United Nations

ECE/CES/GE.20/2014/18

Economic and Social Council

Distr.: General
4 April 2014

Original: English

Economic Commission for Europe

Conference of European Statisticians

Group of Experts on National Accounts

Thirteenth session
Geneva, 6-9 May 2014
Agenda item 4
Challenges and approaches to the implementation of 2008 SNA

Research and Development: Measurement Issues and the Results of the OECD Survey on Intellectual Property Products

Prepared by the Organisation for Economic Co-operation and Development

Summary

A major methodological development in the 2008 System of National Accounts is the inclusion research and development in the asset boundary. This paper provides the results of the 2012 survey of the Organisation for Economic Co-operation and Development on Intellectual Property Products with a special focus on research and development. It focuses on methodology and measurement practices of the countries of the Organisation for Economic Co-operation and Development and will discuss the major measurement challenges that the countries face. In particular, sharing greater detail on service lives, depreciation rates, and the construction of volume measures may be helpful in the implementation of the 2008 System of National Accounts.

I. Introduction

1. One of the major methodological changes between the 2008 System of National Accounts (SNA) and the 1993 SNA is the expansion of the asset boundary to include research and development (R&D). This is an acknowledgement of the growing importance of the knowledge economy and the recognition that R&D is an important input into the production process; it can be used repeatedly and provides benefits to the owner. As of now, six countries of the Organisation for Economic Co-operation and Development (OECD) (Australia, Canada, Israel, Korea, Mexico, and the United States) have implemented the 2008 SNA and have capitalized R&D in their national accounts. The first section briefly discusses how R&D is typically measured; doing so, some issues related to its measurement are shortly dwelt upon. The second section provides the results of an OECD survey on Intellectual Property Products (IPP).

II. How research and development is typically measured and some measurement issues

2. Most countries use (or will use) the OECD's Frascati Manual (FM) based R&D surveys as a data source for deriving estimates of R&D. The FM-based R&D surveys focus on performers of R&D and collect data on intramural expenditures, that is expenditures on all R&D performed by the statistical unit regardless of the source of funds. Therefore, it is relatively straight-forward to determine where the performance (output) of R&D is taking place. The majority of R&D production is for a firm's own use and therefore it should be recorded as gross fixed capital formation (GFCF) of the firm. However, when the R&D unit is part of a multinational enterprise (MNE) or producing the R&D for sale, the issue of economic ownership and the corresponding use of the R&D may become more difficult to measure. Another issue related to the measurement of R&D is how to derive estimates of consumption of fixed capital (CFC) and the measurement of the capital stock. The following section summarizes the guidance and briefly describes what the countries have done or propose to do in practice.

A. Measuring the Capital Stock and Consumption of Fixed Capital

3. The recommended approach given in the OECD Handbook on Deriving Capital Measures of Intellectual Property Products (OECD, 2010) is to derive estimates of R&D capital stock using the perpetual inventory method (PIM). The PIM method is the most commonly used method to derive capital stock estimates of fixed assets within the system of national accounts. As such, and confirmed by the OECD survey, most if not all OECD countries will use the PIM to calculate the R&D capital stock. For this, countries need to make assumptions and/or use sources to estimate the service life, the depreciation function and the mortality function for R&D assets.

4. The key approaches on how to estimate service lives as discussed in the R&D literature and the OECD Handbook can broadly be defined as the patent renewal method, econometric methods, survey based approaches, using other countries' assumptions, or a default of an average service life of 10 years. The Eurostat Manual on Research and Development in the European System of Accounts (ESA) 2010[1] makes the following recommendation:

[1] The OECD Handbook on Deriving Capital Measures of Intellectual Property Products includes the output of licenses to use and non-GFCF licenses to reproduce as part of R&D output in order to

"The service life of R&D products should be determined according to evidence from the activities where they are most used as capital assets. Where this evidence is not readily available in Member States, evidence from other Member States with similar industries and R&D products may be used. Where no equivalent Member State and activity can be identified, then general European practice can be followed. As a last resort, where no reliable evidence is available for the activity in which the R&D product is used, a service life of 10 years is acceptable until further information becomes available."

5. In reviewing the responses from the OECD survey, 7 out of 19 countries reported using the default average service life of 10 years as recommended by the Eurostat Task Force on measuring R&D (as well as in the Eurostat manual), because no other information was available. However, some countries stated that additional research was in progress. Of the countries that supplied information of the sources for estimating the service lives or depreciation rates, no single source of information was predominately used by countries. Three countries stated that they conducted surveys or are in the process of conducting a survey. A few countries used information on patents to derive their service life estimates. For the Netherlands, the service life of R&D is based on data on patent amortization and data on patent values. For market sector R&D, the United States argues that "R&D depreciation reflects its declining contribution to a firm's profit as R&D assets become less valuable or obsolete."[2] Therefore, the United States analysed the relationship between investment in R&D and future profits and derived depreciation rates for several R&D intensive industries by using a forward-looking profit model in which each period's R&D investment contributes to the profits in later periods but at a geometrically declining rate.

6. A summary of country responses on service lives and depreciation are shown in the Appendix II.

B. Ownership and use

7. As was discussed earlier, information on R&D expenditures is collected from performers of R&D, which is unlike most types of capital expenditure, for which data are collected from purchasers or users. However, information collected from the FM-based R&D survey normally asks additional questions on sources of funds for the R&D performed and some countries use this information to make the simplifying assumption that the owner of the R&D asset is the funder.[3] Some countries may give special consideration to government funding of R&D through grants which the ownership of the R&D asset may be deemed to remain with the performer.

derive the total supply of R&D available for total use and GFCF. The OECD recommendation is consistent with the 2008 SNA in that "The value of the copies made is also recorded as production separately from the production involved in the making of the original." (2008 SNA 6.210) The current version of the Eurostat Manual on Research and Development in ESA 2010 assumes that output arising from sales of licenses to use is, in practice, negligible and, so, actual sales are not included in output, and actual expenditures on license to use or reproduce that satisfy GFCF requirements are not included in GFCF. Countries adopting the simpler Eurostat approach should first attempt to ensure that output by domestic firms does not include revenues from these activities and that imports of R&D do not include related payments.

[2] See "Preview of the 2013 Comprehensive Revision of the National Income and Product Accounts," Survey of Current Business 93 (March 2013) 13-39.

[3] Generally this is likely to be the case where the funder is a market producer but countries are advised to investigate national circumstances in cases where the funder is government and develop the appropriate assumptions. For example, in some countries it may be more appropriate for the recipient of government funds to be classified as the owner.

8. However difficulties can arise when the R&D performer receives a source of funds from overseas especially if it is internal funding within an MNE. The Guide to Measuring Global Production (UNECE, Draft 2014) highlighted that “the funding flows inside MNEs do not necessarily reflect change of ownership of IPPs”. Moreover the issue is further complicated by the fact that not all sources of funding, which can include income transfers such as donations and subsidies, can necessarily be hypothecated to the production of R&D.[4] For coherent accounts it is essential that any assumptions made with regards to funding data are consistent with corresponding flows that are (or need to be) recorded in international trade in R&D services statistics. The Task Force on Global Production has highlighted this as an area requiring further research.

9. However, reconciling flows based on Frascati data is only a first step. A perhaps larger issue concerns identifying (economic) ownership from a conceptual perspective. Frascati data will be able to provide an indication of the performer (and funder) but they will not be able to identify subsequent transfers, whether these are made explicitly (and identifiable) in trade in services data or implicit (and often not identifiable at all). And even in cases where transfers are explicit, because MNEs can locate the R&D original asset in an economy that maximizes post-tax MNE profits, many times through Special Purpose Entities (SPEs), it does not necessarily follow that such transfers necessarily align with strict definitions of economic ownership. Establishing who the economic owner is in such cases may not be that easy and straightforward. Determining the economic owner has implications for where the GFCF is recorded and the corresponding treatment of the related flows for the rights to use the R&D, and also, by extension, multifactor productivity estimates. For example, an affiliate in one country may make use of R&D transferred (implicitly, i.e. not recorded in trade in services) to it by its parent. This will, all other things equal, raise the affiliate’s production and value-added and also property income payments to the parent, but, because the R&D ‘transfer’ is not identifiable, the transfer will not be recorded in the affiliate’s capital stock estimates (if the entire, or part of the, original is transferred) or trade in services (if only services from using the asset are provided), and, so, productivity of the affiliate will be overstated. Similarly, for the parent, it will appear that no (less) value-added is being generated by its ownership of the R&D asset, which remains on its capital stock at its full value.

10. The Task Force on Global Production in the Guide to Measuring Global Production has grappled with this issue and adopted the pragmatic recommendation that “intra-group transactions are only recorded when data sources point at receipts for IPP use by member units.” In other words the Task Force recognises that in practice it will not be possible to impute flows in the absence of any information, and that, as a consequence, productivity estimates will necessarily be affected if transfers are made but not recorded in the accounts. The Guide to Measuring Global Production has a chapter dedicated to the ownership issues related to IPPs as well as guidance on how to determine the economic ownership of IPPs.

[4] See chapter 4, “Ownership of intellectual property products inside global production” in the Guide to Measuring Global Production.

III. Synthesis of the Results of the OECD Survey on Intellectual Property Products[5]

11. At the 2011 OECD Working Party on National Accounts meeting it was discussed that there was a need for sharing greater detail on service lives, depreciation rates and national practices related to Intellectual Property Products (IPPs). The sharing of methodology and measurement practices between OECD-countries in this relatively new area may indeed be helpful in the implementation of the 2008 System of National Accounts (SNA).

12. For the above reasons, the OECD developed and launched a questionnaire on IPPs. The purpose of the questionnaire was to arrive at improved metadata on issues related to country best practice, the availability of data sources, improving understanding measurement of capital stocks and update the current progress related to the implementation of SNA 2008 for specific aspects. Topics covered included Research and Development; Mineral exploration and evaluation; Software and databases; Entertainment, literary and artistic originals; and Other intellectual property products.

13. This note summarises the key issues raised by the 23 OECD countries who responded to the questionnaire (listed in Appendix I) as well as information gathered from country's websites on the implementation of the 2008 SNA. A summary of responses related to service lives is given in Appendix II, and the questionnaire is attached in Appendix III.

A. Research and Development

14. *Expected impact*: There is a wide range of the estimated impact of capitalisation of R&D on gross domestic product (GDP), although there was some uncertainty on the magnitude with some countries noting it would be minimal. Estimates range from 0.5% to 3.5% of GDP with an average of around 1.7% of GDP. Four countries have not yet fully analysed the estimated impact.

15. *Data sources*: A large majority of countries have not needed to use any new surveys, although a few countries have captured the new requirements by revising existing surveys. The main data sources used are specific research and development surveys: e.g. GERD (gross domestic expenditure by government), BERD (gross domestic expenditure by business), and specific surveys for private non-profit bodies. Other data sources include: a) administrative data, e.g. universities and grant information, bank records; b) international trade in services; c) additional surveys, e.g. on structural business statistics, earnings statistics, monthly labour force estimates; d) taxes and subsidies data; e) operating surplus and consumption of fixed capital; f) corporate goods price indices. Where data is not available on a regular annual basis, some countries use a supplementary survey for the years in between by using aggregated estimates from other survey data, administrative data such as tax deductions, or extrapolating for the missing years. One country noted that there was limited coverage for business sector expenditures on social science research.

16. *Methods*: All countries implement, or intend to follow, the methods in both the conclusions of the Eurostat R&D task forces and the OECD manual. For some countries there are still specific outstanding issues. Examples included: a) source limitations making it difficult to collect information about external funds to post graduate students; b) no

[5] This section uses a document prepared by Craig McLaren and presented at the 2012 Working Party Meeting on National Accounts. It was updated with information from country responses as well as country's websites.

information about trade margins, or taxes and subsidies on products and changes in inventories; c) for some countries all expenditures on R&D have been considered as providing a benefit; d) for one country lags are not used, e.g. R&D is registered as an investment in the same period as the production costs occur so there are no changes in inventories; and e) for one country R&D purchases by R&D industries are capitalized in the R&D production account with the primary reason being that there is a lack of information to distinguish single from repeated use and that there is an expectation that single use is small. Where Frascati source data does not exist, some countries use the historical survey data and tax data to estimate the missing part of R&D activities, and/or transform it to the definitions according to the Frascati Manual. This can include adjustment for missing size classes and exhaustiveness.

17. *Double counting*: Nearly all countries take account, or use approaches to minimise, any double counting. Some countries noted that information on this issue was not easily available, but for other countries it was not identified as a significant issue. Different approaches used to estimate double counting included: a) use of information about the number of employees in the software industry, e.g. ratio of software developers to all researchers, comparison of employment data with data on persons employed in R&D at the level of the reporting unit to identify any double counting, or unit record matching; b) the addition of questions, or use of aggregation checks, in the surveys; c) using a historical ratio, or deducting a proportion, e.g. 10% or 50% of user-produced software; d) focus on double counting in particular industries where the issue of double counting is known to be significant, e.g. elements of R&D in oil exploration; e) use of survey information on product fields where all expenditures reported by respondents' as software is excluded.

18. *Sector and industry*: Nearly all countries break down data by institutional sector, although slightly less break down the data by industry. For both sector and industry this is done primarily by the use of the underlying source information, or the allocation of individual units to the different sectors which are subsequently aggregated. Some countries referred to the use of the bridge table approach noted in OECD (2010). Some countries have not yet decided on methods for the sectorial breakdown of private R&D.

19. *Historical data*: For years where estimates do not exist the most common approach is the use of modelling. However, there are a small number of countries who have not decided what approach to use. For some countries, there is additional detail available at a microeconomic level for recent years, but only macroeconomic data for earlier or intermediate years which means for those earlier periods a set of simplifying assumptions, or models, will be used to derive back data. Other approaches included: a) the use of backcasting with a suitably chosen end point, e.g. applying average growth rate of R&D expenditures to historic data; b) use of interpolation or extrapolation based on relative or declining proportions; d) use of a benchmark value and then indicators such as wages and intermediate consumption to construct estimates earlier than the benchmark; and e) use of classification adjustments to align earlier data to earlier collected data.

20. *Capital stock and depreciation*: All countries will, or plan to, use the PIM to calculate capital stock and depreciation. The majority of countries use a geometric depreciation function. Countries that assume the default 10 year service life usually apply a geometric depreciation function, and assume a double-declining balance rate to derive a depreciation rate of 20%. In the case of the United States, only depreciation rates are published; by assuming a double-declining balance rate service life estimates have been derived for cross country comparisons. Mortality functions used included: delayed linear, log normal, Weibull. Service lives differ across countries; see Appendix II for a summary. These can differ based on the type and industry of R&D. For example, 13 years (basic research), 11 years (applied research), 9 years (experimental development), and for specific industries: 7 years (computer programming), 9 years (electronics), and estimates of 15, 20

and 60 years (chemical and pharmaceutical products). Finland and Israel (see Israel, 2008) have calculated detailed service lives for a wide range of industries, ranging from 7 – 10 years, and 5 – 60 years respectively. For all countries, overall service lives used for aggregate R&D were: 4.6 years, 6.2 years, 7 years, 8 years, 10 years, and 12 years. Where service life information was not available, assumptions were based on other countries, or the recommendation by the recent Eurostat taskforce on R&D which notes that "… where such information is not available, a single average service life of 10 years should be retained". Some countries continuing research to derive estimates are Germany, Sweden and the United Kingdom.

21. *Other issues*: Issues raised included: a) an inconsistency between the Balance of Payments and International Position Manual (BPM6) on the one hand and the 2008 SNA on the other hand in the treatment of R&D, where BPM6 incorporates trade in patents in commercial services under R&D services and includes a much broader definition of patented entities than what is defined as R&D fixed assets in the SNA; b) for some countries, a need for clarification of the treatment of R&D by multinational corporations, e.g. is the R&D produced by them mostly exports or domestic investments?; c) integrating into calculations the treatment of consumption of fixed capital used for the production of new R&D results, as it can have an accelerating impact on R&D outputs; d) how to ensure consistency between different data sources, e.g. R&D surveys and structural business surveys; e) choice and sensitivity of the deflation method; and f) how to calculate the cost of capital in the R&D output as it could be sensitive to the choice of calculation.

B. Mineral exploration and evaluation

22. *Data sources*: The majority of countries derive estimates for mineral exploration and evaluation. However, five countries do not estimate this as it is not significant. Different types of data sources used are: a) surveys of the mining industry e.g. quarterly capital expenditure surveys which can capture expenses related to mineral exploration and evaluation; and annual inquiries covering enterprises that have a license for exploring, developing and production activities; b) administrative data from government departments and other industry groups, e.g. geological surveys, or specialised energy organisations; c) financial statements, provision of accounts including information on expenditures on items such as exploratory drilling; d) international trade statistics on exploration services. Proxy information was also used, e.g. revenues and budgets, or turnover figures from the monthly manufacturing reports.

23. *Methods*: Methods used can differ greatly between countries. Broadly, approaches used are: a) use of data directly from specific accounts, surveys or administrative datasets; b) sum of costs approach where costs can be related to development, implementation or expenses paid to others involved; c) the use of telephone interviews made with enterprises and own account workers holding prospecting concessions; d) pro-rating of aggregate estimates based on percentages of sub-components, e.g. exploratory and commercial drilling. One particular example is New Zealand where there is no supply side estimate of mineral exploration, so the demand total is used. In this case the demand data is analysed and verified as part of supply use balancing process.

24. *Capital stock and depreciation*: For those countries that calculate capital stock and depreciation, the PIM is used. Two countries do not calculate capital stock and depreciation for mineral exploration and evaluation. There was an equal use of either geometric or straight line depreciation. The mortality functions used included: simultaneous exit, Weibull, Winfrey curves, log-normal and normal. Service lives used had a wide range from: 1 year, 5 years, 7 years, 10 years, 13 years, 20 years, 30 years, 34 years, to 40 years. Appendix II gives a summary table. Some countries are using the implementation of SNA 2008 to update their assumptions, particularly on the depreciation function.

25. Other issues: Some countries noted that it was very hard to compile reliable statistics for mineral exploration. Particular issues included: a) separating imports from the total costs; and b) having a greater understanding how other countries estimate service lives.

C. Software and databases

26. *Data sources*: All responding countries currently compile, or have plans to derive, estimates for software. However, for some countries it was difficult to separately estimate databases from software. There was a wide range of data sources reported with sources different based on different types of software and databases. Some countries use specific surveys on Information and Communication Technology, e.g. capturing sales to known end-users and other sales, and distinguishing between published software and IT services. In some examples a particular sampling frame was constructed based on IT related occupations. Other examples of data sources are: a) labour force surveys on employment and earnings, wages and salaries, including hours worked on development of own-account software and database creation; census information; industry production of commodities; investment surveys; b) data related to balance of payments statistics, e.g. import and exports, trade margins of software from imported goods; household expenditure; capital expenditure, including the value of expenditure on computer software and databases; input-output tables; c) public sector estimates, e.g. survey information and local and central government financial statements; central government income and outlays; d) financial statements, administrative records such as annual accounts, reports from central banks or tax authorities; or those from trade associations and specialised journals. Where data sources or historical data do not exist, modelling is used. Some countries are planning to enhance their data sources to separate out the collection of database information.

27. *Methods*: Methods can differ greatly between countries and can also be complex. In practice, some countries noted that it was difficult to separate database estimates. Broad descriptions of approaches used are: a) use of data directly from either industry specific surveys on Information and Communication Technology or administrative data such as customs or tax records for software licenses. b) production cost method, where labour and non-labour costs are estimated, e.g. using data from the labour force survey for the particular industry such as wages, working hours, number of employees; c) use of ratios, e.g. labour costs associated with the production of own-account software; d) use of a commodity flow framework, e.g. use of input-output tables; or a supply and demand residual approach. One example is used by Canada which estimates components of the software market, with investment determined as the amount that equates demand with supply. The supply consists of domestic production, plus imports, plus the wholesale, retail and tax margins on software sales. Investment in software is then determined as the amount that equates demand to supply. Details on methods used in Canada, Czech Republic, Germany and Sweden methods are included in the references.

28. *Sector and industry*: The majority of countries can create estimates by both sector and industry, although some countries could not create estimates for sectors but could for industry. For the majority of countries, the breakdown of data by sector and industry can be achieved because the source data, survey or administrative, is collected in this way. Specific approaches for sectors include: a) using government accounts to derive purchased software in the government sector; b) for own-account software, the breakdown by institutional sector is derived from the production structure of the different industries; c) using certain industries as a proxy; d) use of shares of production, models or ratios based on input-output tables; d) a bottom up approach based on the individual source data and unit industry information. Specific approaches for industries include: a) the use of labour force survey data, or salary estimates, to estimate investment at an industry level for own account software investment; b) use of specific questionnaires for purchased software, c) a bottom up approach based on the individual source data and unit industry information; e) use of

industrial information from the input-output tables; and e) use of industry proportions from survey data. For countries where the source data coverage is not adequate they mentioned that they will expand the coverage, e.g. for purchased software.

29. *Capital stock and depreciation*: All countries use the PIM to calculate capital stock and consumption of fixed capital, although the depreciation assumptions differ between countries. There was a slight preference for the use of linear depreciation over geometric deprecation. Different mortality functions included: delayed linear, normal, truncated normal, log-normal, Winfrey, and Weibull. Service lives reported included: 3 years, 3.7 years, 4 years, 4.5 years, 5 years, 10 years, and in one country the service life is the same as the one for computer equipment. Some countries use different service lives for different groups. For example, Denmark: 4 years for software purchases, 6 years for own account; Germany noted that software for mainframes had a longer service life with 10 years compared to 5 years for desktop software (see Schmalwasser and Schidlowski, 2007); Israel use 4 years for imported pre-packaged software, and 5 years for own-account and customised software; Sweden use a service life of 5 years for purchased software and 10 years for own developed software and databases. In some countries there were no estimates of service lives based on directly observed data. In this case guidance was used based on administrative sources and recommendations from OECD manuals Measuring Capital (2001 and 2009) and previous task forces. Appendix II gives a summary of depreciation information.

30. *Other issues*: Issues were raised in that it was difficult in practice to separate databases from software, and even with the existing guidance and previous task forces, the quality of the estimates (for some countries) could still be improved. Other aspects were: a) how to distinguish between databases which are fixed assets and those that are not; and b) the distinction between regular maintenance and software maintenance work to be considered as investment.

D. Entertainment, literary and artistic originals

31. *Data sources*: The majority of countries who responded compile estimates for entertainment, literary and artistic originals. There were five countries who currently do not collect, or plan to collect, this information. A wide range of data sources are used in practice. These include: industry specific administrative data about royalties, royalty flows and distribution of royalties; broadcasting companies reports, including reports from specific copyright societies for authors, composers and musicians; surveys on production costs, or income. For originals without an established system of royalty flows (e.g. films, TV, radio productions and literary originals) a production cost approach can be used. Alternatives are the use of administrative data, e.g. tax data which can include performance fees, data direct from TV broadcasters, reports from patent and trademark offices. Some countries have no direct information available from surveys or administrative data. In this case indirect estimates were obtained by using foreign trade in services, household budget surveys; and the use of turnover statistics. Some countries noted that that due to the lack of available and reliable data, external experts outside of the National Statistics Institute were being used to assist in obtaining improved estimates, e.g. liaising with patent offices and academics.

32. *Methods*: As expected, methods differ greatly between countries and between the different assets. They can also be quite complex. Broad examples of approaches are: a) cost based valuation methods directly from data sources, e.g. income, purchases of programmes, data on payments, commissioned works, royalties, tax data; b) production cost method with a correction for operating surplus, e.g. by estimating labour and non-labour costs; c) use of the value of royalties received as a proxy for the value of originals created; estimation methods based on taking the discounted net present value of future receipts; d) use of

payments to domestic beneficiaries, payments to and from foreign companies; e) commodity flow methods; f) use of linear interpolations when data is not available; or g) modelling relationships using data such as expenses, royalties or interest rates.

33. *Sector and industry*: The majority of countries can create estimates by both sector and industry. For the majority of countries, the breakdown of data by sector and industry can be achieved because the source data is collected in this way. As only particular sectors are impacted, it is easier to allocate. Examples of approaches are: a) estimates on films, TV and radio stock programmes allocated to non-financial corporations, while literary works are allocated to the household sector; b) entertainment and literature allocated to non-financial corporations, while music is divided between households and non-financial corporations; c) use of proxy information such as shares of production costs, relative share in employment, editorial costs and royalties can be used to allocate to sector (and industry); d) a bottom up approach based on the individual source data and unit industry information. Regarding the allocation to industries, for the cases where aggregated data is available, the division between the type of original and the related industries is obvious, e.g. investments in originals occur only for select industries. Examples of approaches are: a) use of different type of royalties as a proxy to allocate the total to industries; b) classification of activity according to the type of organisation which is receiving the compensation; c) a bottom up approach based on the individual source data and unit industry information.

34. *Capital stock and depreciation*: All countries use the PIM to calculate capital stock and consumption of fixed capital, although the depreciation assumptions differ between countries. Countries generally used the same assumptions for entertainment, literary and artistic originals. Across countries typically either the linear or geometric depreciation was used. A wide range of different mortality functions were used including: linear, normal distribution, Winfrey curves, log normal and the gamma distribution. Service lives reported were: 3 years, 5 years, 7 years, 10 years, and 13 years. In a majority of cases it was noted that there was no supporting evidence for using these service lives. However, some countries referred to the recommendations from the GNP Committee on Entertainment, Literary and Artistic Originals which recommends a service life of between 5 to 10 years (OECD, 2010, page 163). The Netherlands use different service life assumptions for different assets, e.g. for originals: service life of 5 years, and for royalties a service life of 10 years. While Germany estimated average service lives on the basis of differentiated information on motion pictures, TV productions, sound storage media, music compositions, artistic performances and texts (Schmalwasser and Schidlowski, 2007). Appendix II gives a summary table of depreciation information.

35. *Issues*: Particular issues mentioned included: a) the need to improve the coverage of the computer gaming industry; b) the treatment of data from special purpose entities that focus on royalty and licensing; and c) using the introduction of SNA 2008 / ESA 2010 as an opportunity to introduce revisions, e.g. through improving specific data sources to increase coverage of activity abroad, changing depreciation assumptions and including additional outputs.

E. Other intellectual property products

36. Only two countries mentioned the availability or collection of Other Intellectual Property Products. For example, The Netherlands produce a separate knowledge satellite account outside the main National Accounts estimates. Their satellite account includes: investment in architectural and engineering designs, firm-specific human capital, organisational structures, and brand equity. Similarly, Slovenia noted the availability of documentation related to the design and construction of infrastructure projects, such as expert reports, blueprints and feasibility studies.

IV. Summary and way forward

37. It can be seen from those countries that estimate a unique service life of R&D by industry that there is a reasonable degree of variation across industries. It can especially be seen on the one hand in the service life assumptions of the semiconductor, electronics, and computer industries where there are shorter service lives (5 – 8 years) and on the other hand in the longer service life assumptions of the pharmaceutical and chemical manufacturing industries (varying from 12 to 60 years). The results indicate that some care is needed in applying the 10 year rule of thumb suggested by the Eurostat task force, particularly when the focus is on comparisons of multi-factor productivity across countries and industries.

38. Notwithstanding these issues however it is clear that significant challenges remain. Chief amongst these is the issue of ownership within MNEs, where research continues.

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Appendix I: Responding countries

The following country responses formed the basis of this document: Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, Germany, Hungary, Ireland, Israel, Italy, Japan, The Netherlands, New Zealand, Norway, Portugal, Russia, Slovak Republic, Slovenia, Sweden, United Kingdom, and United States.

Appendix II: Summary of depreciation information

The following tables summarise depreciation information based on country responses to this survey.

Table 1
Research and Development

Country	***Method***	***Service life***	***Depreciation function***	***Mortality function***	***Source***
Australia[1]		11 years			patent information
Austria	PIM	13 years (basic research) 11 years (applied research) 9 years (experimental development)	Geometric	Delayed linear	Other country
Belgium	PIM	10 years*	Geometric		Eurostat Task Force
Canada	PIM	6.2 years	Geometric		
Czech Republic	PIM	8 years	Linear	Log-normal	
Denmark	PIM	Most likely breakdown between basic research, applied research, and experimental development	Geometric		
Finland	PIM	For market sector: Detailed information available by industry: All industries are 10 years, except: (1) Computer programming and information service activities (NACE rev. 2 62-63): 7 years (2) Chemical and pharmaceutical manufacturing (NACE rev. 2 20-21): 20 years For non-market sector: 10 years	Geometric		International experience, patents, and discussions with selected corporations
Germany	PIM	Survey in progress; alternative is 10 years*			Eurostat Task Force Survey in progress
Ireland	PIM	Work in progress			
Finland	PIM	For market sector: Detailed information available by industry: All industries are 10 years, except: (1) Computer programming and information service activities (NACE rev. 2 62-63): 7 years (2) Chemical and pharmaceutical manufacturing (NACE rev. 2 20-21): 20 years For non-market sector: 10 years	Geometric		International experience, patents, and discussions with selected corporations

Country	*Method*	*Service life*	*Depreciation function*	*Mortality function*	*Source*
Germany	PIM	Survey in progress; alternative is 10 years*			Eurostat Task Force Survey in progress
Ireland	PIM	Work in progress			
Israel[2]	PIM	Pharmaceutical: 13 (minor develop) or 21 years (major develop) Chemical: 12 (minor develop) or 60 years (major develop) Semiconductors:5, 8, or 13 years depending on use Monitoring equipment: 13 (develop on existing product) or 20 years (original) Software: 5 (minor) or 9 years (major) Fabricated metal products except machinery & equipment: 12 (minor) or 18 years (major)	Linear	Truncated normal	Pilot Survey
Italy	PIM	10 years*	Geometric		Eurostat Task Force
The Netherlands	PIM	All industries (except chemical and electronics): 12 years Chemical: 15 years Electronics: 9 years	Winfrey	Weibull	Data on patent amortization and data on patent values
New Zealand	PIM	Still need to consider			
Norway	PIM	10 years*			Eurostat Task Force
Portugal	PIM	10 years*	Linear	Delayed linear	Eurostat Task Force
Slovak Republic	PIM				
Slovenia	PIM	10 years*	Geometric		Eurostat Task Force
Sweden	PIM	10 years*; additional work in progress			Eurostat Task Force
United Kingdom	PIM	4.6 years	Geometric	Weibull	Pilot Survey

Country	*Method*	*Service life*	*Depreciation function*	*Mortality function*	*Source*
United States[3]	PIM	**Market Sector:** **Manufacturing-** Pharmaceutical: 20 years Chemical: 12.5 years Semiconductor: 8 years Computer & peripheral equipment: 5 years Other computer and electronic: 5 years Communications equipment: 7.4 years Navigational, measuring, electro medical: 6.9 years Motor vehicles:6.5 years Aerospace: 9.1 years Other manufacturing: 12.5 **Nonmanufacturing-** Scientific research and development services: 12.5 years Software publishers: 9.1 years Financial and real estate services: 12.5 years Computer systems design: 5.6 years All other nonmanufacturing: 12.5 years **Nonmarket sector:** University & colleges: 12.5 years Other non-profits: 12.5 years Federal government defence extramural R&D: 10.1 years Federal government defence intramural R&D: 12.5 years Federal government nondefense: NASA: 27.7 years Health: 22.1 years Energy: 21.4 years Transportation: 12.5 years Other federal nondefense: 12.5 years State and local R&D: 12.5 years	Geometric		**For market sector**: Model that relates R&D GFCF to firm sales & profitability. Analysis done using firm-level and establishment-level data. **For non-profits**: based on estimates of business depreciation (scientific research and development services) **For federal government national defence extramural, NASA, Health, and Energy**: BEA research based on a progression of R&D investments by function that led to observable outcomes, such as investments in stealth technology that resulted in the development of particular military aircraft. **For other federal government and state and local government**: based on estimates of business depreciation (scientific research and development services)

* RECOMMENDATION FROM A EUROSTAT TASK FORCE: "IN CASE, WHERE SUCH INFORMATION IS NOT AVAILABLE, A SINGLE AVERAGE SERVICE LIFE OF 10 YEARS SHOULD BE RETAINED"

1. SOURCE: HTTP://WWW.ABS.GOV.AU/AUSSTATS/ABS@.NSF/PRODUCTS/5310.0.55.002~SEPTEMBER+2009~MAIN+FEATURES~CHAPTER+6%20RESEARCH+&+DEVELOPMENT?OPENDOCUMENT

2. SOURCE: HTTP://WWW.UNECE.ORG/FILEADMIN/DAM/STATS/DOCUMENTS/ECE/CES/GE.20/2008/SP.3.E.PDF

3. ASSUMES A DOUBLE DECLINING BALANCE RATE TO CALCULATE SERVICE LIFE; SOURCE: HTTP://WWW.BEA.GOV/NATIONAL/PDF/BEA_DEPRECIATION_RATES.PDF

Table 2
Mineral exploration and evaluation

Country	***Method***	***Service life***	***Depreciation function***	***Mortality function***
Canada	PIM	7 years	Geometric	
Chile	PIM		Linear	Winfrey
Czech Republic	PIM	10 years	Linear	Simultaneous
Denmark	PIM	30 years	Linear (move to Geometric)	Winfrey
Finland	PIM	10 years	Geometric	
Germany	PIM	30 years	Linear	Gamma
Ireland	PIM	5 years	Geometric	Log-normal
Italy	PIM	34 years, to be revised based on research outcome	Linear	Truncated normal
Japan	PIM	1 year		
The Netherlands	PIM	40 years	Winfrey	Weibull
New Zealand	PIM	20 years	Hyperbolic	Winfrey
Norway	PIM	20 years	Geometric	
Portugal	PIM		Delayed linear	
Russia	PIM	5 – 13 years	Hyperbolic	Normal
Sweden	PIM	10 years	Geometric	
United Kingdom	PIM	Various	Linear	Normal

Table 3
Software and databases

Country	***Method***	***Service life***	***Depreciation function***	***Mortality function***
Austria	PIM		Geometric	Delayed linear
Belgium	PIM	3 years	Linear	Log-normal
Canada	PIM	3.7 years	Geometric	
Chile	PIM		Linear	Winfrey
Czech Republic	PIM	4.5 years	Linear	Truncated normal
Denmark	PIM	4 years (purchased) 6 years (own-account)	Linear (move to Geometric	Winfrey
Finland	PIM	5 years	Geometric	
Germany	PIM	10 years (mainframe) 5 years (desktop)	Linear	Gamma
Hungary	PIM	5 years	Linear	Normal
Ireland	PIM	5 years	Double declining	Log-normal
Israel	PIM	3 years (pre-packed) 5 years (own-account)	Linear	
Italy	PIM	5 years	Linear	Truncated normal
Japan	PIM		Geometric	
The Netherlands	PIM	4 years	Winfrey	Weibull
New Zealand	PIM	4 years		Winfrey
Norway	PIM	4 years	Geometric	
Portugal	PIM		Delayed linear	
Russia	PIM	3 years	Hyperbolic	Normal
Slovak Republic	PIM	Various		
Slovenia	PIM	5 years	Linear	Constant
Sweden	PIM	5 years (purchased) 10 years (own-account and databases)		
United Kingdom	PIM	Various	Linear	Normal
United States	PIM	3 years (Pre-packaged) 5 years (Custom & own-account)	Geometric	

Table 4
Entertainment, literary and artistic originals

Country	***Method***	***Service life***	***Depreciation function***	***Mortality function***
Austria	PIM		Geometric	Delayed linear
Belgium	PIM	7 years	Linear	Log-normal
Czech Republic	PIM	7 years	Linear	Simultaneous exit
Denmark	PIM	5 years	Linear (move to Geometric)	Winfrey
Finland	PIM	10 years	Geometric	
Germany	PIM	5 years	Linear	Gamma
Hungary	PIM	7 years	Linear	Normal
Ireland	PIM	5 years	Double declining	Log normal
Italy	PIM	34 years, to be revised based on research outcome	Linear	Truncated normal
The Netherlands	PIM	5 years	Winfrey	Weibull
Norway	PIM	5 years	Geometric	
Portugal	PIM		Delayed linear	
Russia	PIM	5 – 13 years	Hyperbolic	Normal
Slovak Republic	PIM	Various		
Slovenia	PIM	5 years	Linear	Constant
Sweden	PIM	3 years	Geometric	
United Kingdom	PIM	Various	Linear	Normal
United States*	PIM	21.5 years (theatrical movies) 11.9 years (long-lived TV programs) 16.5 years (books) 7.5 years (music) 18.3 years (other)	Geometric	

Appendix III: Questionnaire sent to countries

1. Research and Development

a) What is the expected impact of capitalisation of R&D on GDP?

b) What data sources have you used to compile estimates of R&D? (e.g. list any surveys or administrative data that you have used including coverage and frequency)

c) The OECD Handbook on Deriving Capital Measures for Intellectual Property Products manual provides guidance on deriving estimates for R&D. Briefly describe the methods you have used for deriving estimates for R&D. (e.g. how closely have you followed the manual, and in particular the links to Frascati data, or if you have used alternative approaches)

d) Have you made allowances for the treatment of software in R&D to avoid double counting? (e.g. yes, no, do not know). If yes, briefly described the methods used.

e) Have you created estimates of investment in R&D broken down by institutional sector? If yes, briefly describe the methods used. Please describe whether the sources and methods differ depending on the sector being covered.

f) Have you created estimates of investment in R&D broken down by industrial activity? If yes, briefly describe the methods used. Please describe whether the sources and methods differ depending on the industrial activity being covered.

g) How will you create historic estimates of investment in R&D? (e.g. by modelling)

h) What method(s) do you use to calculate capital stock and depreciation? Are they consistent with each other? (e.g. PIM, description of alternative method, none).

i) Please describe the main assumptions you use to estimate depreciation: e.g. service lives, depreciation functions, retirement patterns. Please attach data if it is available. (e.g. for service lives broken down between average time of development, average time between end of development and start of use in production/operation, average time from start of use in production until end of use). Please also specify whether the assumptions differ depending on the industry.

j) Do you have any other comments on issues related to measuring R&D?

2. Mineral exploration and evaluation

a) Do you compile estimates for mineral exploration and evaluation?

If yes, what data sources have you used to compile estimates? (e.g. list any surveys or administrative data that you have used including coverage and frequency)

b) Briefly describe (or attach, reference) the methods you have used to derive estimates of mineral exploration and evaluation

c) What method(s) do you use to calculate capital stock and depreciation? (e.g. PIM, description of alternative method, none)

d) Please describe the main assumptions you use to estimate depreciation: e.g. service lives, depreciation functions, retirement patterns. Please attach data if it is available.

e) Do you have any other comments on issues related to measuring Mineral exploration and evaluation?

3. <u>Software and databases</u>

a) Do you compile estimates for software and databases?

If yes, what data sources have you used to compile estimates? (e.g. list any surveys or administrative data that you have used including coverage and frequency)

b) Briefly describe (or attach, reference) the methods you have used to derive estimates of software and databases.

c) Have you created estimates of investment in software broken down by <u>institutional sector</u>?

If yes, briefly describe the methods used. Please describe whether the sources and methods differ depending on the sector being covered.

d) Have you created estimates of investment in software broken down by <u>industrial activity</u>? (e.g. yes, no, unknown)

If yes, briefly describe the methods used. Please describe whether the sources and methods differ depending on the industrial sector being covered.

e) What method(s) do you use to calculate capital stock and depreciation? (e.g. PIM, description of alternative method, none)

f) Please describe the main assumptions you use to estimate depreciation: e.g. service lives, depreciation functions, retirement patterns. Please attach data if it is available.

g) Do you have any other comments on issues related to measuring software and databases?

4. <u>Entertainment, literary and artistic originals</u>

a) Do you compile estimates for entertainment, literary and artistic originals?

If yes, what data sources have you used to compile estimates? (e.g. list any surveys or administrative data that you have used including coverage and frequency)

b) Briefly describe (or attach, reference) the methods you have used to derive estimates of entertainment, literary and artistic originals (e.g. including the coverage and treatment of Films, TV and radio stock programmes, literary works, and musical works)

c) Have you created estimates of investment in entertainment, literary and artistic originals broken down by <u>institutional sector</u>?

If yes, briefly describe the methods used. Please describe whether the sources and methods differ depending on the sector being covered.

d) Have you created estimates of investment in entertainment, literary and artistic originals broken down by <u>industrial activity</u>?

If yes, briefly describe the methods used. Please describe whether the sources and methods differ depending on the industrial sector being covered.

e) What method(s) do you use to calculate capital stock and depreciation? (e.g. PIM, description of alternative method, none)

f) Please describe the main assumptions you use to estimate depreciation: e.g. service lives, depreciation functions, retirement patterns. Please attach data if it is available.

g) Do you have any other comments on issues related to measuring entertainment, literary and artistic originals?

5. Other Intellectual Property Products

a) Are there any other Intellectual Property Products that you include in your National Accounts estimates. Please list them below.