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Introduction

1. The degree of incorporation of intangible capital into economic activity is inducing structural and qualitative changes in the operation of the economy. Steps have been made in the 2008 System of National Accounts (SNA 2008) and the European System of Accounts (ESA 2010) to adapt official measures of economic activity to the changes in the structure of the economy by recognizing the importance of intangible capital. Many of these assets are associated with the establishment of property rights over knowledge in one form or another. In the SNA 2008 and the ESA 2010, this category is called "intellectual property products (IPPs)" rather than "intangible capital" to make clear that the category does not include all intangible capital.[1] In the national accounts, four types of produced IPPs are recognized: (i) research and development; (ii) mineral exploration and evaluation; (iii) computer software and databases; and (iv) entertainment, literary or artistic originals. [2]
2. Eurostat and the OECD have produced over the years a significant amount of guidance for the measurement of gross fixed capital formation (GFCF) in research and development (R&D) and software and databases and are in the process of reviewing, through the Eurostat-OECD "Task Force on Land and Other Non-financial Assets - IPPs"[3], country practices and assessing if further guidance, including more specific guidance on the measurement of stocks is needed to make the estimates comparable across countries. Certainly, implementation of the globalization dimension of IPPs, and notably how the economic location of IPP assets is determined will be reviewed to determine if current guidance as provided in the United Nations Economic Commission for Europe (UNECE) *Guide to Measuring Global Production* needs to be updated.[4] Cross-country comparability of national accounts data is vital for macroeconomic analysis including productivity analysis, policy evaluation, as well as for administrative purposes.
3. This paper is organized as follows: section 1 provides a cross-country overview of the data; section 2 describes the sources and methods used by countries to estimate GFCF in R&D and software and databases; section 3 discusses country practices in estimating the capital stock and consumption of fixed capital of R&D and software[5]; section 4 reviews the issues related to economic ownership of IPPs; the last section, section 5, concludes with a way forward.

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[1] The word "products" is included to make a distinction that IPPs does not include other intangible assets such as marketing assets (e.g. brand names, trademarks, logos, mastheads, and domain names) which are non-produced assets in the SNA and ESA.

[2] The SNA2008 and ESA2010 also recognize "other intellectual property products" as a not elsewhere classified category but does not provide any guidance as to what is included in this category.

[3] Eurostat and the OECD created the Task Force in response to interest on balance sheet data. The Task Force has produced two compilation guides since its creation in 2012: Eurostat-OECD Compilation Guide on Land Estimations available at http://www.oecd.org/publications/eurostat-oecd-compilation-guide-on-land-estimations-9789264235175-en.htm and Eurostat-OECD Compilation Guide on Inventories available at http://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/KS-GQ-17-005?inheritRedirect=true

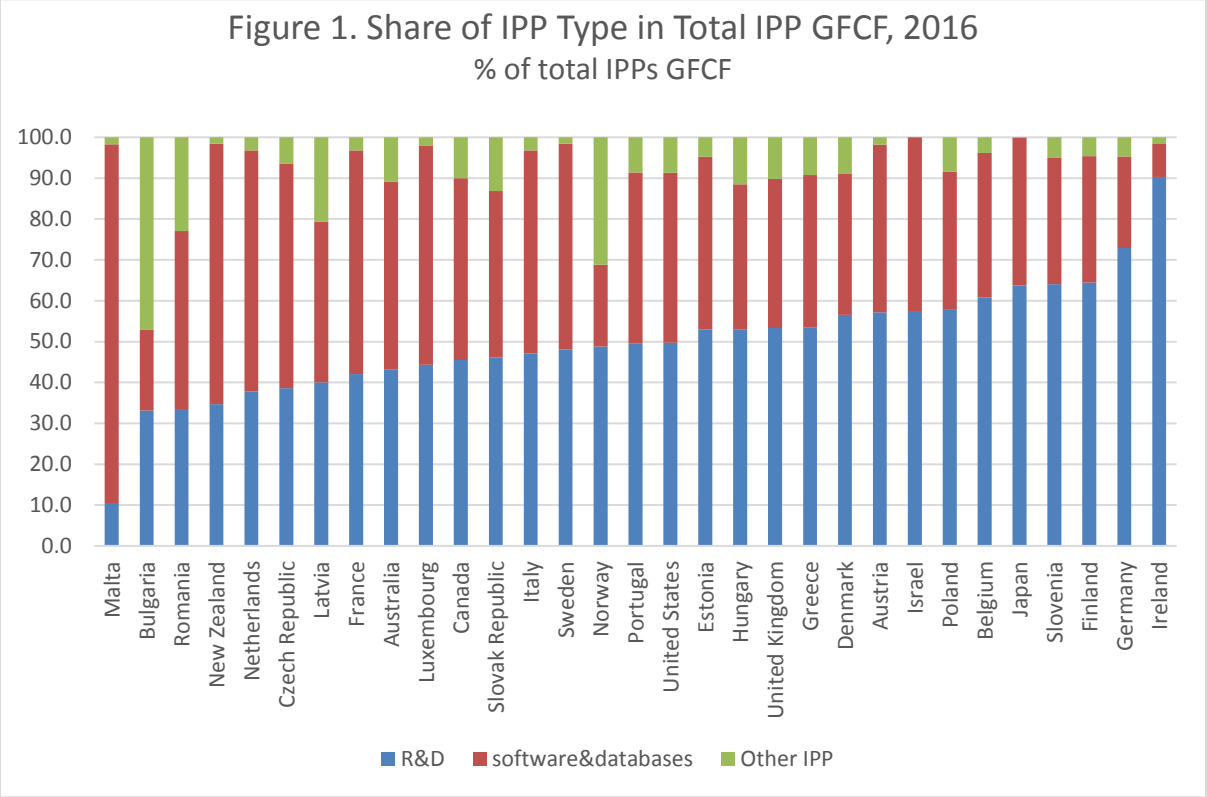
[4] The United Nations Economic Commission for Europe (UNECE) *Guide to Measuring Global Production* discusses the ownership of IPPs inside global production in chapter 4. http://www.unece.org/index.php?id=42106

[5] In practice it appears that if countries estimate databases it is included in the combined category software and databases and the software depreciation profile is used.

1. Cross-country overview of the data

1.1. Importance of IPPs in total GFCF

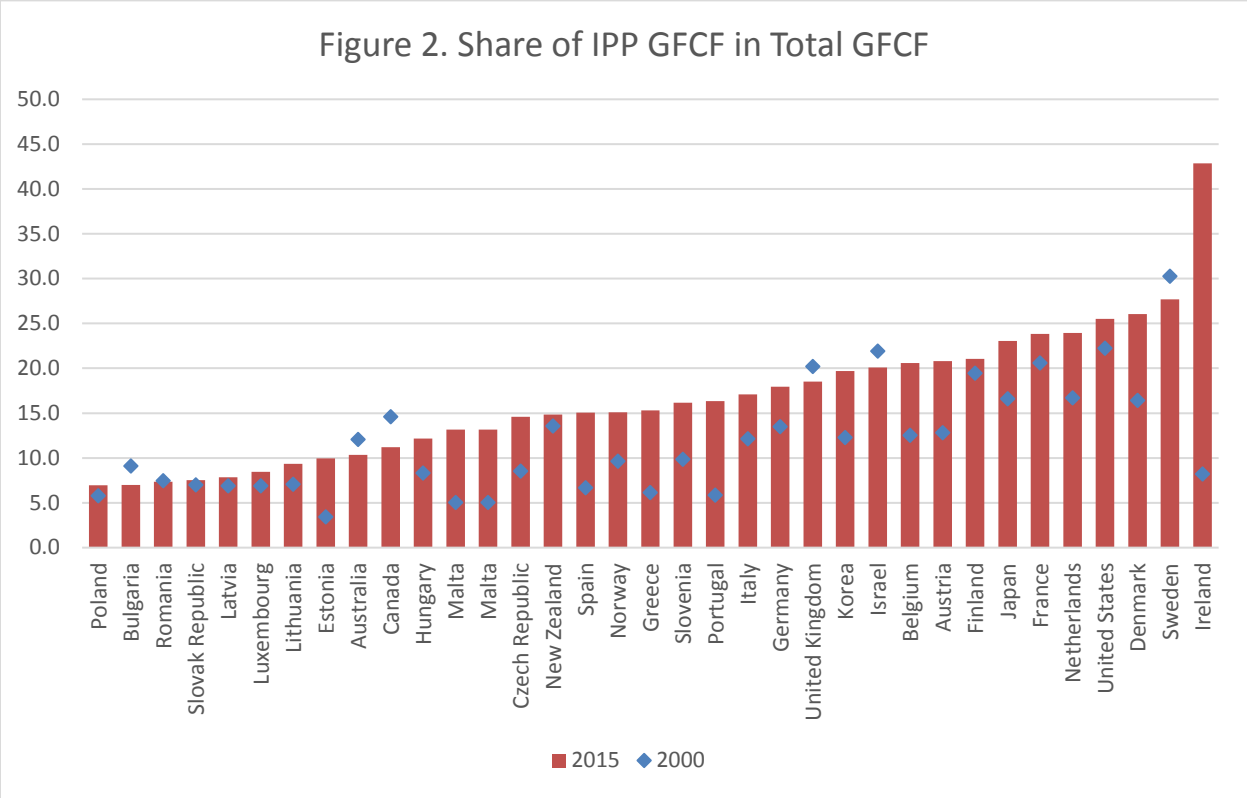
4. In most countries the IPPs category is dominated by R&D and software and databases. The combined R&D and software and databases share ranges from 52.8 percent of total IPP GFCF in Bulgaria to 100 percent of total IPP GFCF in Israel and Japan (figure 1). In most cases the R&D share is larger than the software and databases share, but exceptions to this occur, particularly in Malta, New Zealand, the Netherlands, France, the Czech Republic, Luxembourg, and Sweden where the software share is greater than 50 percent of total IPP GFCF.



Note: 2015 for Canada, Estonia, Greece, Ireland, Latvia, New Zealand, Norway, Poland, Portugal, Romania, and Sweden; 2014 for Denmark; 2013 for Bulgaria and Slovenia
Source: OECD National Accounts Database, June 2018; Eurostat National Accounts Database, July 2018

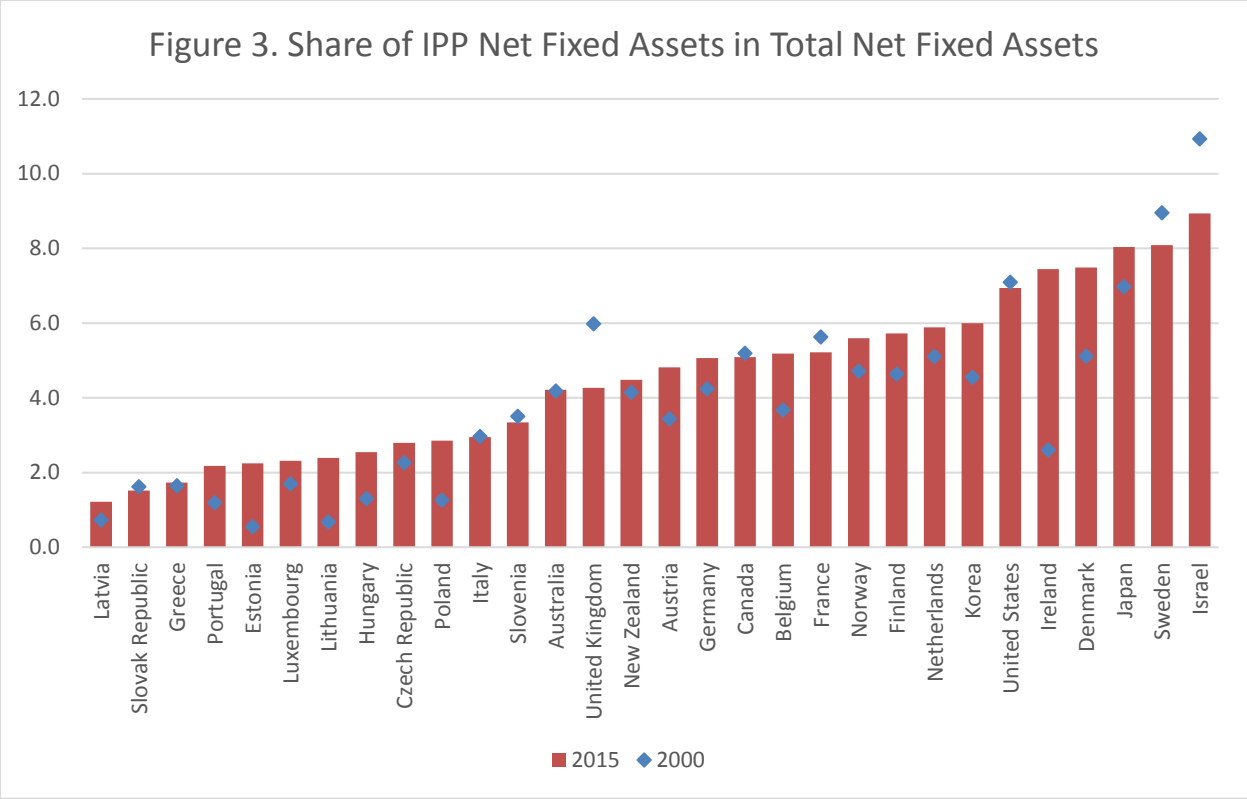
5. In 2015, the share of IPPs GFCF in total GFCF ranges from 7.0 percent in Poland to 42.9 percent in Ireland (figure 2). Most of the countries shown in figure 2 showed an increase in the share from 2000, most notably in Ireland, increasing 34.7 percentage points, but strong increases, over 9 percentage points, were also seen in Greece, Denmark and Portugal (although in the case of Portugal and Greece total GFCF fell but IPP GFCF increased contributing to the increase in the share). In Ireland, much of this increase is attributed to the relocation of R&D assets by multinational corporations. Countries that experienced a decline in the share were Canada, Sweden, Bulgaria, Israel, Australia, and the United Kingdom. The decline in the share in Israel was

more than accounted for by a decline in the R&D share where as in Sweden and Australia the decline in the IPP share was driven by a decline in the software and databases share. In Canada the R&D and software share declined as well as other IPP categories; and in the United Kingdom an increase in the R&D share was completely offset by a decrease in the software share, thus the other IPP categories contributed to the decline in the overall IPP share in the United Kingdom.



Source: OECD National Accounts Database, June 2018; Eurostat National Accounts Database, July 2018

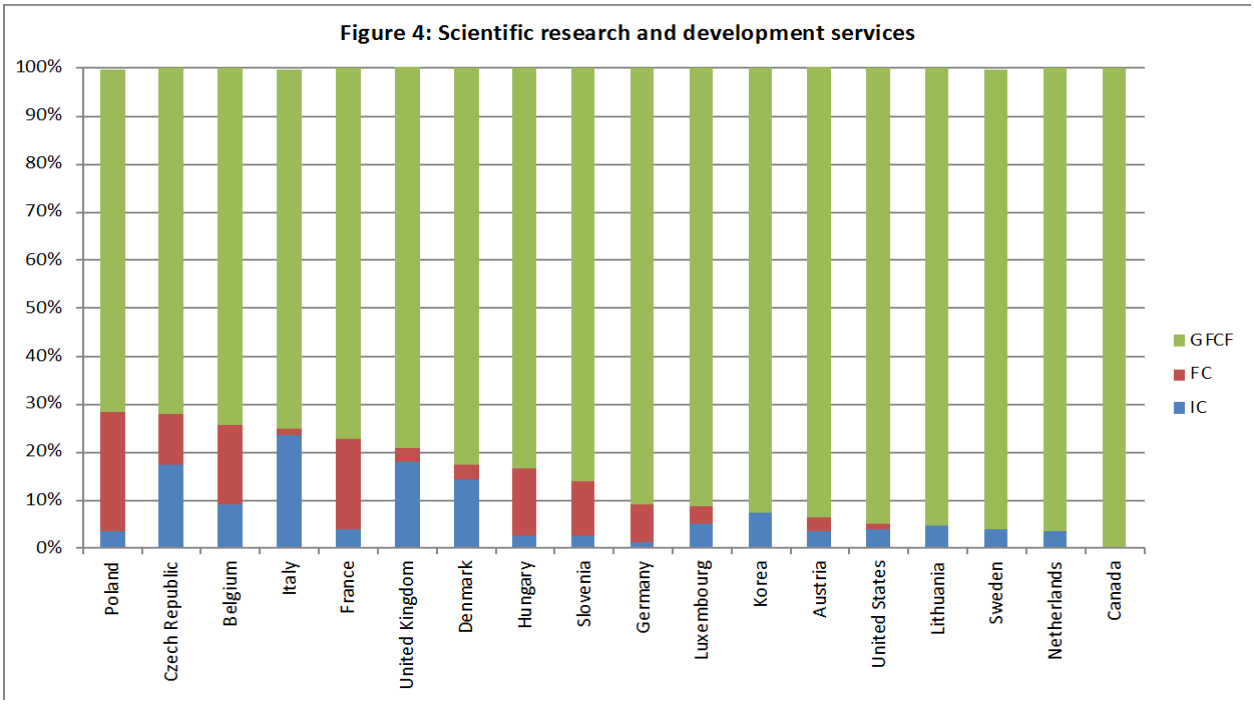
6. In 2015, the share of IPPs net fixed assets in total net fixed assets ranges from 1.2 percent in Latvia to 8.9 percent in Israel (figure 3). Around two-thirds of the countries shown in figure 3 showed an increase in the share from 2000, most notably in Ireland, increasing 4.8 percentage points. Again, in Ireland much of this increase is due to increases in the stock of R&D. Countries that experienced the largest decline in the share were Israel and the United Kingdom. The decline in the share in Israel was more than accounted for by a decline in the R&D share whereas the R&D share was stable in the United Kingdom. Therefore, in the United Kingdom software and databases as well as the other IPP categories contributed to the decline in the overall IPP share in the United Kingdom.



Note 2014 for Ireland
Source: OECD National Accounts Database, June 2018; Eurostat National Accounts Database, July 2018

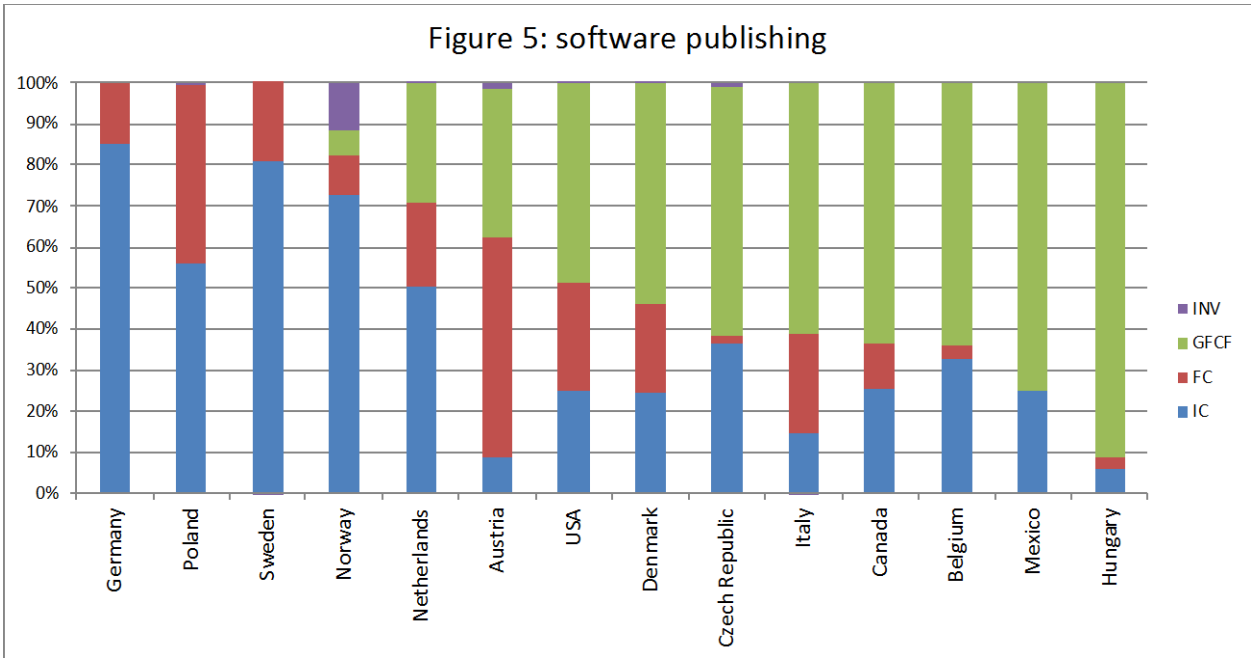
1.2. Allocation of R&D and software and databases to categories of use

7. In the context of the Eurostat-OECD "Task Force on Land and Other Non-financial Assets – IPPs", a number of Task Force countries provided detailed data on supply-use balances for R&D and software and databases. These data give some insight into the actual application of existing international guidance on the recording of these categories.
8. Figure 4 shows the distribution of total domestic use of R&D in gross fixed capital formation (GFCF), final consumption (FC) and intermediate consumption (IC) for a selection of countries. The GFCF share varies between a little more than 70% in Poland and 100% in Canada. What is most striking are the differences in allocation to FC, which is in this case government and NPISH consumption. Several countries have no FC at all, whereas especially Poland and France have significant shares. The same is true for IC, for which in particular Italy, the UK and the Czech Republic have significant shares.



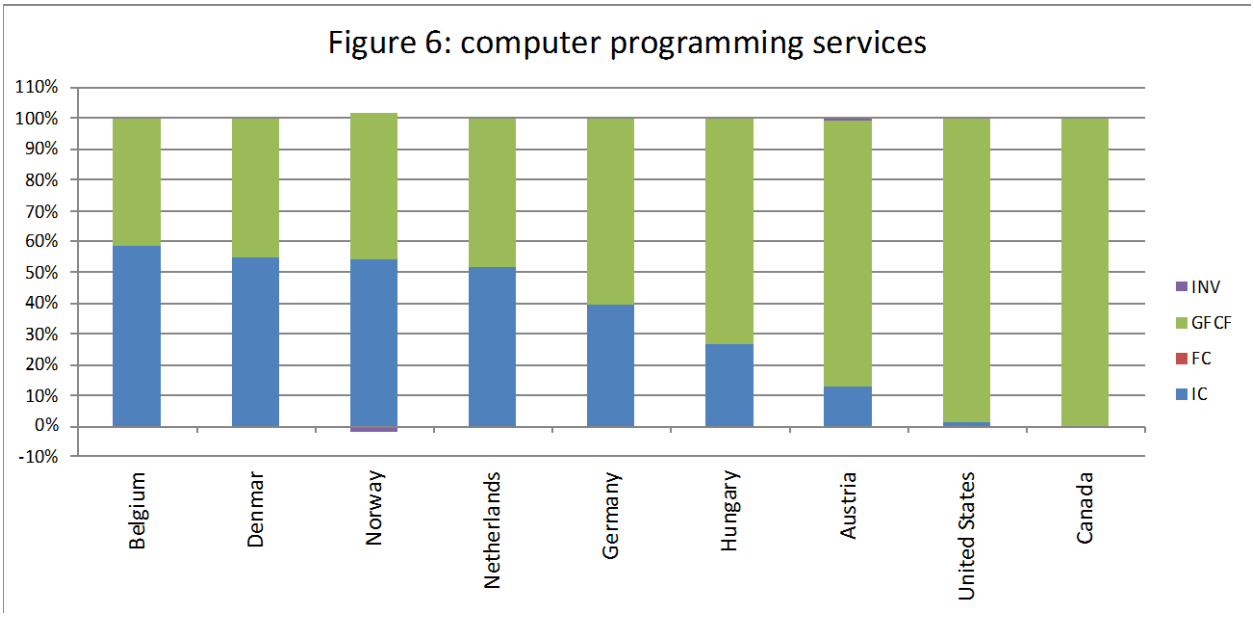
Source: Eurostat-OECD Task Force on Land and Other Non-financial Assets – IPPs

9. Figure 5 shows the same shares (now including changes in inventories (INV)) for the CPA category 58.2 "software publishing", which corresponds to packaged software (including games). Three of the countries included do not capitalize any packaged software. Also, the share allocated to FC (in this case household consumption) varies a lot across these countries.



Source: Eurostat-OECD Task Force on Land and Other Non-financial Assets – IPPs

10. Finally, figure 6 shows the shares for the CPA category 62.01 “computer programming services”, which comprises customized software development as well as own-account software and databases production. Here we note that Canada and the United States capitalize all or nearly all such services whereas European countries tend to allocate a significant share to IC.



Source: Eurostat-OECD Task Force on Land and Other Non-financial Assets – IPPs

11. It should be noted that the occurrence of differences in shares do not automatically imply that the numbers are unreliable. There is indeed no reason for the shares to be identical or even similar across countries. However, if the shares are different because different assumptions are employed then it may be an area where more guidance is needed.

2. Sources and methods for estimation of gross fixed capital formation

2.1. Research and Development

12. Most countries 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 straightforward to determine where the performance (output) of R&D is taking place. As discussed in the Eurostat and OECD manuals[6], this R&D output is most often the starting point for deriving GFCF in R&D. In addition, much of business R&D production is for a firm’s own use and therefore it should be recorded as GFCF of the firm. This is called in national accounts own-account R&D production and is measured using

[6] The Eurostat *Manual on Measuring Research and Development in ESA 2010* and the OECD *Handbook on Deriving Capital Measures of Intellectual Property Products* provide guidance on measuring R&D.

the "sum of costs approach", that is the sum of the costs incurred in the production of R&D including a return on capital for market producers.

13. When the R&D unit is part of a multinational enterprise (MNE), producing the R&D for sale, or receiving funding from the government, the economic ownership and the corresponding use of the R&D may become more difficult to determine. As was just discussed, information on R&D expenditures is collected from performers of R&D. However, the FM-based R&D surveys normally ask additional questions on sources of funds for the R&D performed. The current guidance is that the funder of the R&D should be assumed to be the owner of the final product unless there is evidence to the contrary.[7] Ideally the funding should be further separated between items such as government grants and capital transfers to promote R&D, and contracts intended to generate R&D products to be owned by the contractor which would imply no change in economic ownership. The recently updated Frascati Manual 2015 introduced a recommendation to further decompose funding flows as will be discussed in section 5.
14. In practice, how countries determine the economic owner of R&D varies by country. Initial results from the *Eurostat-OECD Survey on Capital Measures for Research and Development, Software and Databases* (hereafter, Eurostat-OECD survey) suggests that country practices are more nuanced.
15. If the funding is from domestic business sources:
    - When the sources of funds are from businesses then many countries make the simplifying assumption that the funder of the R&D performance (as provided in the FM-based R&D survey) is purchasing R&D services and hence becomes the owner of the R&D asset. Note that a significant share of R&D funding is internal to a firm so that the performer and the funder are the same.
    - A few countries do not use the FM-based sources of funds information but instead use information on R&D services from other sources such as Structural Business Statistics surveys. In addition, a few countries have made modifications to the FM-based R&D survey to ask e.g. sales of R&D, domestic purchases of R&D, and distinction between exchange funds and transfer funds.
16. If the funding is from government sources:
    - When the sources of funds are from government most countries assume that the performer retains ownership of the R&D. Only a few countries record a transfer of ownership of the R&D performed by businesses to the government sector.
    - A few countries make a more nuanced distinction.
        - If funding is through a government grant then the performer is the owner. In other cases where the government is the source of funding (not through a grant), then the government is the owner. However, most countries are not able to make this distinction as information on what is a grant versus other sources of funding is lacking.
    - In some instances, countries assume that if the performer is a business that receives government funding then the business retains ownership whereas if the performer is a government funded research institution or national university then the government is the owner of the R&D.

[7] See paragraph 5.35 of the Eurostat *Manual on Measuring Research and Development in ESA 2010*.

17. If the funding is from non-resident sources:
    - While a few countries use the FM-based non-resident funding data as a source for determining if the domestic performer retains the ownership of the R&D or not it appears that most countries use the Balance of Payments International Trade in Services statistics to determine exports and imports of R&D services (net imports are added to R&D output when deriving total GFCF of R&D).
    - Country specific circumstances provide a more nuanced view, for example, if most foreign funds are grants from the EU to promote R&D then the performer (i.e. producer) is considered the owner.
    - Another country mentioned that the owner of the R&D is the performer if the funding comes from a related party. If the funding is from an unrelated unit then ownership is assumed to be transferred to the foreign funder. However, this case appears to be the exception rather than the rule.

2.2. Software and databases

18. In the national accounts, computer software and databases are defined as follows:
    - *Computer software consists of computer programs, program descriptions and supporting materials for both systems and applications software*. (SNA paragraph 10.110)
    - *Databases consist of files of data organized in such a way as to permit resource-effective access and use of the data*. (SNA paragraph 10.112)
19. Even though they are defined separately, the ESA2010 and the SNA 2008, recognize the need to group the two assets together into one category because a computerized database cannot be developed independently of a database management system (DBMS), which is itself computer software.[8] If a national statistical institute NSI separately produces estimates of databases then what does this category include if the DBMS is recorded as software? Most likely databases are produced in-house and the SNA paragraph 10.113 provides a clue as to what should be included when making estimates using the sum-of-costs approach.
    - *The creation of a database will generally have to be estimated by a sum-of-costs approach. The cost of the data base management system (DBMS) used should not be included in the costs but be treated as a computer software asset unless it is used under an operating lease.* ***The cost of preparing data in the appropriate format is included in the cost of the database but not the cost of acquiring or producing the data. Other costs will include staff time estimated on the basis of the amount of time spent in developing the database, an estimate of the capital services of the assets used in developing the database and costs of items used as intermediate consumption****.* (SNA paragraph 10.113)[9]
20. Since it is difficult to produce separate estimates of databases many countries produce estimates for the combined category “software and databases”. Software and databases can be produced

[8] SNA paragraph 10.109.

[9] It is important to note that this definition therefore implies that the value of the database does not include the value of the data in the database.

on own-account or purchased and the vast majority of countries responding to the Eurostat-OECD survey produce estimates for both categories. However, the Eurostat-OECD survey also reveals that some countries only produce estimates for own account software and databases (or sometimes just the software category which would include the DBMS). The estimates for purchased software are sometimes further disaggregated into the categories pre-packaged software and custom software.

21. All countries use multiple sources to estimate software, three on average. The data sources most used are: Structural business survey, Labour force survey and administrative or tax records. Moreover, half of the countries use specialized surveys such as Information and Communication Technology (ICT) surveys and/or capital expenditure surveys as well.

Own-account software and databases

22. Almost all countries use a macro approach for estimating own-account software and databases. This approach is based on labour costs for relevant occupations plus a markup for other expenses (including the costs of the capital used). Occupations (according to International Standard Classification of Occupations (ISCO)-08) that are included are 251 "Software and applications developers and analysts" and 252 "Database and network professionals". Some countries also include (partially) other categories (like 213 "Computer professionals").
23. Information on the number of employees by occupation are combined with data on average wages and the average time spent on software development. Estimates of the average time spent by in-house staff on software development are either based on specific surveys or on expert knowledge and assumptions. Several countries apply the recommendation from the OECD Handbook on Deriving Capital Measures of Intellectual Property Products (OECD 2010)[10] of 50 percent.
24. The Eurostat-OECD survey shows that countries differ substantially regarding the inclusion of the cost of the capital used (i.e., the consumption of fixed capital (CFC)) for calculating own-account software and databases. About half of the countries do not include (explicitly) any CFC at all. For countries that do include CFC costs, the type of assets that are included differs among countries. However, some countries make implicit estimates by using a general mark-up.

Purchased software

25. Regarding estimates of GFCF in purchased software only a few countries reconcile both demand and supply. The others use either the demand-side approach (i.e. surveys in which enterprises and governments provide details on expenditures) or the supply-side approach (i.e. starting from total domestic supply).

[10] Organisation for Economic Co-operation and Development, *Handbook on Deriving Capital Measures of Intellectual Property Products*, 2010. Available at http://www.oecd.org/sdd/na/44312350.pdf

26. In most cases software is acquired via a licensing agreement. If the agreement fulfils the capitalization criteria this purchase should be recorded as GFCF.[11] However, only a few countries take into account licensing arrangements in estimating GFCF in software.

Economic ownership

27. A limited number of countries use the decision tree presented in the UNECE *Guide to Measuring Global Production* when determining economic ownership for software. In practice many countries rely on business accounting information (balance sheet data) to assume economic ownership.

Databases

28. As discussed above, only a few countries estimate databases distinctly from software. In practice many countries estimate the combined software and databases category as some of the occupations used in estimating own-account GFCF are arguably more related to database development than (other) software development.

3. Measuring Capital Stock and Consumption of Fixed Capital

29. *Measuring Capital* (OECD 2009)[12] explains the theory and methods of capital measurement, and the OECD *Handbook on Deriving Capital Measures of Intellectual Property Products* (OECD 2010), ESA 201013 and the Eurostat Manual on *Measuring Research and Development in ESA 2010*[14] offer recommendations as to how to measure net stocks. Whenever direct information on the stock of fixed assets is missing the recommended approach is to use the perpetual inventory method (PIM)[15]; 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 Eurostat-OECD survey, most if not all European and OECD countries use the PIM to estimate net stocks of R&D and software and databases assets. For this, countries need to make assumptions and/or use sources to estimate the service life, the depreciation function and the retirement pattern for R&D and software and databases assets. It should be noted that R&D and software and databases, as well as intellectual property products more generally, are not subject to wear and tear like conventional assets, but their values decline over time. This is because IPPs are subject to obsolescence (e.g., recent R&D may lead to new processes or products that displace those arising from previous R&D) and because the exclusiveness of the right to use the IPP has expired (e.g., expiration of patent). It should also be noted that a change in value of the IPP could be simply a

[11] Under certain conditions licensing arrangements are considered as GFCF as paragraphs 10.99 - 10.100 of SNA 2008 specify.

[12] Organisation for Economic Co-operation and Development, *Measuring Capital: OECD Manual, Second Edition*, 2009. Available at http://www.oecd.org/sdd/productivity-stats/43734711.pdf .

[13] European System of Accounts 2010. Available at http://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/KS-02-13-269

[14] Eurostat *Manual on Measuring Research and Development in ESA 2010,* 2014*.* Available at http://ec.europa.eu/eurostat/documents/3859598/5937049/KS-GQ-14-004-EN.PDF/eed4dfe2-9b89-4c30-8c49-f6152912c1a7

[15] ESA 2010 paragraph 3.141.

revaluation of the asset which may be hard to distinguish from obsolescence. The following sections describe the most common functions used by countries in determining R&D and software and databases capital stock and CFC.

30. The geometric approach estimates net stock by accumulating past gross fixed capital formation (GFCF) whose value depreciates at a constant rate δ (say, 2%) every year. The depreciation rate δ is usually computed by a declining balance rate (DBR) divided by an average service life, T (δ = DBR/T) and, so, the higher the DBR the faster the rate of depreciation for a given average service life. In general, because they have lower operational service lives, machinery and equipment and intellectual property products tend to depreciate at a faster rate than structures. As a particular vintage of investment approaches its average service life, its value approaches zero but, with geometric depreciation, only reaches zero when combined with a retirement function.
31. The linear approach estimates net stock by accumulating past GFCF whose value depreciates linearly at a constant value every year, within the finite time of its full retirement, adjusted with an assumption for the retirement pattern. Retirement refers to the removal of an asset from the capital stock because the asset is exported, sold for scrap, dismantled, or abandoned. The average service life and its retirement pattern are the most important parameters in estimating capital stocks using the linear approach. The countries that combine linear depreciation with retirement distributions employ a range of mathematical retirement functions to produce bell-shaped or other retirement patterns. They include gamma, quadratic, normal, log-normal, Weibull, and Winfrey. The last three are probably the most widely used in PIM models.[16]
32. The general approach computes an asset's age-price profile as the present value of its future efficiency profile with assumption of future inflation rate in asset prices ρ and discount rate r, adjusted with an assumption of the retirement pattern. As the name implies, this approach can be considered as a generalization of the linear age-price profile while the linear profile is a special case of the general approach, where the former assumes a one-hoss-shay age-efficiency profile (efficiency reduction parameter=1), a simultaneous exit retirement, no asset price inflation and zero discount rate. The hyperbolic function is mainly used as the age-efficiency profile. The average service life, its retirement pattern, age-efficiency parameter, asset inflation rate, and discount rate are the most important parameters in estimating capital stocks using the general approach.

3.1. Research and Development

33. The most common approach, for countries responding to the Eurostat-OECD survey, is to assume a geometric pattern when estimating depreciation profiles of R&D (table 1). Although geometric depreciation does not require separate retirement distributions in theory, some countries report retirement profiles of delayed linear, truncated normal, log-normal, and Weibull. This may be attributable to the treatment of beginning and terminating time for depreciation.

[16] See chapter 13.2 *Measuring Capital: OECD Manual, Second Edition*, 2009 for more information on retirement patterns.

Table 1. Summary of country depreciation profiles for estimates of net stocks of R&D

	Geometric	Linear	General approach	Other
Total	16	10	2	1

Source: Eurostat-OECD Survey on Capital Measures for Research and Development, Software and Databases.

34. The table 2 shows the annual depreciation rates of R&D for the countries that use geometric depreciation. The average depreciation rates for R&D vary across countries: from 0.125 for Mexico to 0.400 for Bulgaria. Some countries apply different depreciation rates by R&D type (Austria), by type and sector/industry (Denmark), and by sector/industry (Finland, Japan, United Kingdom, United States).

Table 2: Depreciation rate assumptions for countries using geometric depreciation for estimates of net stocks of R&D

	Minimum	Average	Maximum
Austria	0.167	0.136	0.115
Bulgaria		0.400	
Canada		0.275	
Cyprus		0.200	
Denmark	0.188	0.185	0.154
Estonia		0.200	
Finland	0.286	0.200	0.100
Ireland		0.200	
Italy		0.200	
Japan	0.183	0.150	0.110
Mexico		0.125	
Norway		0.200	
Poland		0.200	
Slovenia		0.200	
United Kingdom	0.500	0.250	0.167
USA	0.072	0.201	0.400

Source: Eurostat-OECD Survey on Capital Measures for Research and Development, Software and Databases.

35. Linear depreciation is the second most commonly reported functional form (table 1). A total of 10 respondents report using linear depreciation — Belgium, Czech Republic, Hungary, Latvia, Lithuania, Luxembourg, Portugal, Slovak Republic, Israel, Romania. As discussed above, with linear depreciation, the speed of depreciation depends, in large part, on the assumed service life. The service life of R&D, in the case of the linear approach, is around 10 years ranging from 8 to 11 years (table 3).
36. Most of the countries listed above use a bell-shaped retirement pattern like normal, log-normal or truncated-normal. Romania adopts simultaneous mortality (i.e. all assets of a given type and vintage are retired simultaneously) and Portugal uses a delayed linear retirement pattern. For countries that use linear depreciation without a retirement pattern, the pattern of depreciation depends on the service life in a straightforward way. With a commonly used bell-shaped

retirement pattern, on the other hand, some assets will retire before or after the average service life.

Table 3: Service life assumptions for countries using linear depreciation for estimates of net stocks of R&D

	Minimum	Average	Maximum	Retirement Pattern
Belgium		10		Log-normal
Czech Republic		12		Log-normal
Hungary		10		Normal
Israel	8	9.5	11	Truncated normal
Latvia		10		Log-normal
Lithuania		10		Normal
Luxembourg		10		Log-normal
Portugal		10		Delayed linear
Romania		8		Simultaneous mortality
Slovak Republic		10		Log-normal

Source: Eurostat-OECD Survey on Capital Measures for Research and Development, Software and Databases.

37. The Bank of Korea (BOK) and New Zealand employ the general approach, deriving their age-price profiles of R&D from hyperbolic age-efficiency profiles. Both combine the hyperbolic age-efficiency profile (which tends to be concave to the origin) with a bell-shaped Winfrey pattern of retirement. Specifically, BOK assumed mostly a Winfrey L1 retirement pattern for R&D derived from a R&D retirement survey while New Zealand assumes a Winfrey L4. The efficiency reduction parameter is 1 for New Zealand and 0.75 for BOK. Both use the same discount rate of 4 percent (see table 4).
38. Statistics Netherlands uses hyperbolic age-efficiency profiles with a Weibull retirement distribution to describe the decline in the value of an asset cohort over time. The form of the Weibull distribution used assumes that the probability of retirement rises over time (see table 4).

Table 4: Country practice of estimating the capital stock of R&D

Country	**Average service life (years)**	**Depreciation profile**	**Retirement profile**	**Other assumptions**
Korea	Depending on industry: average 9.7 (Min 5 - Max 19)	Age-price profile from hyperbolic age-efficiency profile (efficiency parameter=0.75, discount rate 4%)	Winfrey L1 (and S3)	time varying (every 5 years)
Netherlands	Depending on industry: average 12 (Min 9 - Max 15)	Hyperbolic age-efficiency profile with a Winfrey function	Weibull	
New Zealand	10	Age-price profile from hyperbolic age-efficiency profile (efficiency parameter=1, discount rate 4%)	Winfrey L4	

Source: Eurostat-OECD Survey on Capital Measures for Research and Development, Software and Databases.

3.2. Software

39. In contrast to R&D, most countries apply a linear depreciation profile for estimates of net stocks as shown in table 5. Note that in practice most countries use the depreciation profile of software as the depreciation profile of the combined software and databases category if they include estimates of databases in their country's capital stock.

Table 5: Summary of country depreciation profiles for estimates of net stocks of software

	Geometric	Linear	General approach	Other
Total	12	14	2	1

Source: Eurostat-OECD Survey on Capital Measures for Research and Development, Software and Databases.

40. Most countries adopt 5 years as the average service life of software. Some countries use other service lives and/or adopt different lives depending on the type of software. With regard to retirement patterns, bell-shaped retirement distributions like normal, log-normal, truncated-normal are most often chosen.

Table 6: Service life assumptions for countries using linear depreciation for estimates of net stocks of software

	Software service life		Retirement pattern
		Prepackaged	
Belgium	5		Log-normal
Czech Republic	4		Log-normal
Hungary	10		Normal
Israel	5	3	Truncated normal
Italy	5		
Latvia	5		Truncated normal
Lithuania	4 – 8 by sector		Log-normal
Luxembourg	5		Normal
Poland	5		Log-normal
Portugal	Min 3 – Max 6		Delayed linear
Romania	5		Simultaneous mortality
Slovak Republic	10		Log-normal
Slovenia	5		
United Kingdom	5		Normal

Source: Eurostat-OECD Survey on Capital Measures for Research and Development, Software and Databases.

41. The second most common reported approach for estimating a depreciation profile of software assumes a geometric pattern. As stated previously, although geometric depreciation does not require separate retirement distributions in theory, some countries do report retirement profiles.
42. Among countries that apply a geometric depreciation pattern, the majority use the double declining balance rate (DBR=2) while some use 1.5 (Austria, Denmark) or 1.65 (Canada, Japan, United States) combined with the service lives to derive the assumed annual depreciation rates of software. Table 7 shows the depreciation rates for countries that use the geometric depreciation pattern.

Table 7: Depreciation rate assumptions for countries using geometric depreciation for estimates of net stocks of software

	Software service life	
		Prepackaged
Austria	0.30	
Bulgaria	0.40	
Canada	0.33	0.55
Cyprus	0.22	
Denmark	0.25	
Estonia	0.40	
Finland	0.40	
Ireland	0.40	
Japan	0.22	
Mexico	0.40	0.67
Norway	0.50	
United States	0.33	0.55

Source: Eurostat-OECD Survey on Capital Measures for Research and Development, Software and Databases.

4. Issues of economic ownership

43. The intangible nature of intellectual property products means that once they are produced their ownership and use are not easily observed since IPPs are not physically constrained and are non-rivalrous in nature. In other words, where IPPs are produced, used, and owned do not necessarily occur in the same country (or institutional sector or industry). This provides significant freedom for enterprise groups because the use of the IPP by one part of an enterprise group does not prevent the simultaneous use by another part and that the legal ownership of IPPs can be placed anywhere amongst the group.
44. The concept of economic ownership is used in the national accounts and balance of payments statistics. Economic ownership is defined as follows: "*The economic owner of entities such as goods and services, natural resources financial assets and liabilities is the institutional unit entitled to claim the benefits associated with the use of the entity in question in the course of an economic activity by virtue of accepting the associated risks*." (SNA 2008 paragraph 3.26) A change in

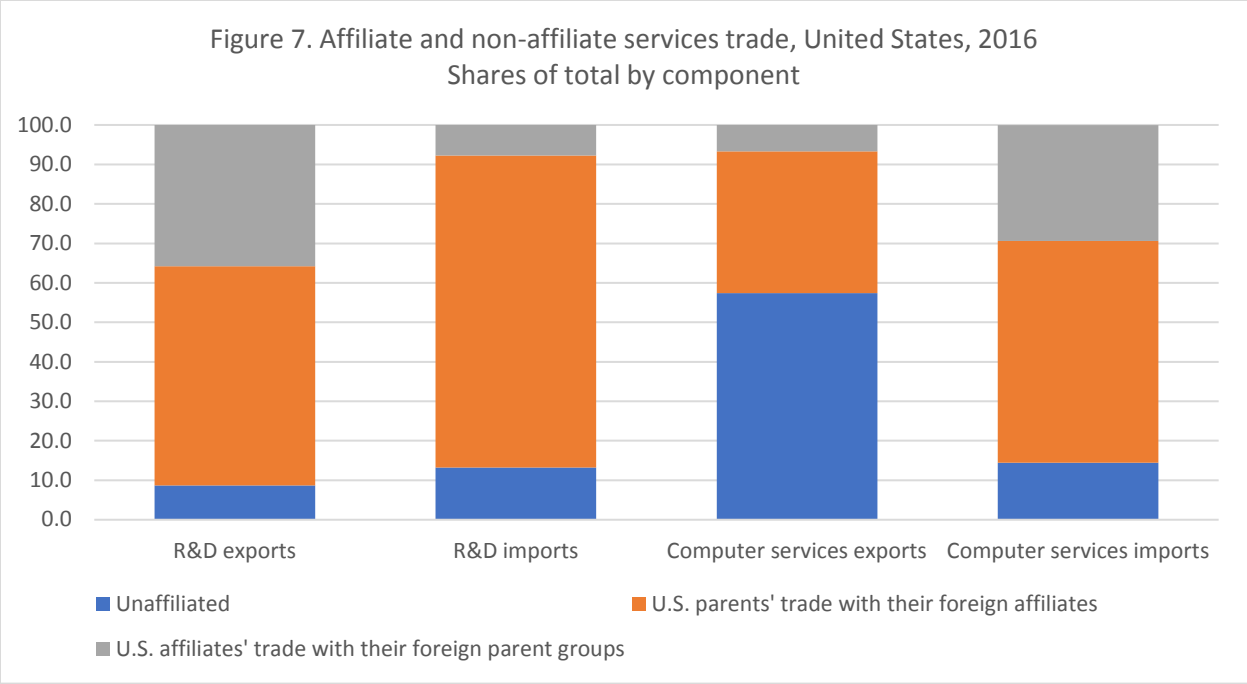
economic ownership typically coincides with a financial transaction between two institutional units[17] and this would therefore usually coincide with a change in legal ownership, although there are exceptions to this rule.[18]

45. The principle of economic ownership is not straightforward in the case of MNEs. As is discussed in Moulton and van de Ven (2018), "*All affiliates of an enterprise group are to some degree controlled by their parent, whereby the case of multinational enterprise groups has the added complication of having non-autonomous affiliates which are considered as institutional units by convention, simply because they are resident in an economic territory that is different from the parent's. Transactions between units of a multinational enterprise, or the absence of such transactions as recorded in business accounts, may therefore be at odds with the principle of economic ownership*."
46. Determination of economic ownership of IPPs, and the recording of related transactions is a major issue as it affects the recording of assets and related income flows, and consequently also directly impacts the allocation of output and value added to units and countries.

4.1. What countries do in practice

47. As was described above, countries begin with FM data on the performance of R&D much of which is own-account production. For a firm that is purely domestic this means that the ownership of the R&D stays in the country where the performance occurred. Where it gets tricky is when the enterprise is part of a multinational enterprise (MNE) group for reasons described above. To derive the total supply of R&D available for domestic use countries must add imports and subtract exports. Many countries use the international (foreign) trade statistics (as recorded in the balance of payments statistics) to determine exports and imports of R&D services and in some cases information from the Frascati Manual are used to determine these flows. International trade statistics are also used in the national accounts statistics to determine imports and exports of software. Most countries cannot separately identify flows between affiliated units in the international trade statistics.
48. However, where information does exist, albeit for one country, trade between affiliates can be a significant share as shown in figure 7. For the United States affiliated trade accounts for more than 90% of R&D exports and around 42% of computer services exports from the United States. Much of this affiliated trade is driven by trade between US parents with their foreign affiliates (around 60% for R&D affiliated exports and nearly 85% of computer services affiliated exports).
49. Affiliated trade is also important for imports, accounting for over four-fifths of US R&D and computer services imports. Again, much of this affiliated trade is driven by trade between US parents with their foreign affiliates (over 90% for R&D affiliated imports and almost two-thirds of computer services affiliated imports).

[17] An institutional unit is a unit that is capable of owning assets, incurring liabilities, and engaging in economic activities and in transactions with other entities. (SNA 2008 paragraph 4.2) The first step in the process is to determine if the unit is an institutional unit. This issue is not further explored in the paper.
[18] An exception to the rule is for financial leasing. The lessor is the legal owner of the relevant asset but the lessee is considered to be the economic owner.



Source: Bureau of Economic Analysis. US Trade in Services, by Type of Service and by Country or Affiliation, October 2017.

50. Transactions in R&D services and software services in international trade statistics follow the guidance given in the Balance of Payments Manual and are to be recorded when a change in economic ownership occurs[19] (the same concept followed within the national accounts). It is important to note that while the majority of countries use the international trade statistics to account for R&D and computer services exports and imports (and hence changes in economic ownership that occur with the rest of the world) not all of the category is necessarily used to determine GFCF and, in turn, the capital stock. This is because these services categories may include services that do not fit the definition of an asset in national accounts[20], such as R&D testing services or software games.
51. For R&D services, the Manual on Statistics of International Trade in Services (MSITS) recommends a further breakdown of research and development services into two subgroupings: work undertaken on a systematic basis to increase the stock of knowledge (reflecting the coverage of research and development within a 2008 SNA context) and other. Charges for the use of proprietary rights or charges for licenses to reproduce and/or distribute the intellectual property are included in a separate category. Table 8 shows the Extended Balance of Payments Services

[19] See paragraph 3.41-3.42 in the Balance of Payments and International Investment Position (BPM6) manual.
[20] An asset is a store of value representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time. It is a means of carrying forward value from one accounting period to another. (SNA 2008 paragraph 3.30, ESA 2010 paragraph 7.15). All assets in the SNA are economic assets (SNA 2008 paragraph 3.31). The asset boundary for fixed assets consists of goods and services that are used in production for more than one year. (SNA 2008 paragraph 10.11).

(EBOPS) R&D categories mapped to the Central Product Classification (CPC) categories to provide an understanding of how the BOP categories map to the national accounts products.

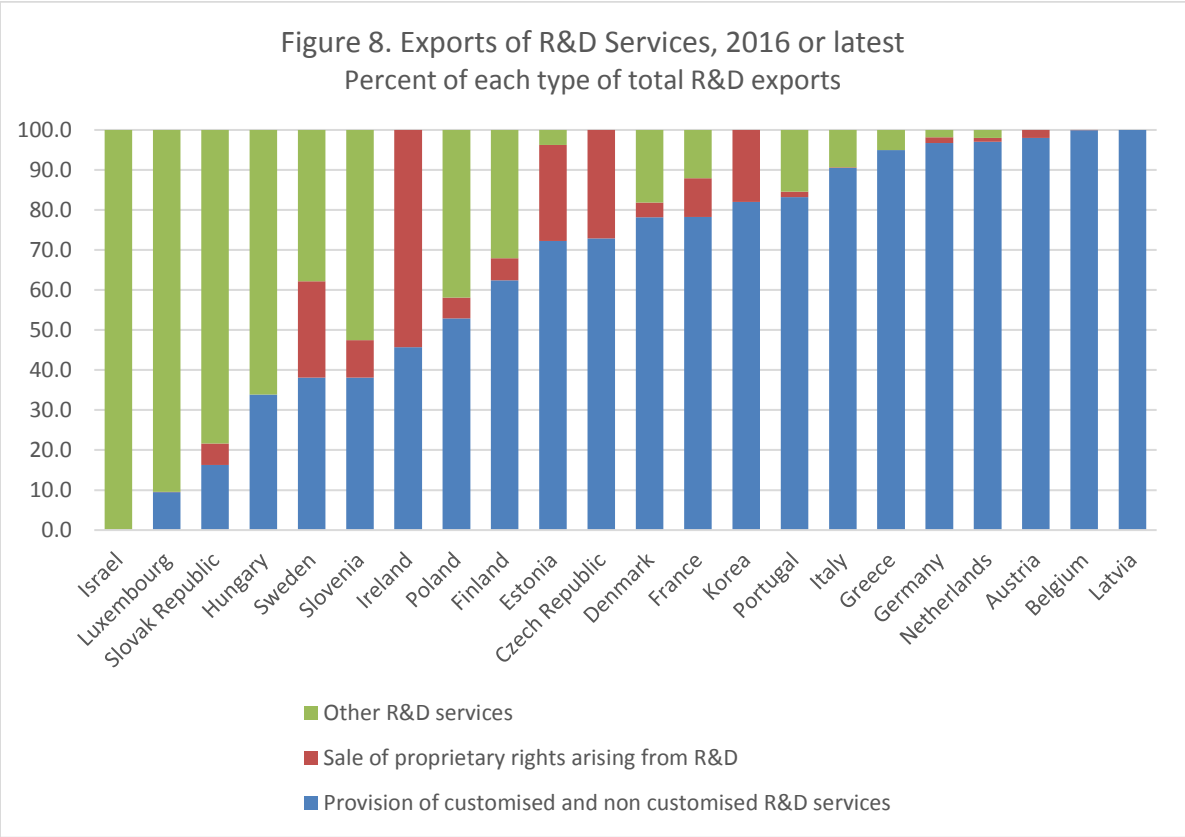
Table 8. EBOPS R&D categories mapped to CPC

EBOPS category	CPC category	Notes
Research and development services 10.1.1 Work undertaken on a sytematic basis to increase the stock of knowledge		
10.1.1.1 Provision of customized and non-customized research and development services	R&D in natural sciences (811) R&D in socal science and humanities Interdisciplinary R&D (813) Industrial design services (83912)	Covers sales/purchases of the R&D performed in the current period.
10.1.1.2 Sale of proprietary rights arising from research and development	Research and development originals (814) Design originals (8392)	Covers the change in economic ownership of the whole of the intellectual property right (IPR) in question. The seller no longer has any rights or obligations associated with the intellectual property. Includes second or subsequent outright sales of IPRs (i.e., a sales/purchases of the R&D originals).
10.1.2 Other R&D services	Technical testing and analysis services (8344)* - Partial CPC correspondance	In theory outside of the scope of the FM and SNA R&D definition, but may include some transactions that fit the definition. The principal correspondence of this CPC item is with scientific and other technical services (EBOPS 10.3.1.3) since these activities fall outside the boundary of Research and Development (covered in EBOPS 10.1.1 Work undertaken on a systematic basis to increase the stock of knowledge). However if there is reasonable evidence that some of these services will ultimately
8. Charges for the use of intellectual property, n.i.e.		
8.2 Licenses for the use of outcomes of research and development	Licensing services for the right to use R&D products (7333)	Payments made for the licences may be described in various ways, such as fees, commissions or royalties, but however they are described they are treated as payments for services rendered by the owner. This may or may not be recorded as GFCF by the licensee. It depends if it satisfies the national accounts asset criteria. (see footnote 13)

Source: Extended Balance of Payments Services Classification, 2010, BPM6, and correspondence with CPC classification https://unstats.un.org/unsd/tradeserv/tfsits/msits2010/ebops2cpc_detailed.htm#ebops10

52. While data are most often only available for the total R&D services EBOPS category, some countries provide the more detailed categories as shown in table 8. Two-thirds of countries in figure 8 record at least half of their R&D services exports as provision of customized and non-customized R&D services, the category most closely aligned to the FM R&D performance data.

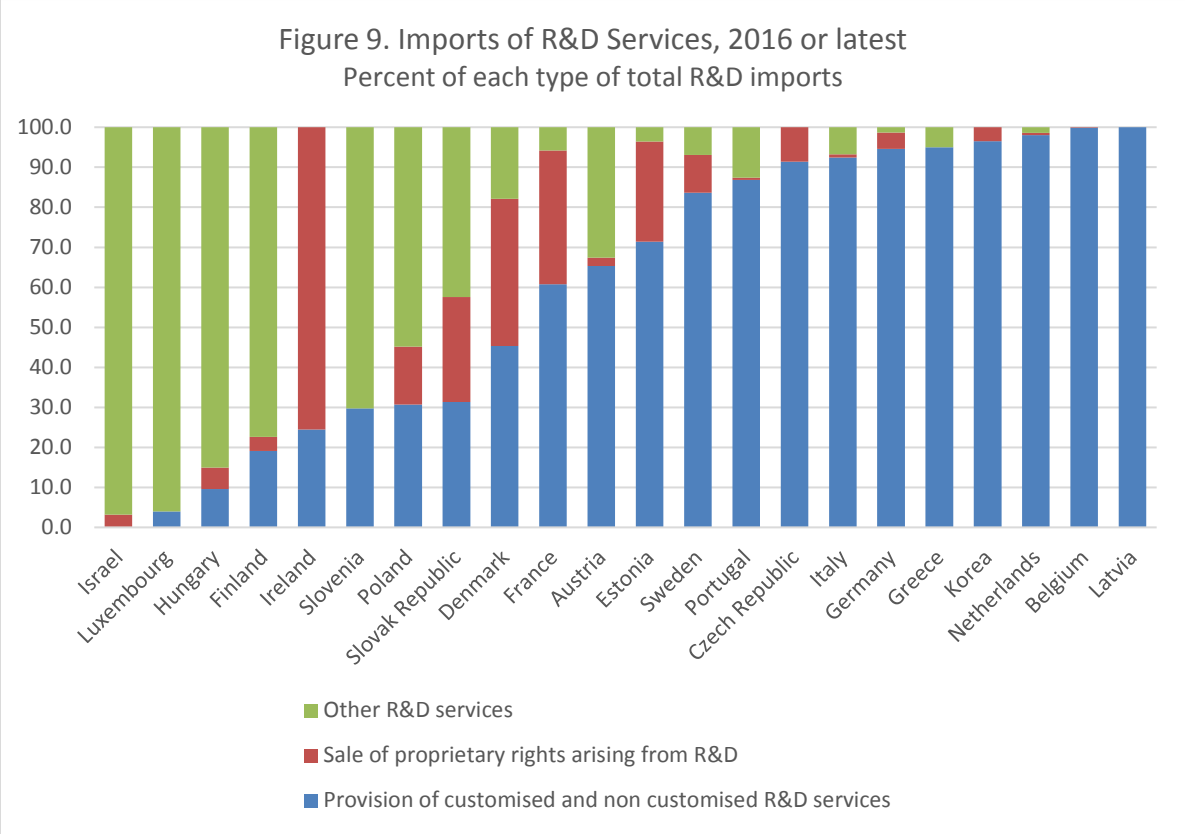
Outright sales of property rights arising from R&D is a relatively small share of total R&D services for the countries shown in figure 8 except in Ireland (accounting for a little more than 50 percent), Czech Republic (27 percent), Sweden and Estonia (24 percent, each). Perhaps surprising is that some countries record a significant share in the other R&D services category: countries with over 50 percent in this category are Slovenia (53 percent), Hungary (66 percent), Slovak Republic (78 percent), Luxembourg (90 percent) and Israel (nearly 100 percent).



Note: 2015 for the Netherlands
Source: OECD EBOPS 2010- Trade in Services by Partner Economy Database, June 2018

53. When looking at imports of R&D services a similar picture emerges (figure 9). Three-fifths of countries record at least half of their R&D services imports as provision of customized and non-customized R&D services. A large share of R&D services imports from the purchases of property rights arising from R&D is recorded in Ireland (76 percent), Denmark (37 percent), France (33 percent), Slovak Republic (26 percent), and Estonia (24 percent). Six countries reported more than a 50 percent share of other R&D services imports: Poland, Slovenia, Finland, Hungary, Luxembourg and Israel. It is unclear at this point if countries that have the more detailed EBOPS

categories exclude the other R&D services category or not when allocating net imports of R&D services to GFCF.[21]



Note: 2015 for the Netherlands
Source: OECD EBOPS 2010- Trade in Services by Partner Economy Database, June 2018

54. For computer services, the MSITS recommends a further disaggregation into computer software services and other computer services. Computer software services includes software originals, software downloads, online games, and online software whereas other computer services include services such as IT consulting and support services, IT design and development services for applications and for networks and systems, etc.[22] A limited amount of countries provide data separately identifying computer software services. Also, if software is under a licensing arrangement it depends on how the arrangement is set-up whether it is considered GFCF or not.[23]

[21] Israel and Luxembourg record a significant share in other R&D services exports and imports. Comparisons of FM R&D performance data to national accounts R&D GFCF as a share of GDP for Israel and Luxembourg suggest that a significant amount of R&D performance is exported.
[22] For concordance between EBOPS and CPC see https://unstats.un.org/unsd/tradeserv/tfsits/msits2010/ebops2cpc.htm
[23] Under certain conditions licensing arrangements are considered as GFCF as paragraphs 10.99 - 10.100 of SNA 2008 specify.

Therefore, it is not straightforward to determine what proportion of imports of computer services are allocated to GFCF. In addition, some products that are considered software GFCF may be physical products and be included in goods rather than services.

55. Disaggregating information at the EBOPS level of detail for R&D and computer software services as well as separately identifying affiliated versus unaffiliated international transactions may allow for a more refined treatment of change in economic ownership. The next section reviews some of those options.

4.2. Review of theoretical options for recording economic ownership

56. Determining the economic ownership of IPPs is a non-trivial task. One can think of four broad options for how to determine economic ownership: (1) the unit that produces the IPP is deemed the economic owner; (2) the unit that makes explicit payments for the creation of the IPPs (or obtains the whole of the intellectual property right) is deemed the economic owner; (3) the unit within an MNE structure that is the parent (ultimate investing country) of the legal owner of the IPP is deemed the economic owner of the IPP; (4) the unit that uses the IPP in the production of other goods and services is deemed the economic owner (this may or may not be evidenced by a transaction); and (4a) for affiliated units, determining use of IPP through apportionment. One could choose to blend some of these options to create other scenarios. Or perhaps another option not identified above could be explored. For example, if a level within an MNE that is not necessarily the parent nor the producer of the IPP but could be considered the economic owner of the IPP can be identified.
57. Some think that the consequences of capitalizing R&D were not thought through good enough. De Haan and Haynes (2018) provide an excellent discussion of the consequences of capitalizing R&D by looking at the issue from the perspective of the entire MNE. One could also revisit the guidance on what constitutes an institutional unit but this issue is beyond the scope of this paper.[24] Next let us briefly review the implications of each of these options for R&D and software services (the IPPs discussed in this paper).
58. *Option 1: the unit that produces the IPP is deemed the economic owner*
    - If this assumption is strictly followed, then there is no recognition that there can be sales or purchases of R&D or software services between two institutional units. This in turn means that there should be no exports or imports of these types of services, a rather severe assumption.
    - Under this option the owner of the output cannot be different than the producer of the output. In the case of unaffiliated units, this option assumes that there cannot be a change in ownership and does not correspond very well with the concept of change in *economic* ownership. Thus, one may want to apply different rules based on whether the units are affiliated or not.

[24] Raiser (2017) proposed that in the future international standards for compiling national accounts to consolidate SPEs with their ultimate owners. Also, see Moulton and van de Ven (2018) for further discussions.

- If this assumption is applied differently between affiliated and unaffiliated units it would be recorded as follows:
    - If the unit that produces the IPP is producing it for an unaffiliated unit then there can be sales or purchases of R&D or software services. If the unit that produces the IPP is producing it for an affiliate then it is deemed that no change in economic ownership occurs so there cannot be affiliated sales or purchases of these services. This in turn means that in the international trade statistics only unaffiliated exports and imports of R&D and software services should be recorded. In the case of the United States, this means a significant amount of R&D and computer services imports and exports would be excluded (see figures 8 and 9 above).

59. *Option 2: the unit that makes explicit payments for the creation of the IPP (or obtains the whole of the intellectual property right) is deemed the economic owner.*
    - This option records a change in economic ownership when a financial transaction between two institutional units occurs
    - This would coincide with a change in legal ownership.
    - This is consistent with the actual cross-border cash flows resulting from transactions and it follows the business accounting. It can be succinctly called "follow the money" method.
    - This would include an affiliate that pays for the whole of the intellectual property rights (i.e. purchase of the original) for use in the production of other goods and services as well as a special purpose entity (SPE) acting as the legal owner of IPPs and obtaining the revenues of IPP copies or licenses to use or reproduce.
    - If this assumption is applied differently between affiliated and unaffiliated units, then the recording would be as described in the second bullet under option 1.
    - Another refinement of this option is to record transactions if it is for the provision of customized and non-customized R&D services (EBOPS 10.1.1.1) because this represents purchases/sales of R&D performed in the current period and exclude the outright sales of IPRs (EBOPS 10.1.1.2) as this may be mainly done for tax minimization purposes. In the case of Ireland, this means a significant amount of R&D services would be excluded. However, there may be outright sales of IPRs that occur between unaffiliated parties that you may want to include in the BOP data, thus a further refinement of breaking down EBOPS categories between affiliated and unaffiliated transactions would be needed.

60. *Option 3: the unit within an MNE structure that is the parent (ultimate investing country) of the legal owner of the IPP is deemed the economic owner of the IPP*
    - This option assumes that since the parent exercises some degree of control and ultimately receives the benefits (if not through the generation of income by production, then through direct investment income received from affiliates) and takes the risk then the parent is always deemed the economic owner of the IPP.
    - Focusing on the R&D service transactions that are considered as investment (i.e., EBOPS 10.1.1) implies that economic ownership stays with the parent and adjustments to the exports and imports of R&D services may be required. To implement, you would remove

any parents' exports with their foreign affiliates of R&D services and any affiliates' imports from their foreign parent group of R&D services. However, you would not eliminate all affiliated transactions, you would include any parents' imports from their foreign affiliates of R&D services and any affiliates' exports with their foreign parent groups of R&D services.

- The extent to which countries internationalize their R&D production varies by country, but it is probably too strong of an assumption to assume that the parent explicitly pays for all R&D performance not taking place in the country it is domiciled. Thus, it is unlikely that this type of implicit financing is recorded in international trade in services data. Therefore, imputations for the missing piece (i.e. parents' imports of (unrecorded) R&D services from their foreign affiliates; and the corresponding exports of (unrecorded) R&D services from the foreign affiliate) would be needed to fully implement this approach.
- The above bullets focus on recording the R&D services transactions to obtain the correct capital stock, but one could also argue that since the parent is the economic owner of the IPP then the associated revenue from the IPPs should be allocated to the parent. This may require imputing exports from the parent to the affiliates for the use of the IPPs (i.e., EBOPS 8.2).[25]

61. *Option 4: the unit that uses the IPP in the production of other goods and services is deemed the economic owner*
    - This option assumes that the economic owner of the IPP is any unit that uses the IPP in the production of other goods and services.
    - Since IPPs are non-rivalrous and can be used in multiple locations simultaneously this may lead to a partitioning of the IPP asset based on use.
    - If use of the IPP by both affiliated and unaffiliated units is treated consistently then this would mean transferring ownership of at least part of the IPP asset (at least temporarily) to the unaffiliated foreign firm. The consequence of this assumption does not appear to correspond very well with change in economic ownership in the case of unaffiliated units. Therefore, one may want to apply different rules based on whether the units are affiliated or not.
    - If this assumption is applied differently between affiliated and unaffiliated units it would be recorded as follows:
        - If the unit that uses the IPP in the production of other goods and services is an unaffiliated unit then there is no transfer of ownership unless there is an explicit sale or purchase of R&D or software services.
        - If the unit that uses the IPP in the production of other goods and services is an affiliated unit then there is always a transfer of ownership (even if not evidence by a transaction).
    - This option blurs the line between payments for an outright purchase of an asset which corresponds with a change in economic ownership of IPPs and the charges for the use of

[25] Note that this may require removing certain transactions that are currently included in exports and imports (e.g., payments from the parent to their affiliates for the use of the IPP).

the IPP which does not correspond with a change in economic ownership of the underlying asset. Thus, rather than showing a sale/purchase of (part of) the IPP asset, a service flow should instead be recorded (i.e. charges for the use of the IPP).

62. *Option 4a: For affiliated units, determining use of IPP through apportionment*
    - Rassier and Koncz-Bruner (2015) demonstrate for the U.S. a method of formulary apportionment of MNE profits based on compensation of employees and sales to non-affiliates. A similar method could be used to partition the IPP asset.
    - While the indicators used for apportionment do not necessarily correspond with use of the IPP in the production process it is one way to try to proxy use of the IPP by an affiliate.
    - Moulton and van de Ven (2018) point out that this alternative would allocate IPPs and related income to production facilities, for example an affiliate in China, even though the economic activities taken place there may be low-skilled labour assembling a final product. They argue it is similar to imputing profits on the basis of tax considerations by the relevant enterprises.

4.3. Current guidance

63. The United Nations Economic Commission for Europe (UNECE) *Guide to Measuring Global Production* provides a decision tree as guidance for countries in determining the economic ownership of IPPs. The decision tree is divided into units that operate within an MNE versus units that are not part of an MNE. For units that are not part of an MNE it is noted that it is less problematic to establish economic ownership because these are autonomous units and payments for the whole of the IPR or the use can be observed from market transactions.
64. For units that are part of an MNE a detailed decision tree is made based on whether the unit is a producer of the IPP or not, whether it receives explicit payment to produce the IPP or a payment to acquire the whole of the IPR (corresponding with a change in ownership) or the use of the IPP (no change in ownership). The decision tree assigns IPP ownership to one unit within the MNE structure even if other members of the MNE benefit from the IPP. Changes in ownership essentially follow the type of monetary transaction observed (i.e., whether it is payment for the current production, payment for the whole of the IPR, or licensing the use of the IPP).
65. National Statistical Institutes (NSIs) are encouraged to test the decision tree and provide feedback on its application in practice to inform further discussions. However, there is a growing discomfort with the implementation of the economic ownership principle in relation to IPPs, where current international standards basically follow the monetary transactions.

5. Way forward

66. As a vehicle to review current practices, Eurostat and the OECD created the “Task Force on Land and Other Non-financial Assets - IPPs”. The mandate of this Task Force is to review country practices and to develop best practices and practical guidance for countries. As was discussed in this paper country estimation practices vary but there may be legitimate reasons for diverging practices (differences in source data being one major consideration). Thus, the Task Force will try to determine if the various practices can be further brought into line.

67. Part of this review will also include research into whether more practical guidance can be developed for countries to determine economic ownership of IPPs. Some have expressed the view that the decision tree in the UNECE *Guide to Measuring Global Production* is too complicated and not practically feasible (if they even use it at all). In addition, the Task Force has identified a potential new source of information based on the updated Frascati Manual 2015. The updated Frascati Manual introduced a recommendation to break R&D funding flows down into:
    1. Exchange funds - funds received in exchange for providing R&D services in return; these relate to a sale and purchase of R&D
    2. Transfer funds - funds transferred for R&D performance but with no expectation that the funder will directly receive the R&D results in return.
68. Such data can allow for an improved approach where only financing of R&D by exchange funds corresponds to a change in economic ownership (the unit providing the exchange funds is the economic owner) and financing of R&D through transfer funds corresponds to no change in economic ownership (the R&D performing unit is the economic owner).
69. While the implementation of the Frascati Manual 2015 recommendation would be useful, many NSIs rely on the international trade statistics as the main source for cross-border trade in R&D services. Therefore, it would be beneficial for NSIs to conduct research comparing overseas funding flows from FM-based R&D surveys with data on R&D from international trade in services and/or MNE surveys.
70. International initiatives such as OECD's Base Erosion and Profit Shifting (BEPS)[26] aim to ensure that MNE profits are taxed where economic activities generating the profits are performed and where value is created. BEPS action 13 provides a template for MNEs to report annually and for each tax jurisdiction in which they do business (called country-by-country report). In addition, recent changes to US tax law could have a yet to be determined impact on U.S. MNE activity.[27]
71. Proposals for alternative ways of assigning economic ownership of IPPs and related income have also been discussed in other fora. Examples include formulary apportionment (e.g. based on compensation of employees and/or sales to non-affiliates) and the consolidation of SPEs with the foreign parent. These alternatives would most likely go beyond the 2008 SNA and are therefore not within the mandate of the current Eurostat-OECD Task Force. This is not to say that recommendations that go beyond the current framework are not being explored. The Inter-Secretariat Working Group on National Accounts (ISWGNA)[28] and the Advisory Expert Group on National Accounts (AEG) recommended to establish an ISWGNA Task Force to develop a way forward to advance the SNA research agenda for priority areas through the drafting of discussion notes that elaborate on the clarification and interpretation of the relevant issues within and beyond the 2008 SNA. Globalization (and the related issue of economic ownership of IPPs) will be one of the priority areas of research for the ISWGNA Task Force.

[26] http://www.oecd.org/ctp/beps-actions.htm

[27] The U.S. Tax Cuts and Jobs Act of 2017 reduced the corporate tax rate from 35% to 21% and moved the U.S. from a worldwide tax system to a modified territorial tax system.

[28] The ISWGNA is one of the oldest interagency bodies set up by the United Nations Statistical Commission (UNSC) to enhance cooperation among international organisations working in the same field. ISWGNA consists of the following five members: Eurostat, IMF, OECD, United Nations, and World Bank.

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