traffic signs and signals, police patrols, management and planning, and so forth. The output of R&D has no capacity constraint and there is no current cost to the government for disseminating the knowledge. Expenditures on R&D are sunk costs. Once the R&D is performed and the results disseminated freely, the government has no control over the knowledge, cannot recover its costs, and does not receive any benefits. R&D output that is not disseminated freely is controlled and does provide benefits in the form of future royalties or higher profits for the owner.

For: The results of R&D can have a continuing benefit over many years. For example, the discovery of the structure of DNA was made over fifty years ago, but it continues to provide benefits. Although R&D

[7] Taken from the questionnaire used to survey major users of macroeconomic statistics (Aspden, 2004a), of which the results are presented in Appendix III.

output may be disseminated freely it does not necessarily mean that the producer receives none of the benefits. For example, government may fund medical research with the aim of reducing the cost of providing medical services in the future, e.g. the development of key-hole surgery. The fact that the flow of capital services from roads is input into the production of road services, while the capital service flow from R&D output flows directly to intermediate and final users is irrelevant. What matters is that the output of suburban roads is provided free of charge to users.

Against: Once the results of R&D have been disseminated freely, their use does not coincide with any opportunity costs and as a result no reasonable value can be assigned to the services derived from the non-market R&D. In this respect non-market R&D differs significantly from public assets such as roads.

For: The value of public assets such as suburban roads cannot be determined in terms of opportunity costs, because without a market for such assets there is no way of obtaining a reasonable estimate of the opportunity cost. Instead, the values of such public assets are determined on the basis of what it cost to construct them, the expected asset life and the expected decline in value over that period. Government R&D assets could be valued in the same way.

Against: If general government R&D is capitalized then current practice would dictate that the value of general government output should be increased by the value of the depreciation of the asset. If general government R&D capital formation were to include that which is made freely available GDP would be overstated. This is because there would be an asymmetry between giving a value to the flow of capital services from the general government sector and giving a zero value to the corresponding input to the market sector. With the benefit of the free R&D output, the output of the market sector would increase, at least in real terms, without any corresponding increase in intermediate input.

For: While this is true, the argument applies equally to all government services – not just capital services – that are provided to the market sector without a direct charge.

Appendix III

REPORT OF SURVEY OF MAJOR USERS OF MACROECONOMIC STATISTICS ON THE CAPITALISATION OF R&D

Introduction

At the latest meeting of Canberra II in March 2004 it was agreed that the views of major users of macroeconomic statistics should be sought on the issue of the capitalisation of R&D. It was further agreed that the best way to do this was to present to major users, as a basis for discussion, a short paper summarising:

a) the current situation;

b) the arguments in favour of capitalizing R&D in principle; and

c) the arguments for and against capitalizing R&D produced by the non-market sector.

Accordingly, a paper was drafted, distributed to members for comment and finalised on 3 June 2004 (Attachment A). A message, with the paper attached, was then sent to members of Canberra II asking them to prepare summaries of the views expressed by the users they had consulted. By 27 August 2004 I had received four responses in respect of Australia, Finland, Germany and Israel[8].

Summary of responses

<u>Australia</u>

The Reserve Bank of Australia supports the full capitalisation of all forms of R&D. The Australian Treasury agrees in principle to the capitalisation of all forms of R&D, but has some concerns about the practical difficulties involved in estimating depreciation rates, determining the quality of R&D and boundary issues generally.

<u>Finland</u>

Of the three respondents, two favour capitalizing all forms of R&D, but one has qualms about capitalizing general government R&D.

<u>Germany</u>

Of the eleven respondents, two favour capitalizing some, but not all R&D, and nine (including the most important users) favour the current SNA treatment. Most of the respondents feel R&D should be capitalized in principle but had concerns about practicality and data quality.

<u>Israel</u>

Of the four respondents, two are strongly in favour of capitalizing all R&D, one supports the present SNA treatment, and one supports the capitalization of R&D but has some reservations.

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[8] There was also a null response from the Netherlands