Handbook on measuring data in the System of National Accounts

Executive summary

The production of data is now a regular process for most companies and organizations across the economy. The digitization of so many facets of the economy has made the collection of facts and information cheaper and easier than ever before while at the same time providing ample evidence of the benefits that data use can provide organizations. The production of massive amounts of data has created brand-new business models reliant on data, while increasing the risk that many traditional enterprises will be usurped by more productive and efficient, data focused producers.

While data impact on the economy is indisputable, it has only recently been explicitly recognized as an output of production and asset within the System of National Accounts (SNA), the internationally agreed standard set of recommendations on how to compile measures of economic activity.

The inclusion of data into the SNA production and asset boundary was formally endorsed at the 2024 UNSC (United Nations Statistical Commision, 2024) as part of the planned publication of the 2025 system of National Accounts (2025 SNA). However, the commission also "emphasized the importance of addressing conceptual uncertainties, and stressed the importance of continuing to develop implementation guidance on the new recommendations to facilitate the implementation of the 2025 SNA in an internationally comparable way" (United Nations Statistical Commision, 2024).

In response the Inter sector working group on national accounts (ISWGNA) formed the Eurostat-IMF task team on Measuring Data as an Asset in National Accounts. The task team, made up of representatives from national statistical authorities and international organisations was tasked with providing "recommendations on how to estimate data as an asset in the national accounts by exploring data sources and methods. The TT should develop concrete guidance for countries on how to compile the requested data in line with the 2025 SNA" (Task force on measuring data in the National Accounts, 2023). This handbook forms the primary output of the task team and its publication coincides with the official endorsement of the 2025 SNA.

In chapter 1, the handbook begins by providing clarity around the definition of data for the purpose of the SNA. This includes clarifications on which types of data should be considered as an output of

production, who is likely to be producing it, where the line exist between the production of data and the production of other goods and services (including other IPPs) and how it should be reported in the accounts. The clarifications are offered to provide insight to users to better comprehend the concept behind the data estimates, while also helping to guide compilers to better understand what kind of information and source data are likely to be useful in the compilation of data.

Chapter 2 details the methodology involved in compiling nominal estimates of data output and GFCF using the sum of cost methodology. It includes the default source material and recommendations that have been gradually refined following testing by the task force. Unlike the clarifications included in chapter 1, the recommendations in chapter 2 (as well as the remainder of the handbook) offer both default and aspirational recommendations. The task force agreed that a default set of compilation recommendations would greatly assist in promoting international comparability as countries began the task of compiling estimates of data output and data GFCF for the first time. At the same time, the inclusion of aspirational recommendations reflects the task force desire to see the methodology continually developed and improved, so that users are able to have greater confidence in the accuracy of the estimates. Aspirational recommendations also provide countries the ability to use already available source material and compilation practices, including those beyond what is required in the default recommendations.

Chapters 3-5 cover compilation requirements such as the deflation of nominal estimates, the creation of depreciation and capital stock estimates through the perpetual inventory method (PIM), recommendations on back casting and other compilation challenges. Similar to chapter 2, these recommendations usually contain both a default and aspirational variety.

Prior to the formation of the Eurostat-IMF task team on Measuring Data as an Asset in National Accounts, several countries had already compiled experimental estimates of data investment. While this work formed the basis of the discussion, additional testing, source data gathering and research by task team members refined the recommendations to arrive at a final set of conceptual clarifications and compilation recommendations. A summary of these are presented below.

The handbook also contains case studies from countries that participated in the task team which often provided the basis for the aspirational recommendations. As well as offering real world reference material which other countries can learn from, these case studies provide a foundation for the overall continual improvement of data estimates.

Overall, this handbook has been written to serve two main purposes. Firstly, as a compilation guide to assist economic statisticians compile outputs consistent with the 2025 SNA. While also providing information to users who seek to understand what is represented in the estimates of data output and GFCF of data being produced by statistical offices.

Conceptual clarifications regarding the measurement of data production.

Definition of data: *Information content that is produced by accessing and observing phenomena, and recording and storing information elements from these phenomena in a digital format and that provides an economic benefit when used in productive activities.*

Treatment of non-digital data: *For the purpose of the 2025 SNA, only digital data is considered within the 2025 SNA production and asset boundary.*

Treatment of Auxiliary data: *If the data is not providing a direct economic benefit to the business, it is considered outside of the 2025 SNA production and asset boundary.*

Reporting of combined data and databases asset: *While conceptually different assets, both assets are usually produced or purchased together, therefore it is practically difficult to compile separate estimates for each. As such, for reporting purposes, data and databases are combined into a single detailed intellectual property (IP) product called data and databases.*

Separately identifying data even when used in the production of other IPP: *It is recommended that the value of produced data should be separately identified when capitalized. The value should be excluded from the cost of own account production of other goods and services regardless of how data dependent the final output is.*

The production of data across all sectors of the economy: *Data can be produced and used in production by all sectors of the economy including the government sector.*

The limit to expenditure associated with data production: *The incorporation of additional information content or improving the data's quality at either a granular or aggregate level is considered expenditure on data production and is considered GFCF. Analysis of the data to obtain insights or using the information contained in the data in productive activities is considered the production of a good or service other than data.*

Potential adjustments to account for short lived data: *All expenditure on production of data on an own account basis is regarded as a capitalised expense and should be classified as GFCF, with no adjustment made to represent data consumed within one year. However, if countries have obtained statistically appropriate information that can provide guidance on the proportion of data that is consumed within one year, they are encouraged to make such an adjustment. If such an adjustment is made, countries are recommended to publish the accompanying microdata to improve the comparability across countries. If an adjustment is undertaken, in order to follow convention and be consistent with other own account output consumed internally, the proportion of data produced on an own account basis but consumed within a year should not be explicitly identified, rather it is considered embedded into the output of the subsequent product.*

Recommendations associated with the compilation of estimates of data output and GFCF.

Valuation approach: *Data produced on an own account basis is valued using the already established sum-of-cost methodology.*

Choice of occupations: *In the absence of other sources, national statistical authorities (NSAs) should use the list of occupations provided in this handbook for the compilation of data output. However, if possible, NSAs are encouraged to derive a list of occupations through an objective and systematic approach to better determine which occupations are most likely to be involved in data production. Importantly, occupations should be considered for the list if the occupation involves tasks which explicitly contribute to adding value to the production of data and the worker undertakes these tasks in a proactive and calculated manner.*

Involvement rates: *NSAs are recommended to apply the same or very similar involvement rates to those listed in this handbook. However, NSAs are encouraged to develop and use involvement rates derived through more systematic objective means.*

Non-labour costs: *It's recommended that non-labour costs are incorporated into the final estimate via a single mark-up applied to labour costs. Such a mark-up represents the costs of inputs, consumption of fixed capital used in production, as well as a return on capital (operating surplus). A single mark-up, based on the ratio of compensation of employees applied against total gross output from the "Computer programming, consultancy and related activities" (ISIC 62) and "Information service activities" (ISIC 63) – or similar available aggregate - is applied to total labour costs. However, NSAs are encouraged to apply specific non-labour information (including mark-ups) into the estimate separately so that differences in , consumption of fixed capital and operating surplus across occupations and industries can be applied more accurately and transparently.*

Adjustment for short lived data: *No adjustment is made to the nominal estimate of own account data production to represent data that is consumed within one year, therefore, all data produced on an own account basis is capitalised accompanied by a short asset life. If possible, NSAs should seek to obtain appropriate information that can provide guidance on the proportion of data that is consumed within one year, to make such an adjustment.*

Market transactions: *Data assets that are purchased with exclusive rights are treated as a purchase of an asset (with an offsetting sale of an asse by the seller). However, assuming that the transaction is not a cross-border or inter-sector one, similar to sales of other second-hand assets, this transaction would net off and not impact the overall level of GFCF. Data that is purchased without exclusive rights is treated as a purchase of a copy and contributes to the GFCF of the purchaser if it satisfies the necessary conditions of GFCF, (i.e. use in production for more than one year).*

Price index used: *Any price index used to deflate nominal estimates of data must reflect the price change observed in both the labour and non-labour costs involved in data production as well as appropriately accounting for the technological and quality improvements that have been observed in the production of digital products over the past several years. Ideally, chain volume estimates of data output should be compiled using a 'pseudo' output price index. This can be created by aggregating appropriate input price indexes and weighted to reflect the actual input costs included in the sum of cost calculation. An adjustment to reflect quality and productivity improvements made to the final output would be added to transform the input price index into a pseudo-output price index. As a default position, compilation can be undertaken using an output price index based on an alternative but similar product.*

Quality adjustment applied to price index: *The handbook recommends including an aggregate adjustment to reflect quality and productivity improvements made to the final output. Such an adjustment may be calculated as*

- *The difference in growth between the input price index for data and the output price index for a similarly produced product where market prices are available.*
- *The growth between the calculated difference in Input price and output price index for similarly produced products where market prices are available.*

- *The total factor productivity estimates for industries that contain a large amount of the occupation identified as data producers*.

Additional deflation consideration: *The intention of any recommendation in this handbook is not to overrule any existing regulations, rather the handbooks' goal is to assist countries compile the most accurate estimates of data output possible. It is the view of the task team that the introduction of a quality adjustment on top of an input price index is conceptually appropriate and would improve the accuracy of the final estimate. It is accepted that countries will continue to adhere to other frameworks and standards that oversee the compilation of their national accounts*.

Parameters used in PIM (Excluding Average service life): *Countries should apply the same parameters in the compilation of depreciation and net capital stock of data as applied currently to other IPPs. However, countries should aspire to continually collect additional information on different assumptions and parameters to refine and improve the estimates of depreciation and capital stock being compiled*.

Average service life: *In the absence of other information, countries should apply a default average service life of 5 years for data assets, Ideally, countries should aspire to break up the estimate of data investment by industry in order to allow for different service lives to be applied based on the industry producing the data*.

Chapter 1 – The conceptual boundary of data in the 2025 System of National Accounts.

How does the 2025 SNA define data?

1. The production of data is now a fundamental process for most companies and organisations across the economy. The digitisation of so many facets of the economy has made the collection of facts and information cheaper and easier than ever before while at the same time providing ample evidence of the benefits that data use can provide organizations to leverage data. Therefore, while the fundamental practice of observing and recording information is not a new business process, digitalisation has created a large increase in the information that can be collected and used, as well as expanding the number of companies and organizations actively involved. This has resulted in an unprecedented amount of data being produced and used in the modern economy. The production of massive amounts of data has created brand-new business models reliant on data, while increasing the risk that many traditional enterprises will be usurped by more productive and efficient, data focussed producers.

2. Although much has been written about data, including describing it as being like oil, sunshine, or water, among countless other descriptions, and while its impact on the economy is indisputable, it is largely absent in economic statistics, including previous iterations of the System of National Accounts (SNA). In order to ensure that the SNA is reflective of the modern economy, as well as properly understanding the benefits that data can provide, data needs to be appropriately measured and incorporated to existing standards. A first step in this process is defining exactly what data is.

3. Due to the many possible understandings of what data is, or is not, and potential for misinterpretation, for the purpose of economic measurement a detailed and extensive definition is required. Within this handbook and the 2025 System of National Accounts (2025 SNA) data is considered as ***"information content that is produced by accessing and observing phenomena, recording, and storing information elements from these phenomena in a digital format and that provides an economic benefit when used in productive activities"*** (2025 SNA §22.22).

4. Such a technical definition differs from the perspective of the proverbial "person in the street." For many, data is a simpler concept even though it can refer to many different things. In fact, when used by most people, the term data is broadly indistinguishable from 'information' and can cover anything ranging from a single fact or point of knowledge up to large datasets from which numerous insights can be drawn from. These perspectives are not wrong and are not necessarily inconsistent with the System of National Accounts (SNA) definition provided, which includes describing data as information content. Data, from the SNA perspective can be produced on a single item (the personal information of an individual) or on whole economies (the GDP for an entire country) lending further alignment with the common understanding of data. Where the two perspectives differ is the additional caveats regarding being produced in a digital format and providing an economic benefit. As will be discussed further below, these two caveats are added

to ensure both consistency with the existing SNA as well as making a concept of data which is feasible to measure for statistical compilers.

The purpose and composition of this handbook

5. This handbook has been written to serve two main purposes. Firstly, as a compilation guide to assist economic statisticians compile outputs related to the production of data that are consistent with the SNA. With data included as an explicit asset within the 2025 SNA production and asset boundary, countries will be required to compile estimates of data production and use in their own economies. This handbook assists countries achieve this.

6. The second purpose of this handbook is to provide information to users who seek to understand what is represented in the estimates of data output and gross fixed capital formation (GFCF) of data being produced by statistical offices. As well as providing conceptual clarity, the handbook can help users better understand why the measurement of data is undertaken in the specific manner that it is.

7. To achieve both these aims the handbook will provide clear recommendations which countries can follow in order to produce estimates of the production and stock value of data. This allows for a consistent baseline methodology to be introduced by all countries. Discussions and presentations of the practical compilation recommendations begin from chapter 2. However, in Annex 1.1 of this chapter, there is a summary of the recommended sum of cost methodology that countries should aim to follow in the construction of estimates. The handbook will also include case studies by countries of their compilation methodology, some of which go beyond the baseline or default recommendations. As well as offering real world reference material which other countries can learn from, these case studies provide a foundation for the overall continual improvement of data estimates, leading to increased confidence in the estimates by users.

8. Chapter 1 of this handbook will further explore the conceptual boundaries of data for the purpose of measurement within the confines of the SNA. Chapter 2 focuses on the compilation of a nominal estimate of data, introducing the sum of cost methodology for estimating own account production of data. As will be further covered, for a range of reasons, this is seen as the most important perspective in ensuring that a comprehensive but internationally comparable estimate of data output is compiled. It presents the various inputs required to successfully implement the methodology while also covering additional compilation aspects such as the production of quarterly estimates.

9. Chapter 3 covers the deflation of the nominal estimates, to produce volume estimate of data production consistent for inclusion in headline aggregates of GDP and GFCF. Chapter 4 discusses the use of the Perpetual Inventory Method (PIM) for deriving estimates of capital stock and depreciation. Chapter 5 presents remaining compilation challenges, including back casting data to incorporate the estimates into existing aggregates.

How the treatment of data in the 2025 SNA differs from that in 2008 SNA

10. Data was not explicitly defined or categorized as an asset in the 2008 System of National Accounts (2008 SNA). It has been argued that within the 2008 SNA, data, if included at all, was

implicitly included in estimates of purchased goodwill (Calderón & Rassier, 2022)[1] making it a non-produced asset. However, this treatment reflected the slightly different viewpoint of how the term data was interpreted to those tasked with drafting the 2008 SNA.

11. The discussions leading up to the 2008 SNA viewed data simply as information (Ahmad, 2005), meaning that 'data' existed even before it had been accessed, recorded and stored. This interpretation of data included the embodied information content of what is now typically referred to in the new lexicon of data value chains as the information content of 'observations' or 'observable phenomena'[2]. This consideration of data as simply embedded information is one reason why the authors of the 2008 SNA, in an attempt to limit the possibility of implicitly "capitalising knowledge" (Ahmad & van de Ven, 2018), chose to limit the value of databases to only include the cost of preparing data in a format that conforms to the "database management system (DBMS)" while excluding the cost of acquiring or producing the data (2008 SNA §10.113).

12. The 2025 SNA considers data the information content that comes from accessing and observing phenomena, recording, and storing information elements from these phenomena rather than the embedded information contained in the phenomena themselves. In simple terms, the concept of data, for the purpose of economic measurement and analysis has moved from the first to the second box in the data value chain represented in Figure 1.1[3]. This movement introduces a clear element of production (as defined in the SNA)[4] to the process as well as a clear line where non-produced information embodied in non-produced facts and situations (regarded as data in 2008 SNA) can be transformed into information content, produced by accessing, recording, and storing information elements from observable phenomena (regarded as data in 2025 SNA).

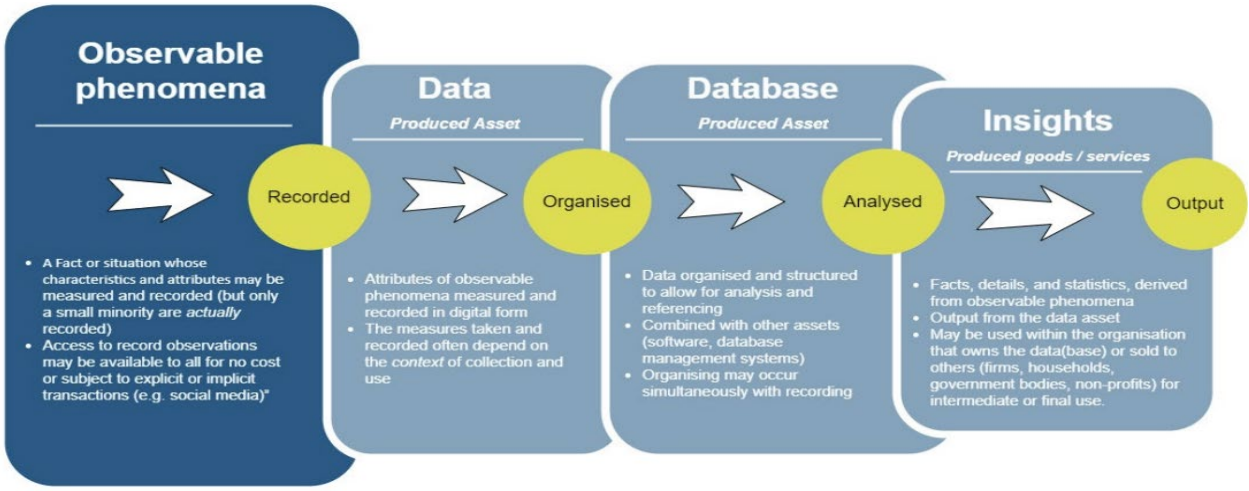
Figure 1.1: Data-information chain from a System of National Accounts perspective

[1] It is considered "implicitly" as data was not explicitly considered a non-produced asset. Rather when an explicit transaction in goodwill was made, it was considered that some of the value of the goodwill (a non-produced asset) was derived from the value of the data contained within business.

[2] In Mitchell, Ker & Lesher (2022) Observable Phenomena are defined as "a fact or situation, whose characteristics and attributes may be recorded".

[3] This is visibly represented in Figure 1.1 by the movement from the dark blue box representing items that are non-produced into the lighter coloured blue box representing output from production.

[4] The technical definition of production is 'an activity, carried out under the responsibility, control and management of an institutional unit, which uses inputs of labour, capital, and goods and services to produce outputs of goods and services'. In this case the output is the data product, while the input is the resource and labour used to access, observe, and record the information elements.



(Mitchell, Ker, & Lesher, 2022)

13. Figure 1.1 separates data from database which accurately reflects the 2025 SNA, as the standard has explicitly identified and defined data as a separate asset from the complementary database asset that already exist within the SNA production boundary. However, the two assets, Data and Database are still unequivocally intertwined. So much so that there is limited expectation that data and databases will be reported separately. Paragraph 22.25 of SNA 2025 make this point quite clear by stating *"despite their conceptual difference, data and databases are difficult to measure separately because they are produced with similar inputs and because transactions prices generally reflect the combined value of the database and the data. For reporting purposes, data and databases are therefore combined into a single detailed intellectual property (IP) product called data and databases"* (2025 SNA §22.25).

14. The reporting of data will be further discussed in chapter 5, however it is the recommendation of this handbook that **within the purposes of the SNA, outputs and investments (GFCF) in data should be reported together with databases as a single IP product, however, this should be reported separately from computer software.**

The specific characteristics that data must exhibit to be considered a produced asset within the System of National Accounts.

15. The addition of the caveats regarding the digital nature of data and the provision of economic benefit allows for data to be conceptualised and measured in a way that is not only feasible for statistical offices but also consistent with other fixed assets in the SNA.

16. The SNA considers produced fixed assets to be "*assets that have come into existence as outputs from production processes*" (2025 SNA §11.11) and that "*are used repeatedly or continuously in production processes for more than one year. The distinguishing feature of a fixed asset is not that it is durable in some physical sense, but that it may be used repeatedly or continuously in production over a long period of time, which is taken to be more than one year.*" (2025 SNA 11.13).

17. In today's economy, there are countless examples of data being created as an output of a production process and subsequently being used in business processes '*repeatedly or continuously*' over a period of one year. Simple examples include sales data to assist with forecasting demand, customer information as part of loyalty programs, or cookies collected from websites and used to personalize your searching experience. As such, the suggestion that data is used in the economy, and it should, for the purpose of the SNA, be considered a produced asset, has been widely supported.

18. However, it has also been acknowledged that there exists data, which due to either the way it is created or used, may not meet the concept of a produced output as defined by the SNA. To compensate for this, the 2025 SNA definition of data brings in several aspects that must be fulfilled for data to be considered an output of production and as an asset. This includes being on a digital format and providing an economic benefit to the owner.

19. It is well established that non-digital data exists and has been used previously in production. However, within the modern economy, due to the greater resources required to process and transfer non-digital data, it is considered that this would make up a very small and inconsequential amount of the overall data used in production. Furthermore, the inclusion of non-digital data is considered a significant measurement burden for countries and not commensurate with the influence of this data on the economy. **Therefore, while acknowledging that non-digital data exists, for the purpose of the 2025 SNA, only digital data is considered within the 2025 SNA production and asset boundary.**

20. In addition, most businesses generate data that is not directly relevant to the primary production of the business. This auxiliary data may be captured digitally, however, **if the data is not providing a direct economic benefit to the business, it is considered outside of the 2025 SNA production and asset boundary.** It is not practical to explicitly list what type of data this might entail as it will be different from business to business and may change over time. However, if the data is not used to derive insights or information which may increase the level or efficiency of production (a.k.a., providing an economic benefit), then any costs associated with its generation should be considered as a current input cost of production of the underlying output of the entity rather than a capital cost (GFCF of data).

21. A delineation between the generation of these different types of data (produced data providing an economic benefit and data that is considered auxiliary) can be implied through the occupations chosen as contributing to the sum of cost of data production. While elaborated further in chapter 2, it is recommended that **occupations should be considered as data producing if the occupation involves tasks which explicitly contribute to adding value to the production of data and the worker undertakes these tasks in a proactive and calculated manner.** Such a recommendation combined with the general theory of expected return on investment suggests that any occupations specifically tasked with producing data are doing so with the intent that the data produced will be utilised in productive activities and thus should be included.

22. This assumption extends to the non-market sector. **Like all other assets in the economy, data can be produced and used in production by all sectors of the economy including the non-market sector.** For example, the production of data is often done to improve the mechanisms

of a government's taxation or social security systems. The workers involved in occupations producing this data are not undertaking their work to generate a direct financial return, but rather this is an example of the government undertaking data activities to conduct their production (government final consumption expenditure) in an efficient manner.

23. Overall, this delineation is not always clear cut. It is possible that data may have been kept for record keeping originally, only for businesses to later realize its value. For this reason, the list of data producing occupations (discussed in chapter 2), and each occupation's involvement rate (see chapter 2) should be regularly reviewed to ensure that it reflects the current approach to data production.

24. While the fundamental concept of excluding auxiliary data is not considered controversial and, in fact, merely brings data in line with other assets included within the 2025 SNA asset boundary, the practical implementation is challenging. It is not feasible to classify data as productive or auxiliary based on the actual type of data produced due to it being estimated at an aggregated level. However, a delineation based on the type of occupation creating the data is considered more achievable.

Separating the production of data from production of other intellectual property products

25. The introduction of a new asset class, predominately measured through the sum of cost methodology brings inherent risks of double counting. These risks are not new, in fact, in 2010, following the introduction of R & D into the asset boundary the OECD cautioned compilers that it was *"important to ensure, in using the sum of costs approach to valuating of IPP assets produced on own account, that the same costs are not included in the valuation of more than one asset"* (OECD, 2010). Such advice remains fundamental today, albeit with additional IPP assets to consider. The following paragraphs will cover the conceptual differences between the IPP categories, while chapter 2 will further discuss the avoidance of double counting.

26. When describing the conceptual boundary of data, it is worth clearly stating that just because something is stored on a computer does not mean it should automatically be considered data as defined in the 2025 SNA. As pointed out by the OECD, the concept of data often takes on a quantity perspective when it refers to "*Internet Protocol (IP) traffic or the volume of digitised information stored on servers and other hardware"* (OECD, 2022). As such, additional clarifications are provided to separate data, as defined in the 2025 SNA from other intangible assets.

27. Most digital content such as videos, photos, emails will likely not only fail to meet the characteristics of data they are likely to not even be considered a fixed asset as defined in the SNA (*used repeatedly or continuously in production processes for more than one year*)[5]. Those

[5] While there is no explicit rule stating that data cannot take the form of audio and visual files, it is thought that the vast majority of data will be alphanumeric. However, the changing use of data may impact this in the future, as AI models increasingly use audio and visual data for training. This is particularly evident in applications like computer vision, where image and video data are essential, and in speech recognition systems, which rely heavily on audio data.

that do meet the asset test may fall into other, already existing SNA intangible asset classes. These include artistic originals, computer software, mineral exploration and evaluation, and research and development. Since these intangible assets usually generate their value from the information content contained in them and are almost always stored in a digital manner (and for some it's a necessity) they do share many conceptual similarities with data. What distinguishes them from data is how they are produced and the type of information content they possess.

28. It should be noted that this handbook will not discuss separating data from the existing IPP of databases. As covered earlier in the chapter despite their conceptual difference it is expected that the compilation of estimates of data production and database production will be done in combination and subsequently reported as a single IPP category of *data and databases*.

Computer Software, Artistic Original and Mineral exploration

29. In order to separate these intangible assets, one must look at the different characteristics of the information that each contains including the source of this content. Computer software "consists of computer programs, program descriptions and supporting materials for both systems and applications software" (2025 SNA 11.112). Artistic originals are "Entertainment, literary and artistic originals consist of the original films, sound recordings, manuscripts, tapes, models, etc., on which drama performances, radio and television programming, musical performances, sporting events, literary and artistic output, etc., are recorded or embodied" (2025 SNA 11.119). The information content of both assets differ greatly from that of data produced by '*accessing and observing phenomena; recording, and storing information elements from these phenomena in a digital format.'* The information contained in computer software has a relatively narrow remit, focused on ensuring the correct running of computer programs on appropriate hardware. While the information contained within artistic originals can vary greatly, it has been well established that a key requirement for artistic originals is that the work should have 'primary artistic intent' (OECD, 2010). Information content in data extends well beyond a set of instructions in a programming language and artistic endeavor and so, while data shares some similar conceptual ground with software and artistic originals, there is still clear conceptual difference between the asset categories.

30. Software can be created for the specific purpose of producing data, or the ability to produce data can be a significant consideration in the development of certain software. As discussed in chapter 5, the purpose of the software does not remove its fundamental nature and classification and therefore, expenditure on, and production of, software should remain as such regardless of it's level of contribution to data production.

31. Mineral exploration and evaluation contain information content on the "*exploration for petroleum and natural gas and for non-petroleum deposits and subsequent evaluation of the discoveries made"* (2025SNA §11.108). Producing data on mineral deposits could be considered a subset of data production, However, the information elements collected as part of mineral exploration cover a very specific topic with a very specific use, meaning that the phenomena searched for and observed to produce the information are also very specific. Thus, to maintain consistency with the existing assets already covered in the SNA, expenditure on producing data on petroleum and natural gas and non-petroleum deposits should remain as mineral exploration

and evaluation[6]. Additionally, there remains a large amount of expenditure unrelated to data production that still contributes to the estimate of Mineral exploration and evaluation.

Research and Development and Artificial intelligence

32. The line between data, and research and development (R & D) is not quite as clear cut. Fundamentally, R & D includes *expenditure on creative work undertaken on a systematic basis in order to increase the stock of knowledge* (2025SNA §11.105). A key component of this research aimed at increasing knowledge is generating information content from recording information elements from observable phenomena (often undertaken in controlled circumstances). Such activities could include data production (as defined in the 2025 SNA).

33. However as outlined in the Frascati manual (OECD, 2015) not all data generated by organizations is automatically considered as expenditure on R & D. Rather to qualify as R & D expenditure, the work must satisfy five core criteria[7], several of which can serve as a means to delineate between the two asset classes. The first is the notion of creative and/or novel work. While some methods of data production (particularly the collection aspect) should certainly be considered as innovative (or even creative) most data production is undertaken for a well-established specific purpose (creating economic benefits) rather than a novel one. Did sales go up or down? How many people accessed the website, how long was the package in the depot before being delivered? Expenditure related to obtaining information on this kind of routine business-related questions shows that the data is being collected for a specific purpose, unrelated to R & D and are thus, excluded from R & D.

34. Additionally, but just as important, expenditure on 'general data collection' is also excluded from the measurement of R & D unless the data is being collected '*solely or primarily for the purpose of R & D*' (OECD, 2015). The majority of data produced by both market and non-market organizations is unlikely to fulfil this criterion as the information is collected as an externality of "routine" production rather than for the specific purpose of expanding the 'stock of knowledge'. This is not to say that accurate and organized data on production and consumers are not beneficial to the company. They certainly are, which is why businesses invest in ensuring they can gain insights from them and why the SNA considers them an asset. However, the purpose of this data production is considered different to the purpose of R & D.

35. The exclusion of general data collection from R & D fits with the newly proposed framework of measuring data assets. The conceptual boundaries of data as defined for the 2025 SNA specify that once the information content (obtained through accessing, observing, and recording information elements from OPs) is fit for use in productive activity, the production of the data asset is finished. This data asset could theoretically be used for R & D, in which case the expenditure on doing this (i.e., analyzing or testing the data to gain insights) would be capitalized[8], or it could be used as an input to production of another good or service. Either way,

[6] This situation already exists in the SNA, in that mineral and petroleum exploration is arguably a subset of R & D, however, since it covers a very specific area of research, it is separately identified and classified.

[7] The five criteria are that the activity must be: novel, creative, uncertain, systematic, and transferable and/or reproducible (OECD, 2015).

[8] Conceptually, in such a circumstance, the value of the own account R & D, measured via the sum of costs, would need to include a depreciation cost associated with the data asset, being used as an input.

while the **incorporation of additional information content or improving the data's quality at either a granular or aggregate level is considered expenditure on data production, analysis of the data in order to obtain insights or using the information contained in the data in productive activities is considered the production of output of a good or service other than data[9].** This conceptual treatment is an important consideration when choosing occupations as outlined in chapter 2, for instance occupations that heavily *use* data may not contribute significantly to *producing* data.

36. A reason for having this conceptual endpoint in data production is due to a desire to separately identify the production of data from the output that the data asset is contributing to. A significant driver for the explicit inclusion of data in the 2025 SNA was that expenditure contributing to an input that is used repeatedly in the production of other goods and services should be identified and treated appropriately (i.e., capitalized). Since a majority of data is produced with a particular final use in mind, the 2008 SNA did not explicitly identify much of this expenditure and simply recorded this as intermediate costs in the production of another product.

37. This treatment of separately identifying and capitalizing data should be applied regardless of if the data dependent good is subsequently consumed (such as advertising, logistics, finance, retail) or capitalized itself (production of other IPP).

38. An example of this is the explicit identification of Artificial Intelligence (AI) being included for the first time in the 2025 SNA. In the 2025 SNA framework, it is envisioned to separately identify the production of AI software as a subset of computer software[10]. It is well established that the production of AI is fundamentally dependent on the generation of data that the AI algorithms can use to train and learn. In the SNA guidance note on the incorporation of AI into the SNA, this point was raised, where it was agreed that the "value of the cost of producing training datasets be excluded from the value of own-account AI and included instead in the value of Data assets" (ISWGNA, 2023).

39. This is an appropriate treatment for two reasons. Firstly, it clearly identifies the separate asset (the data) which contributes to the production of the AI software, a desire amongst users of the accounts. Secondly, by not embedding the value of the data within the AI software, and recording it as a stand-alone asset, it 'allows' for the data asset to theoretically also contribute to the production of other goods and services, a phenomenon likely to have already occurred. This point is the reasoning behind the exclusion that exists in this area whereby "data assembled in a database created solely as a step in the production of an AI computer program and that cannot be re-used may be included in the costs of producing AI programs" (2025 SNA §22.36).

40. **As such it is recommended that the value of data produced on an own account basis should be separately identified and capitalized. The cost associated with producing the data asset**

[9] While this statement is true for the vast majority of examples, it is conceivable that the original data asset could be used to produce additional data output, however this would still not involve analysing or using the data in productive activities.

[10] The SNA is defining AI as 'capabilities of a computer program, or system controlled by a computer program, of recognition, reasoning, communication, and prediction emulating human recognition, reasoning, and communication' (2025 SNA §22.35).

should be excluded from the cost of own account production of other goods and services regardless of how data-dependent their final output is[11].

41. One area where conceptual cross-over may exist is the production of data 'integral to the production of Research and development' or 'data assembled in a database created solely as a step in the production of an AI computer program and that cannot be re-used'. Since 'general data collection' is excluded from the R & D, and for the various reasons outlined in paragraph 32-35, much of the data produced in the economy does not meet the characteristics of R & D, it is not expected that expenditure on data 'integral to R & D' is significant. The production of AI is a more recent phenomenon that will require more research. Specifically regarding how much AI is produced based on already existing data sources compared to specifically assembled data, 'used solely as a step in the production of AI'(2025 SNA §22.36).

42. Therefore, **expenditure relating to the creation of a data asset should be categorized as production of data, regardless of the subsequent use of the data asset with the exception of data integral to the production of Research and development and data assembled in a database created solely as a step in the production of an AI computer program and that cannot be re-used.** Ideally, countries should investigate to see if a noticeable amount of expenditure related to "single use" data is included in the sum-of-cost method when estimating own account production of R & D and the computer software subset of Artificial intelligence. Existing practices related to compilation of own account R & D and software will need to be reviewed to ensure that the same expenditure is not recorded twice and classified to both assets.

43. It is envisioned that in the next update of the Frascati manual, this inclusion of data collection considered integral to R & D may be removed entirely from the R & D asset boundary reflecting the fact that a standalone data and database asset category is now established in the SNA.

Is all data output capital formation? The treatment of short-lived data.

44. The concept that data assets exist and are being used in the modern economy has been strongly and broadly agreed to. Where there is less certainty is what proportion of data output is actually fulfilling the characteristics of a fixed asset as outlined in the SNA, often referred to as the capitalization rate of data. While a large amount of this handbook will focus on the idea of measuring data assets used in production, fundamentally, the inclusion of data in the SNA begins with measuring the output of data. Since output is simply goods and services produced by an establishment, data is first an output of production, which can then (and often will) be considered a fixed asset. The SNA is very clear that expenditure on products (or in the case of own account production - own account output) should only be capitalized if the product produced is involved '*consistently and repeatedly'* in production for more than one year.

45. Within current compilation practices, most expenditure is earmarked as either capital formation or not based on the type of product being purchased or produced. A business buying a car is considered to undertake 100% capital formation, while expenses related to a business buying a pencil is considered a current expense with 0% capitalized. That is not to say that a car will

[11] The costs associated with using the data assets will feed into the capital service costs associated with the own account production costs of other goods and services.

automatically have a service life of greater than a year, or that a pencil will be fully consumed within a year. Rather, common-sense assumptions are made based on the normal characteristics of the inputs.

46. These common-sense assumptions seem to be applied consistently by the SNA and international corporate accounting standards (International Financial Reporting Standards (IFRS)). Assets classified as such in the SNA (Structures, Software, Machinery and equipment) are also considered assets within the accounting standards. This makes collection of the expenditure through business surveys a relatively easy task as the expenditures have already been separated in the company accounts. This is not (yet) the case for data expenditure which, while not explicitly excluded, is not (yet) considered an asset within the international accounting standard.

47. Currently this is somewhat inconsequential as compilers have focused on producing estimates of data investment at the aggregate level (a.k.a. the supply side), using existing data sources rather than business surveys. While this will hopefully change in the future, it currently leaves the decision on the exact capitalization rate of data in the hands of statistical compilers. As such, several countries in their initial estimates of data GFCF have made an adjustment to the final nominal estimate of own account output of data to represent the data that is consumed within one year and thus should not be capitalized. However, as noted by the NSA's who have made these adjustments, they are, at the moment, considered quite arbitrary as information on the percentage of data used within one year is so far not readily available from businesses or any other source.

48. There is general agreement that the long-term trend of data collection and use has shifted from one entirely based around stable stocks of digital information – databases of names and other well-defined personal and business data - to one which is more about real-time flows of often unstructured data (Eurostat-OECD, 2019). This has meant that a large amount of the value placed on data is driven by the time sensitive nature of data. Such a phenomena would mean that an increasing amount of data is used quickly and – importantly – only once in production, meaning expenditure related to its production should be treated as an intermediate cost.

49. Conversely, over time, the cost of producing and, more importantly, storing data, has declined precipitously. This combined with introduction of new digitalisation concepts such as generative AI, has meant that even if used once, data is often stored for re-use as businesses have found that the overall quantity of data at their disposal can be just as important as the quality.

50. Broadly, countries are encouraged to continue to seek information from data producers on what an appropriate capitalisation rate may be. **If countries have obtained statistically appropriate information that can provide guidance on the proportion of data that is consumed within one year, they are encouraged to make such an adjustment**.

51. However, since this information is considered unavailable in most countries, it is the view of the task team on measuring data in the national accounts that as **a default position, all expenditure on production of data on an own account basis is regarded as a capitalised expense and should be classified as GFCF, with no adjustment made to represent data consumed within one year.** More context on this recommendation is provided in Chapter 2.

52. Such a decision should not be viewed in isolation but also in conjunction with the recommended average service life assigned to data assets. This is discussed in chapter 4 and reflects the known uncertainties that still exist regarding how data is used. Additionally, it is possible to incorporate the retirement of a large cohort of data assets within the first year of existence through the Perpetual Inventory Method (PIM) – See chapter 4. This would alleviate the need for an adjustment based on unavailable data. This treatment would also align with the proposal that was supported by the global consultation and expert group when considering the incorporation of data as an asset in the 2025 SNA (ISWGNA, 2023).

53. This measurement challenge is acknowledged in 2025 SNA which suggest an approach consistent with the recommendation given here. Specifically the SNA suggest that "When feasible, the cost of production of data whose service life is clearly short (e.g., data that is stored for only a short time) should be treated as intermediate consumption rather than fixed capital formation" (2025 SNA §22.30) before adding that "the information needed to separately identify the costs of producing the short-lived data and the costs of producing the long-lived data is often unavailable" so therefore "When the separate cost of producing the short-lived data is unknown, a relatively short average service life that reflects the inclusion of the data with a service life shorter than a year may be used" (2025 SNA §22.31). This handbook supports this approach as will be discussed in chapter 4.

54. A final consideration regarding the capitalization rate is where any data considered as short-lived data would actually be reflected in the national accounts. While allowing for exceptions, the SNA points out that "It is unusual to record goods and services used as intermediate consumption within the same establishment" (2025 SNA §7.131). When applied to the production of data this would mean that any produced data which is not considered an asset will not be shown explicitly as output, rather the value of the output will feed into the overall value of the subsequent product produced by the organization. Such a practice is relatively normal within the accounts. For example, many large organizations have specific people producing accounting services but these are not shown separately since they are entirely consumed in the production of the main output of the organization. Theoretically, it could be argued that this is essentially how data is being treated currently, i.e., as an input, produced on an own account basis, but entirely consumed in the production of other goods and services.

55. If this convention is followed, any adjustment applied to data produced on an own account basis will not be explicitly visible in the accounts, as the proportion of produced data considered to be used within a year is consumed and embedded in other products. Therefore, within the Supply and Use Tables, any difference between the level of data output and the level of data GFCF will be limited to only purchases of data between two separate establishments in which the data was subsequently and entirely consumed within a year.

56. When the recommendation on capitalization is combined with the established convention of not separately identifying output entirely consumed internally, the recommendation concerning the capitalization rate for own account data take on the following order.

    I. **All expenditure on production of data on an own account basis is regarded as a capitalised expense and should be classified as GFCF, with no adjustment made to represent data consumed within one year.**

II. However, **if countries have obtained statistically appropriate information that can provide guidance on the proportion of data that is consumed within one year, they are encouraged to make such an adjustment**.

III. If an adjustment is undertaken, in order to follow **convention and be consistent with other own account output consumed internally, the proportion of data produced on an own account basis but consumed within a year by the same establishment should not be explicitly identified as data output, rather it is considered embedded into the output of the subsequent product.**

The incorporation of data in product and industry classifications used in economic statistics.

57. Data (as defined in the 2025 SNA) has not been explicitly identified in many of the existing statistical classifications that complement the SNA, such as Central Product Classification (CPC) and International Standard Industrial Classification (ISIC). However, in unison with the update to the SNA revisions are also occurring across various statistical classifications and standards. This includes the CPC and ISIC, the most recent versions of which, incorporate new categories on a range of issues, including the production of data.

Central Product Classification

58. Previously, specific examples of data such as 'On-line directories and mailing lists' and 'Web search portal content' were included in the CPC. These products reflect the relatively concentrated focus on data which previously existed in the economy, whereby data was likely produced by dedicated data producers and used for narrow purposes rather than being a product produced and used by most firms throughout the economy. As such the categories had a relatively narrow definition which excluded much of the data that is produced in the modern economy. These categories still exist as separate products, representing the specific services of compiling and organizing information, although both are obviously very reliant on the data.

59. CPC version 3.0 explicitly defines a new group "*Data and data compilation*" consisting of two classes – 8371 *"data"* and 8372 *"compilation services of data"* to facilitate the classification of data output, regardless of the specific information content within the data. The definition of the data used in the CPC is "Original compilations of information content organized for retrieval and consultation, produced by accessing and observing phenomena."

60. The small but understandable difference that exists between this definition and that used for data within the 2025 SNA revolve around the specific caveats added to the SNA definition (i.e., data must be in digital format and provide an economic benefit) to ensure its consistency with the broader classification of fixed assets. The CPC does not require this as the central product classification must retain relationships with statistical classifications beyond the SNA, as well as provide a classification that can be used by policy analysts and businesses that use economic data for studying industrial activity (UNSC; Task Team on ISIC, 2024).

Industrial Classification of Economic Activity (ISIC)

61. Since a single industry can produce a range of products, it is expected that data (as defined in the revised CPC) will be produced by almost all industries across the economy, likely reflected in the SUTs as an additional product on top of their primary product. Such a result would also reflect the expectation that most data is produced for own account use.

62. However, some producers are focused on producing data for sale or providing their data production service to other organizations. With data now being used for so many different facets of production, these data producing firms are expected to be more prevalent than previously. As such, this has been reflected in a new ISIC division 'Computing infrastructure, data processing, hosting, and other information service activities' being included in the revised ISIC (UNSC, Task Team on ISIC, 2024) with intent of mapping the CPC data product to this ISIC category. This division and accompanying group and class 'Computing infrastructure, data processing, hosting and related activities' include such activities as digitalisation of files (for further processing of data), provision of data entry services and data processing services.

63. It should be noted that many countries, do not directly use the CPC or ISIC. Rather statistical offices apply regional or national variations based on these international frameworks[12]. However, having these changes introduced into the CPC and ISIC will allow for the flow down of revisions into these local variations. Importantly, having data better represented in the product and industry classification is a vital complementary step in the quest for consistent estimates of data in the SNA. While this handbook focusses on providing a consistent methodology that can be applied across countries, the consistent classification of this output and investment is just as important to ensuring comparability across countries. The revised product and industry classification offers countries the opportunity to do so.

The production of data by all sectors across the economy.

64. Like all other assets in the economy, **data can be produced and used in production by all sectors of the economy including the non-market sector**. Occupations listed as part of the sum of costs calculation (see chapter 2) would include those working for the general government and NPISH sectors. The data produced by these occupations may include both publicly available and non-available data since both are considered as contributing to the output of the government sector. For example, data compiled by security forces, that assists in the provision of public safety as well as taxation and social security databases, created to assist in the efficient delivery of government services, are clearly data investments (GFCF in SNA speak) made by government that provide an economic benefit to its owner (the government) over future periods.

65. Like other assets that are publicly owned and made available to use with no direct charge to the users, the services produced by these data assets are consumed collectively and theoretically the value that the public places on these assets may extend well beyond the sum of costs it took to produce them. Despite this, data produced on an own account basis by the non-market sector should be valued using the sum of costs methodology, similar to own account data production undertaken by the market sector. This would include an adjustment to factor in a return on

[12] Examples include NAICS and NACE for industry and CPA and NAIPS for the product dimension.

capital. Previously this adjustment was for the market sector only. However, the 2025 SNA has expanded such an adjustment to the sum of cost methodology for all sectors. The fact that some data produced by the government sector is publicly available, does not negate the ownership of the data by the data producer (the government). While they may not be able to obtain financial benefit from the data, the production and dissemination of the data often represents government output.

66. Theoretically, data can also be produced by the household sector. However, since data for the purpose of SNA involves information content obtained through accessing and observing phenomena rather than simply anything saved digitally, this would exclude a substantial majority of videos, photos, blogs, and other self-published material from being considered as data in the SNA[13]. Therefore, while conceptually possible, it is considered that the contribution of the household sector to the overall amount of data production would be minor compared to other sectors[14].

[13] Influencers and other producers of social media content who have monetized their output would theoretically count as production and so their posts could be considered an asset, however they are likely more akin to artistic originals than data.

[14] One transaction that would not constitute production of the household sector involves monetary payments made in relation to participation in a survey or other data gathering tools. While these transactions are considered to be minor, the 2025 SNA explicitly includes these transactions as rent on other non-produced non-financial assets.

Annex 1.1 – Summary of estimation methodology

Step	Short description	Default recommendation	Alternative/Aspirational Methods & Approaches (where applicable)
	Compute own-account data		
1	Identify occupations involved in data production	Occupation list compiled from task team	[1] Survey [2] Expert knowledge [3] Key words within statistical classification [4] Natural language processing (NLP) on job advertisements [5] Based on occupations selected by another country
2	Determine the number of employees in each occupational group	Survey / census data	
3	Determine the average wage in each occupational group	Survey / census data	
4	Determine the involvement rate for each occupational group.	List of involvement rates compiled by task team	[1] Survey [2] Expert knowledge / best guesses [3] Natural language processing (NLP) on job advertisements [4] Based on involvement rates from another country [5] Key word search using occupation classification
5	Calculate labor costs	(number of employees) * (average wage) * (involvement rate)	
6	Calculate non-labor costs, includes - Cost of inputs - Depreciation of assets used in production - Return on capital	One single mark-up applied to labor costs - Based on ratio from ISIC 62 and ISIC 63 (Total output / ROE)	[1] Survey focussing on data production expenses [2] One single mark-up on labor costs [a] Based on industries with large amount of output from data-producing occupations [3] Three separate mark-ups covering intermediate consumption expenses, CFC, and return on capital [a] Based on industries with large amount of output from data-producing occupations [b] Based on ISIC 62 and ISIC 63
7	Compute domestic own-account data output	(labor costs) step 5 + (non-labor costs) step 6	
	Compute aggregate estimates of domestic output of data		
8	Calculate domestic output of data	= to total provided in step 7	
9	Calculate total data output by industry and sector	Use indicator (i.e., labour costs, occupation count) to break up aggregate provided in step 8.	Domestic data purchases can be used to adjust industry and sector totals.
	Compute purchased data		
10	Calculate domestic data purchases	Survey – However incorporate only when available.	
11	Calculate net imports of data (For Data GFCF only)	Apply ratios to trade data to delineate estimates of data imports and exports	[1] Survey [2] Use net imports from similar IPP assets

	Total data investment (GFCF)		
12	Calculate total data investment	Own-account data (Step 8) + Net imports of data (step 11)	
13	Calculate total data investment disaggregated by industries and sectors	Use indicator (i.e., labour costs, occupation count and domestic purchases) to break up aggregate provided in step 13	Domestic data purchases can be used to adjust industry and sector totals.
	Compute volume estimates of data		
14	Identify or estimate price indices for data	Use IPD for similar IPP assets, taken from SUTs.	Compile data specific input price index based on input costs used in the production of data. Include adjustment for quality and productivity improvements.
15	Compute price-adjusted total data investment	Total data investment in current prices (step 12) / price index (step 14)	
16	Compute price-adjusted total data output	Total data output in current prices (step 8) / data price index (Step 14)	
	Compute capital stocks and CFC		
17	Determine average service lives	Recommendation provided by task team (see chapter 4)	[1] Tax lives [2] Company accounts [3] Statistical surveys [4] Administrative records [5] Expert advice [6] Other countries' estimates [7] Implicit service lives in depreciation rates [8] Based on service lives of similar assets
18	Determine the functional form of depreciation	Consistent with current country practice for deriving capital stock for other IPP	[1] Linear [2] Geometric
19	Specify the retirement pattern	Consistent with current country practice for deriving capital stock for other IPP	[1] Simultaneous exit [2] Linear [3] Delayed linear [4] Bell-shaped [a] Winfrey distribution [b] Weibull distribution [c] Gamma distribution [d] Lognormal distribution [e] Quadratic distribution
20	Calculate sufficiently long times series of total data investment and output	Use appropriate indicators and apply to total data investment (Step 13) and total data output (step 8) to create time series	Use business indicators to move data back Based on time series of similar (IPP) assets
21	Calculate capital stocks and CFC	Perpetual Inventory Method (PIM) Using information from step 17, 18, 19, 20	

Annex 1.2 – List of recommendation associated with the conceptual boundaries of data.

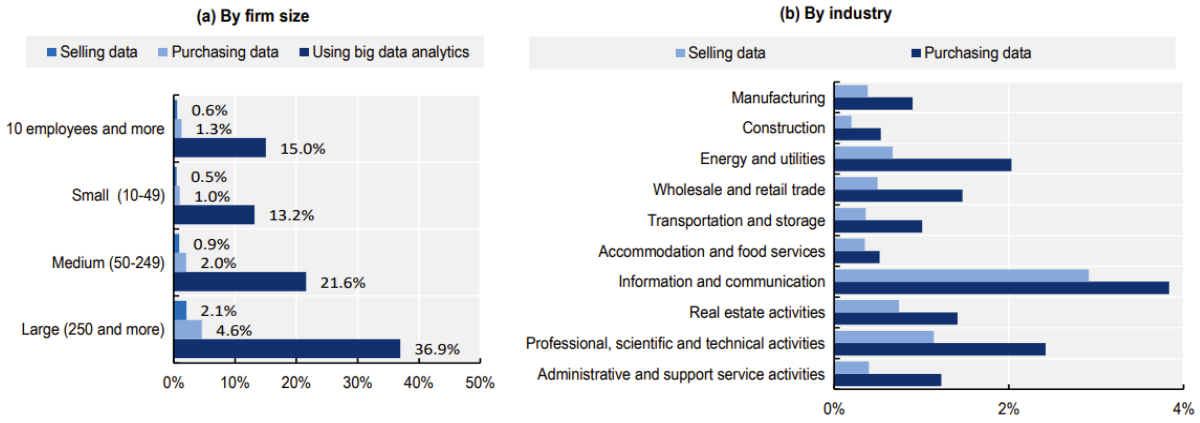
Topic	Recommendations
Definition of Data	Information content that is produced by accessing and observing phenomena, recording, and storing information elements from these phenomena in a digital format and that provides an economic benefit when used in productive activities.
Non-digital data	For the purpose of the 2025 SNA, only digital data is considered within the 2025 SNA production and asset boundary.
Auxiliary data	If the data is not providing a direct economic benefit to the business, it is considered outside of the 2025 SNA production and asset boundary.
Reporting of data and databases together	Within the SNA, outputs and investments (GFCF) in data should be reported together with databases as a single IP product, however, this should be reported separately from computer software.
Separately identifying data even when used in the production of other IP products	It is recommended that the value of produced data should be separately identified when capitalized. The value should be excluded from the cost of own account production of other goods and services regardless of how data dependent the final output is.
Exclusion of data integral to R & D or created solely for AI which cannot be re-used.	Expenditure relating to the creation of a data asset should be categorized as production of data, regardless of the subsequent use of the data asset with the exception of data integral to the production of Research and development and data assembled in a database created solely as a step in the production of an AI computer program and that cannot be re-used.
The production of data across all sectors of the economy	Data can be produced and used in production by all sectors of the economy including the government sector (or non-market).
The limit to expenditure associated with data production	The incorporation of additional information content or improving the data's quality at either a granular or aggregate level is considered expenditure on data production. Analysis of the data to obtain insights or using the information contained in the data in productive activities is considered the production of a good or service other than data
Potential adjustments to account for short lived data	1. All expenditure on production of data on an own account basis is regarded as a capitalised expense and should be classified as GFCF, with no adjustment made to represent data consumed within one year. 2. However, if countries have obtained statistically appropriate information that can provide guidance on the proportion of data that is consumed within one year, they are encouraged to make such an adjustment. If such an adjustment is made, countries are recommended to publish the accompanying microdata to improve the comparability across countries. 3. If an adjustment is undertaken, in order to follow convention and be consistent with other own account output consumed internally, the proportion of data produced on an own account basis but consumed within a year should not be explicitly identified, rather it is considered embedded into the output of the subsequent product.

Chapter 2 – Compiling a nominal estimate of Data output.

Introduction

2.1 Theoretically, the total output of a product in an economy includes that which is produced on an own account basis as well as the amount purchased in market transactions. However, unlike many other products in the economy, recent studies have shown that most data used in the economy is obtained on an own account basis. A 2019 ICT use survey from Eurostat (See Figure 2.1) showed that although 15.3% of large business were using data analytics, only 1.3% of these businesses were buying this data, meaning that the remaining firms were using data created by themselves. Similarly in 2022, the Japanese special internet survey revealed that of the workers involved in the production of data, nearly 75% of them produced the data for use "in-house" (Japanese Cabinet Office, 2022). These results provide important empirical evidence to the well-established opinion that most data used in the economy is created on an own account basis.

Figure 2.1: Share of enterprises using, purchasing, and selling data, Europe, 2019



Source (OECD, based on Eurostat, 2021)

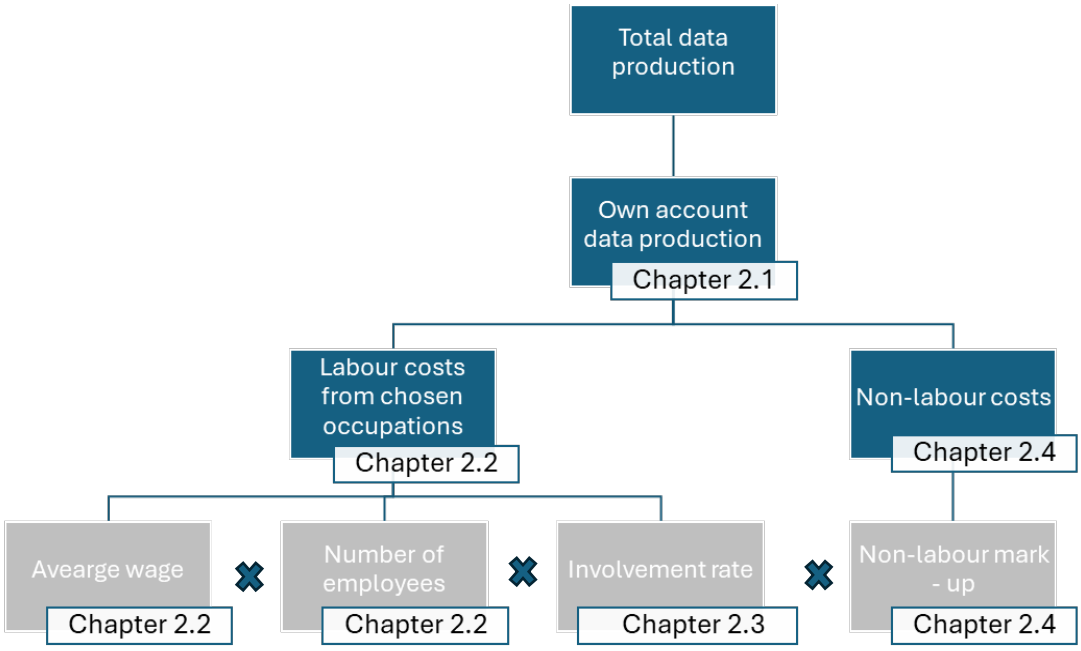
2.2 Such a revelation makes logical sense since one of the central pillars of data's value is exclusivity: an organization possessing data that its competitors do not provides a clear point of comparative advantage and thus, value. While publicly available data or data that is not exclusive can still be used in production, its potential for adding value is greatly diminished. For this reason, it has been consistently observed that business models are becoming more dependent on proprietary data (Nguyen & Paczosi, 2020), a trend that is likely to continue with increases in legislation aimed at protecting consumer privacy that prohibits or limits the sale of third party data (Corrado, Haskel, Iommi, Jona-Lasinio, & Bontadini, Data, Intangible Capital, and Productivity, 2023). This is further discussed in Box 2.1.

2.3 As such, the focus of this chapter will be how statistical organizations should approach valuing the production of data created on an own account basis as this will form the basis of the final estimate of total data output.

2.4 It is recommended to value the output of data via a sum of costs methodology. When producing a nominal estimate of data output using this method, different source components are required. These are shown in grey in Figure 2.2 (along with the portion of the chapter that discusses the

item). Some of these are already collected by statistical organizations, while others will either require new data collection, modelling, or both. Each of these source components will be discussed separately in this chapter and a summary of the recommendations is provided in Annex 2.7.

Figure 2.2 - Simplified representation for deriving nominal estimates of data output & GFCF.



2.5 Primarily, this chapter will focus on the compilation of annual estimates of data output. Preliminary estimates of data output have focused on obtaining annual estimates. This reflects the fact that much of the inputs used to derive the estimate are available only on an annual basis. Similar to other estimates within the National Accounts, annual estimates are considered of superior quality to quarterly data, especially when subsequently benchmarked to other measures, including within the supply and use tables. However, quarterly estimates will be required as part of the standard compilation of quarterly national accounts. At the conclusion of the chapter, the subject of deriving quarterly estimates based on the previously derived annual estimates will be covered.

2.6 Unlike the recommendations provided in chapter 1 concerning the conceptual boundary of data, the recommendations in this chapter are presented in two forms. The first is a default option for National Statistical Authorities (NSAs) which do not have more specific sources or information on data production. This is complemented with a more aspirational set of recommendations that countries should attempt to work towards.

2.7 Due to the compilation of data output being in its infancy, there is a shortage of information on assumptions used to compile the nominal estimates. As such, NSAs are encouraged to continue to research various aspects to improve the quality and robustness of the output. In this vein the

recommendations labelled as aspirational will likely involve the incorporation of information that is not yet available for many countries.

2.8 At the same time, clearly defined default recommendations are provided to promote international comparability in the estimates, an important requirement of any estimate included within the SNA. These recommendations are also included in these chapters and should be considered as a default methodology that NSAs can use to compile their estimates.

2.9 Finally, while this chapter focuses on, and provides default recommendations for, compiling nominal estimates of data, in practice, NSA's are likely to be compiling a combined estimate of data and databases. As pointed out in the 2025 SNA *"Despite their conceptual difference, data and databases are difficult to measure separately because they are produced with similar inputs and because transactions prices generally reflect the combined value of the database and the data. For reporting purposes, data and databases are therefore combined into a single detailed intellectual property (IP) product called data and databases"* (2025 SNA §22.25) This is discussed further in chapter 5, however its well understood that while this chapter will only refer to the compilation of data, the methodology put forward can be applied for the measurement of both assets if it is intended that they will be reported together as a single item[15].

Chapter 2.1: Outline of Sum-of-cost valuation approach.

2.10 **It is recommended that data produced on an own account basis is valued using the already established sum-of-cost method, used regularly by National Statistical Authorities (NSAs) for other purposes**. Attempts to value data and its impact on the economy have been extensive and there are examples of other valuation methods beyond those outlined in the SNA[16]. However, many of these (often put forward by academia or private organizations) are considered either not consistent with the overall SNA framework or not practical for consistent implementation across countries. For example, the very low level of market transactions in data combined with the heterogeneous nature of data, makes the valuation of data using market transactions unfeasible. Similarly, due to the individual nature of data and its value being so dependent on context, calculating present value based on future returns is considered similarly unpracticable. A more extensive discussion on how output is valued in the SNA and what this means for data measurement is provided in Box 2.1.

[15] While fundamentally the methodology is the same for both assets, additional consideration may be required on the occupations chosen and involvement rates if the production of databases is shared with the production of data.

[16] An excellent summary of the many different ways that data can be valued is presented in (Coyle & Manley, 2022).

BOX 2.1. How the SNA values output and what this means for measuring data.

Since most data is produced on an own account basis and cannot be valued using the conventional practice of recording of market transactions, it is worth briefly covering how the System of National Accounts (SNA) records such output, and how it relates to data.

The 2025 SNA is not prescriptive in its choice of valuation methods for measuring output or asset, it is only directive on the valuation principle. That is, to make the SNA the powerful analytical tool that it is, it uses a single accounting unit, money terms. Therefore, while the 2025 SNA does suggests primarily using values "at the actual price agreed upon by the transactors" (2025 SNA §3.60) thereby making exchanged prices the basic reference for valuation in the SNA, several other valuation approaches are mentioned as appropriate or acceptable in certain circumstances.

One of those circumstances is when there is an absence of market prices, a situation that is certainly applicable for data assets. For example as shown in results published by Eurostat, the vast majority of data that is used in production is produced by corporations and organizations themselves. This results in only a small amount of market transactions in data relative to the amount being used in production (see Figure 2.1).

Importantly, even if a greater number of market transactions existed, the extreme heterogeneity of data prevents their use as proxy for own-account produced data. The highly contextual and independent nature of data means that the collected prices are not nearly as representative of other (non-observed) transactions as is the normal case for the measurement of many other goods and services.

This absence of market prices and the difficulty in using them when they are available, means that compilers must search for alternative valuation methods. The 2025 SNA provides several options for valuing output or assets where market prices are absent. These include.

- Estimating a value according to costs incurred (2025 SNA §3.60)
- By referring to market prices for analogous goods or services (2025 SNA §3.60)
- Estimating a discounted present value of future returns expected from a given asset (2025 SNA §3.61)

The very low level of market transactions in data combined with the heterogeneous nature of data, makes the second option unfeasible. The third option is often used within the national accounts, for example when valuing natural resources. However, while data is often referred to as the "new oil," from a valuation perspective there are clear differences between the characteristics of data and natural resources that impact the ability to accurately forecast future returns. These include the near limitless stock of future data, the lack of homogeneity in data products as well as the highly contextual nature that data is used in production. As such, the creation of a future earnings forecast that would allow for an accurate estimate of the current value of all data assets within the economy was considered unrealistic.

Overall, due to these data characteristics the 2nd and 3rd valuation options are considered untenable and as such **it is recommended that data output produced on an own account basis is estimated based on the sum of costs involved in its production.**

How the sum of costs methodology is applied to data production.

2.11 The 2025 SNA provides a simple description of the sum of costs approach (see Figure 2.3). It lists the value of output as equal to the sum of the following items: intermediate consumption,

Renumeration of employees, depreciation and other taxes on production less other subsidies on production[17]. It is necessary to also include an estimated mark-up to account for the producers' net operating surplus, also referred to as the return on capital. This last addition was previously reserved solely for market producers, but the 2025 SNA considers that such a return on capital is an expense for all producers, both market and non-market[18].

Figure 2.3 : Formula for Sum of Costs approach (2025 SNA §7.141)

Gross Output = Intermediate Consumption
+ Renumeration of employees
+ Depreciation
+ Other taxes on Production
- other subsidies on production
+ Mark up representing return on capital

2.12 All countries that have produced estimates of data output have used this sum of costs approach when constructing estimates of data output and gross fixed capital formation (GFCF) of data. Ideally, data is available on all costs components involved in the creation of data, but country practices have shown that this is often difficult to obtain at that level of detail. For that reason, most NSA's have focused on capturing the most important cost element, i.e., renumeration of employees, and to then derive the remaining elements of the sum of costs approach via a mark-up.

2.13 Figure 2.4 provides an example of this practical approach from work by the United States Bureau of Economic Analysis. In this formula, for each occupation (ω), industry (i), and year (t), the labour cost is calculated by multiplying the annual number of employees ($H\omega,i,t$) by the average annual wage ($W\omega,i,t$). Additionally, an occupation-specific time-use factor ($\tau\omega$) that reflects the actual time-effort that the occupation allocates to data-related activities is applied. A final parameter (α) represents a mark-up that reflects other costs (not included in the wage bill) including capital costs and intermediate consumption, and operating surplus (Calderón & Rassier, 2022).

Figure 2.4: Sum of costs approach presented mathematically.

$$Ci,t = \alpha \sum \tau\omega W\omega,i,t H\omega,i,t$$

Source: (Calderón & Rassier, 2022)

[17] The 2025 SNA has revised certain terminology compared to the 2008 SNA, these include Compensation of Employees, which is now referred to as Renumeration of Employees and Consumption of Fixed Capital which is now referred to as Depreciation. Conceptually there has been no change to either concept.

[18] Previously, net operating surplus for non-market producers was considered zero by convention.

Detailing aspects of the sum of costs formula for data in more detail

2.14 The use of this equation in compiling nominal estimates of data can be broken down into four key input requirements. Although terminology differs across the various work streams undertaken by countries so far, each of the components are fundamentally the same. In this handbook the four components, as outlined in Figure 2.2 and Figure 2.4, will be referred to as:

- **The relevant occupations (ω)**, that is a list of the occupations considered to be involved in producing data output. Importantly, the specific data input concerns the number of employees working in these occupations.
- **The labour costs of these occupations (W).** As will be discussed further down, in the established work this labour cost can be calculated in different ways depending on the data sources available, but conceptually it should cover all labour costs associated with occupations chosen (including those beyond renumeration of employees).
- **The involvement rates specific to each occupation (τ).** All NSAs apply some form of time use adjustment to acknowledge that each worker in the stated occupations is unlikely to spend 100% of its time producing data. This adjustment seeks to appropriately capture the proportion of their labour that is *actually* contributing to producing data output.
- **The mark-up representing non-labour cost (α).** While conceptually these additional costs of production could be calculated and summed to the labour cost estimate, and if the information is available, countries should apply these known costs to the labour cost estimate. However since this information will likely be unknown for most countries it is recommended that this non-labour expenditure is estimated by applying a proportional mark-up to the labour cost value.

2.15 For completeness, the final section of this chapter will cover additional clarifications regarding specific compilation questions that go beyond the previously presented formula, but which NSA's should be aware of in order to produce useable estimates consistent with the default recommendations.

Chapter 2.2: The choice of occupation in the compilation of own account data output.

Overall Recommendation: **NSAs should use a list of occupations as the foundation for deriving an estimate of labour costs involved in producing data. Such a list should only include occupations that undertake data producing tasks in a proactive and calculated manner. While occupations will be added and removed over time, reflective of changes in the way that data is produced, in order to ensure that methodological decisions do not create breaks in the time series, this list should remain broadly consistent across periods. Furthermore, it is important to publish the metadata of what occupations have been included (and excluded), so that users have a good understanding of how the results have been derived.**

Default recommendation: **In the absence of other sources, NSAs should use the list of occupations provided in this handbook for the compilation of data output.**

Aspirational recommendation: **NSAs are encouraged to derive a list of occupations through an objective and systematic approach to better determine which occupations are most likely to**

be involved in data production. Examples include the use of machine learning or survey information as well as the use of key words when reviewing occupation classifications or job advertisements.

2.16 The choice of occupations is an important foundation stone in the construction of nominal estimates of data output. It has been observed from initial research that the list of occupations considered as possible data producers is broader than those involved in the production of other IPP assets[19]. While there has been some consistency in selected occupations within the studies completed to date, there is also some variance, with a large number of occupations included by only one or two countries, often with a small involvement rate. Such a result displays the potential for divergent estimates of data being produced across countries despite using the same fundamental methodology.

2.17 Although several other possibilities exist (e.g., surveying businesses, applying key word searches of occupation classifications or using occupation lists created by other countries), the current approaches applied by NSAs who have already produced estimates of data are limited to the following two:

- A selection of occupations within a statistical classification through expert knowledge of the analyst or by using some key words.
- Creating a list of occupations through nominating specific tasks or key words that are associated with the production of data and then review job advertisements or occupation classifications to identify occupations that include these specific tasks[20].

2.18 Regardless of the manner in which the list of occupations is created, it is desirable to select the occupations at the most detailed classification level possible. The more detailed the class level, the more accurate the estimate of data can potentially be as there is less scope for including workers who are undertaking tasks unrelated to data production. Ideally, at least the 4th digit of the ISCO classification (or equivalent) should be used. That said, it is important that any list of occupations can be complemented by additional data on employment, either labour costs associated with the occupation or, as a minimum, the number of workers within the class. Such a requirement may dictate the level of detail of the occupation list. In this way, the actual data source required is not a list of occupations but actually the number of employees and self-employed people working in these occupations.

Selection of occupations through expert knowledge

2.19 A selection of occupations through expert knowledge can be produced relatively easily. Analysts review tasks considered as contributing to the production and attempt to match these with tasks undertaken by specific occupations. It's important to note that **occupations should be considered as contributing to the production of data only if the data producing tasks are**

[19] As will be discussed in chapter 2.3, while there appears to be more occupations involved in the production of data, these occupations appear less specialised with lower involvement rates than those occupations contributing to Software, or research and Development.

[20] This process not only identifies data producing occupations but is able to also provide a systematic measure of the occupations' level of data intensity or time factor spent producing data (referred to as involvement rate in this handbook) such information is also required (see chapter 2.3).

undertaken by the occupation in a proactive and calculated manner. Some occupations may technically be involved in the production of data; however, their role is an extraneous one, at best, occurring due to circumstance rather than fundamentally adding value to the output of data. In these circumstances, the cost of their labour should *not* contribute to the overall production costs. More information on this is provided in Box 2.2.

2.20 The SNA research guidance note endorsed by the AEG following global consultation (ISWGNA, 2023) outlined the following broad tasks as contributing to the production of data:

- Planning, preparing, and developing a data production strategy,
- accessing, recording, and storing information embedded in OPs,
- processing, and cleaning the data to allow for use in productive activities.

2.21 As discussed, reasonable differences of opinion can exist in the selection of data-producing occupations. Due to this, a survey was undertaken by the task team on measuring data whereby members submitted their respective opinion on which occupations (and their involvement rate) are involved in the production of data. The results of this survey along with occupation lists derived through more systematic approaches have been aggregated, reviewed and tested by task team members. The final outcome is an The list is displayed in Annex 2.5.

2.22 This list forms the basis of the default recommendation for NSAs compiling estimates of data for the first time. The list is not designed to be a comprehensive list of data-producing occupations. Rather, the task team on data took the view that any list used for compilation of estimates, and created to encourage international comparability, should be limited to occupations which are *likely* involved in the production of data rather than *possibly* involved. NSAs are encouraged to seek more information on data producing occupations and build on the list as required.

2.23 It is acknowledged that when producing estimates, there may be slight variations on this list due to differences in the nature of occupation classification used, and the level at which data is collected by NSA's. In addition, NSAs may arrive at a different list of occupations through the collection of additional information such as discussed in the next section. That said, **the default recommendation is that, in the absence of other information, NSAs should use this initial list of data producing occupations, aggregated by the task team on measuring data and presented at the International Standard Classification of Occupations (ISCO – 08) four-digit level for the compilation of data output.**

Systematic approach to identifying occupations.

2.24 The identification of occupations using Machine Learning techniques is broadly similar to the one above in that specific tasks or key words are identified as being related to the production of data. Blurbs from job advertisements are then reviewed to match the identified tasks or key words with those mentioned in the job advertisements. This process allows for specific occupations to be identified as involved in the production of data. To demonstrate, Annex 2.3 contains the list of key words that were used by Statistics Canada when they applied this approach to determining which occupations should be considered as data producing.

2.25 The most significant advantage is the removal of the subjective element from the selection of occupations and ensuring that selections are based on real world evidence rather than on any

assumptions, potentially improving the accuracy and consistency of the estimates across countries and over time. Evidence of this is the much larger number of occupations that are selected through this method than through manual analysis and research.

2.26 Machine Learning also has the advantage of selecting occupations in a more robust manner. The systematic approach has the potential to detect changes occurring in the tasks undertaken by occupations in a more robust manner than via personal knowledge and opinion. Occupations that may not produce data currently but might in 5 years' time, will be picked up quicker using this method than the more subjective expert knowledge approach. This feature is important as while it is desirable to have a certain level of occupational consistency across periods to ensure that breaks in the series are not introduced, this desire must be weighed against the need for the list to appropriately reflect the occupation actually producing the data.

2.27 However, the use of machine learning also creates additional challenges, namely the resources required to make it operational, which may make it unavailable to many countries. Additionally, by removing the "common sense check," the results produced can sometimes be unrealistic and extremely sensitive to method changes. For example, slight changes in the tasks or key words selected can result in a significantly different selection of occupations, which would lead to considerably different estimates of data output. As such it is likely that some human refinement would be needed on top of any occupation list created using systematic approaches.

2.28 A final method to derive a list of occupations considered as data producing occupations involves selecting tasks or competencies considered as involved in producing data and matching these those listed in the occupation classification or similar occupational data sources. The Federal Statistical Office of Germany (FSO) developed such an approach as part of the task teams work. This approach referred to as the Competence-Relevant Occupation Methodology (CROM) is outlined in Annex 2.4.

2.29 Despite this need for additional resources, early testing of the different approaches provides confidence that a more objective selection of occupations will improve the accuracy and robustness of the estimate. As such **NSAs should aspire to derive a more systematic list of occupations through approaches beyond subjective expert opinions**.

Box 2.2. When is an occupation actively producing data vs being passively involved in data production.

The labour cost component used as part of the formula displayed earlier (see Figure 2.4) should include labour costs related to occupations associated with producing data. However, it is not straightforward to determine the relevant occupations. If followed scrupulously, many occupations may be considered as being *associated* with the process of accessing, recording, and/or storing information elements.

For example, today many electronic goods that contain internet connectivity include data tracking software that feeds information elements from observable phenomena associated with the product, back to the original producer who use these information elements to create data. In this situation, it could be argued that the salesperson who facilitated the sale of the product has assisted in the producer being able to access and record observable phenomenon. As such, a (very small) portion of their wage could be considered expenditure related to the production of data. Based on such an interpretation many retail workers, such as cashiers in retail shops might be considered as producers of data since the information elements involved with scanning purchases are contributing to the production of data for the retail shop.

The inclusion of such employees considered as being passively involved in the production of data is not the intention of the measurement framework and compilers should not follow such an interpretation. Rather, **occupations should be included if their job involves tasks which explicitly contribute to adding value to the production of data and the worker undertakes these tasks in a proactive and calculated manner. This is opposed to occupations that complete tasks involved in the production of data in a passive manner where the added value is incidental to their primary task** such as the cashier and retail worker. These occupations are essentially involved in the data creation chain only due to the circumstances surrounding how certain information elements are recorded (i.e., digital scanning of purchases).

The data produced by the retail store (quantity and price of products purchased, etc.) are indifferent to how the data is collected. The cashier does not quality ensure the collection of information elements that make up the data, rather their primary role is to ensure payment for the purchases. Importantly from a national accounts' perspective, the value that the producer places on the data does not differ depending on how the information is collected and recorded. As such, from a data valuation perspective it would appear conceptually inconsistent to apply a greater level of labour costs in the creation of one type of data just because a cashier recorded the sale in person compared to the value assigned to data of purchases made online.

If, however, the collection of information elements associated with certain OPs involves specifically tasked human intervention, then the labour costs associated with this labour input should be included. As the data producer has made a conscious decision to observe, collect and record OPs using human intervention rather than through digital means, this labour input is explicitly adding value to the data output by collecting the information elements from the OPs.

While the line of active vs passive contribution to the data value chain is not always clear, the occupation list included in this handbook aims to include occupations which not only contain tasks associated with the production of data but for which the worker would have to be aware and engaged to complete these tasks.

Calculating the Labour costs associated with these occupations (W).

Overall Recommendation: **The final nominal estimate of output associated with data must reflect non-direct labour costs as well as traditional wages and self-employed income (Gross mixed income).**

Default recommendation: **NSAs are recommended to use average annual wage for each of the occupations selected in determining the labour costs associated with own account data output for a specific year. For annual estimates of labour costs outside of periods when wages rates are collected and in the absence of occupation specific labour cost information, the default recommendation is to use an appropriate indicator to move forward the nominal labour costs at the aggregate level. This assumes that the labour costs of data producers are changing at the same rate as changes in wages for the broader economy.**

Aspirational recommendation: **NSAs are recommended to use the average wage for each of the occupations selected in determining the labour costs associated with own account data output for a specific year. Ideally, for annual estimates of labour costs outside of periods when wages rates are explicitly collected, the labour costs can be moved forward with an appropriate indicator at the individual occupational level.**

2.30 Conceptually, the final labour estimate used in the calculation of data output must include expenses beyond the direct wages and salaries paid to employees or mixed income paid to a self-employed business owner. How this is done will differ across countries, often dependent on the exact data source available to each country.

2.31 These additional costs, represent other non-direct labour costs paid to workers, such as pension contributions or any taxes payable associated with the employee. Since households are unlikely to know this information, this amount may need to be added as an adjustment on top of the basic labour cost (i.e., wages received).

2.32 Such an adjustment is already in place in many of the estimates produced by NSAs. For example, Destatis, in their work, notes that "In addition to wages and salaries we consider in our calculation non-direct labour costs, such as the costs of the associated human resource management and financial control, social security contributions [...] As no direct information on these costs is available, they are taken into account as a mark-up factor on wages and salaries" (Destatis, 2024). While Australia, Canada and the USA all observe that the mark-up applied in their work represents (among other things) 'non-direct labour costs' (Statistics Canada, 2019), 'non-direct salary' (Smedes, Nguyen, & Tenburren, 2022) and 'employee benefits (not included in the wage bill)' (Calderón & Rassier, 2022). All four of these NSA's have correctly accounted for non-direct labour costs but have done so as part of the overall mark-up applied to labour costs which mainly represents non-labour costs.

2.33 An adjustment is necessary since the data source for most NSA's will be Wages and salary information usually collected from the household perspective. The most obvious advantage of

this is that wage estimates can be stratified by occupation as households are able to provide both sets of information[21]. This is in contrast with wage data obtained from employers (collected in the form of wages paid) which is often only able to be collected as an aggregate and therefore delineated by industry rather than occupation. For small business, with a similar set of employees, an assumption can be made between industry and occupation, but this issue is more problematic for large entities which employ a range of occupations.

2.34 If the data source is from the household perspective (i.e., population census or household survey) it is important that the wage estimate used covers only employee wages and salary and/or own unincorporated business income, but excludes other income received (i.e., investment income, government benefits). This is usually possible as 'other income' is normally separately identified.

2.35 Some NSA's have access to tax data which may allow for actual wage estimates to be used rather than average wage. Such data would remove the need to multiply an average wage by number of workers, thereby arriving at the a total wage bill in a single step. Depending on the scope of this data, its likely that an adjustment would still be required to turn this wage estimate into total labour costs.

2.36 How NSA's then incorporate non-wage labour costs into the labour cost estimate will depend on the specific data sources used, as even from the household's perspective, there is a range of possibilities. Most NSAs use on of the following: population census, labour force surveys, household income and expenditure surveys, all with different levels of conceptual coverage and timeliness. As such, there is no definitive compilation recommendation on the data source that must be used for labour costs. However, conceptually, **the final nominal estimate of output associated with data must reflect non-wage labour costs as well as traditional wages and self employed income (Gross Mixed Income).**

2.37 Similarly, the data sources available in a country will also dictate how annual estimates of each occupation's wage is derived every year. Some NSAs will have information on wages at the occupation level available every year, either through a micro census, household earnings surveys or even tax data. Ideally, **NSAs should aim to project labour costs forward with an appropriate indicator at the individual occupational level. It is important that such an indicator reflects both the price of the labour (wage) and the quantity of labour (number of employees),** this will assist in more appropriately reflecting changes in the labour costs of data producers rather than economy wide changes in employment and wages.

2.38 In many countries this level of information will only be available at a more infrequent basis, perhaps as rarely as population census, undertaken every 5 or 10 years. In these circumstances the wage indicator available on an annual basis will likely only be at the aggregate or industry level. Therefore, **in the absence of occupation specific labour cost information, the default recommendation is to use an appropriate indicator to move forward the nominal labour**

[21] It should be noted that NSA should remain vigilant regarding the volatility occasionally displayed in these detailed level occupation data. It may be that additional data cleaning may be required if data is being skewed by outliers.

costs at the aggregate level, assuming that the labour costs of data producers are changing at the same rate as the broader economy wide changes in wages.

2.39 Recommendations in existing material covering the compilation of IPP suggest that when units specialize in producing an IPP for sale, costs associated with acquisitions or the production of such products should be expensed (Eurostat-OECD, 2019). Often statistical compilers have taken this recommendation to mean that specific industries should be excluded when estimating own account capital formation on the expectation that these industries are predominately producing products for sale, which will be captured at a later date. The task team on data has taken the view that such a recommendation is *not* appropriate for the production of data and that **the sum of costs methodology includes the labour costs of all specified occupations regardless of the industry or unit they are working in which may include workers employed by units that specialize in the production and sale of data.**

2.40 Such a recommendation reflects the task team on data's belief that there is a broad distribution of businesses and industries producing data. Unlike other IPP such as computer software, the production of which is concentrated among relatively few industries, the production of data is widely observed across all industries, this characteristic combined with the scarcity of transactions (due to so much data being produced on an own account basis) resulted in the task team on data considering that there was a greater risk of undercounting data production by excluding certain industries than the potential double counting by not excluding these industries. As with all assumptions associated with the compilation of data, NSAs are encouraged to continue to monitor and gather information when possible.

Chapter 2.3 The need for involvement rate adjustments and recommendation on such adjustments.

Overall Recommendation: **Involvement rates, representing the amount of time an employee or self employed worker actually spends producing data, are applied at the occupation level so that the actual labour cost associated with producing data is appropriately reflected.**

Default recommendation: **NSAs should apply the default involvement rates to the default occupation list, unless they are able to systematically derive involvement rates (along with an occupation list) based on empirical information**.

Aspirational recommendation: **NSAs are encouraged to use estimates of involvement rates derived through more systematic means, such as business surveys or results from machine learning.**

2.41 It is well accepted when compiling estimates of own account output of a single good or service that the entire output from a single worker is unlikely to be contributing entirely to the single good or service. This may be due to the specific requirements of the workers role, their skill limitations or the characteristics of the industry or organizations that the occupation is placed in. Regardless of why it is occurring, some form of an adjustment is required so that this phenomenon is appropriately factored into the final estimate of output.

2.42 Such an adjustment is already recommended in the compilation of output of other IPPs. For example, the application of involvement rates in the compilation of own account computer

software is recommended with the final Eurostat-OECD report on land and other non-financial assets[22].

2.43 No two workers, despite having the same occupation are likely to contribute exactly the same amount of time to the production of a single product. This may be the case within a specific industry, but may particularly hold for people occupied in different industries.

2.44 The previously mentioned Eurostat-OECD report mentions this phenomenon, also noting that firm size may play a role in the level of involvement that an employee might have. As such, it recommends making the adjustment at the most granular level possible, since "workers in specific industries may spend more time on own-account software and database production, and workers in larger enterprises may be able to spend more time on own-account software and database production than those in smaller firms" (Eurostat-OECD, 2019). However, conceptual accuracy needs to be managed with practical implementation, and it is not always feasible to apply a ratio or adjustment at such a detailed level.

2.45 A very simplistic approach would be to apply a single adjustment to the aggregate labour cost estimate. However, this would appear to be an unnecessarily broad approach and given the fact that the results will be based on occupational data, it would be reasonable that such an adjustment would be done at this level of detail, at a minimum. Therefore, **it is recommended that, an involvement rate adjustment is applied at the occupation level rather than at an aggregate level for the economy as a whole.**

2.46 That said, while there is consensus on the need for such an adjustment and the level at which such an adjustment might be made, the adjustment rates themselves must still be determined. Data on these proportions is very difficult to capture, with many of the NSAs who have produced estimates already using involvement rates sourced via subjective expert opinion, best guesses or applying upper and lower bound involvement rates resulting in upper and lower bound estimates of data output and data GFCF. Such an approach is understandable for standalone research or experimental output; however, such a range estimation is not suitable for the inclusion of data in the core national accounts. Rather, for inclusion within the SNA production and asset boundary, NSA's will need to produce a single estimate using the best available information.

2.47 While the information on involvement rates has been difficult to source, there are several examples of work that has been undertaken to inform compilers. The Japanese Cabinet Office uses information from a special internet survey to help guide estimates of how much time workers are spending on data related work. This survey, including preliminary results, is presented in Annex 2.2.

2.48 Alternatively, the OECD and others have used natural language processing (NLP) on job advertisements to estimate the involvement rate / data intensity of occupations as well as identifying the occupations themselves. This work has tended to produce slightly lower involvement rates than those estimated via expert opinion. However, it is important to note that these lower rates tend to be applied to a larger number of occupations, thereby producing similar

[22] The report uses the terminology 'time factors' for involvement rates but the two are interchangeable.

overall estimates of labour costs. As such it is not recommended to mix and match selection methods (i.e. applying higher rates, selected via expert opinion with the larger number of occupations derived through a systematic approach). More information on the OECD's work is documented in Annex 2.1.

2.49 If possible, **NSAs are encouraged to obtain and use estimates of involvement rates, generated via systematic approaches, such as a business survey or via machine learning.** These are considered preferential to involvement rates sourced from expert opinion.

2.50 However, it is well accepted that obtaining the information required to produce these involvement rates can be quite financially and resource intensive. In this circumstance, in order to promote international comparability, it is the default recommendation that NSA's apply the involvement rates accompanying the default occupation list provided in this handbook,. For this purpose, the Task Team on data have generated these rates based on involvements rates currently applied by NSA's estimating data estimates combined with empirical evidence coming from machine learning, key words associated with occupation competencies and survey data.

2.51 The Task Team agreed upon several key points when determining the default set of involvement rates. These are reflected in the list provided in annex 2.5 and include the following:

I. It was agreed that an involvement rate of 100% should not be assigned to any occupation. It was acknowledged that it is unrealistic to suggest that 100% of a worker's time is always undertaken on a single productive output. A maximum involvement rate recommended for any occupation is around 70%.
II. As discussed in the previous section, the task team on data decided that the default list of occupations should contain only occupations that were *probably* contributing to data production (rather than *possibly* contributing) see Box 2.2.
III. Involvement rates and occupations chosen through more systematic methodologies (surveys, web scrapping, etc.) suggest that the while the number of occupations contributing to data is quite broad, and those occupations with high involvement rates are relatively high (i.e., 60 – 80%), the level of involvement in data production declines precipitously after these initial occupations. This evidence has also been taken into consideration with the formation of the default list of occupations and involvement rates.

2.52 **The default list of involvement rates should be applied only when the default list of occupations is also used to produce estimates of data**. NSA should not apply one aspect of the default methodology (occupation list or involvement rates) and combine them with a list or set of rates obtained separately as this significantly impact the international comparability of the estimates.

2.53 Since some occupations may also be involved in the production of other goods and services for which the output is determined via the sum of costs approach (particularly other IPP), **NSAs should ensure that costs are only taking into consideration once, i.e., the production stemming from a single occupation should not exceed 100% of the workers time. Overall, it is recommended that the compilation of estimates for the various IPP assets (including data) is undertaken in a holistic way in order to avoid double counting.**

Chapter 2.4: Deriving the mark-up for non-labour cost.

Recommendation: **Non-labour costs are incorporated into the final estimate via a single mark-up applied to labour costs. Such a mark-up represents the costs of other inputs, depreciation of assets used in production, as well as a return on capital.**

Default recommendation: **A single mark-up is applied representing the non-labour costs of data production, including a return on capital. The mark-up is derived from information within "Computer programming, consultancy and related activities" (ISIC 62) and "Information service activities" (ISIC 63) or similar available aggregate. The ratio is the weighted sum of renumeration of employees applied against the weighted sum of total gross output (Renumeration of employees, intermediate consumption, depreciation and net operating surplus).**

Aspirational recommendation: NSAs are encouraged to investigate potential data sources that may provide more detailed information on the non-labour expenses involved in the production of data. **If possible, NSAs with specific non-labour information (either actual data or mark ups covering different expenses) are encouraged to incorporate these into the estimate separately (i.e. one mark up or value for non-labour production costs, another for return on capital). So that differences in COFC and operating surplus across occupations and industries can be applied more accurately and transparently.**

Final alternative: **A final alternative, which should be seen as least desirable and only to be used if specific industry level information is not available, is to use the same mark-up as that applied to similar IPP assets compiled in existing compilation via the sum of costs.**

2.54 The final nominal estimate of data output must contain expenses beyond the cost of labour. These non-labour costs include expenditure on other types of intermediate consumption, depreciation of assets used in production of data and the net operating surplus from the production (a return on capital).

2.55 To date, no countries have been able to obtain expense information on data production, direct from data producers. Existing business surveys are usually designed to provide expense information at an industry level and not at the level of specific activities. In addition, operating surplus is a conceptual expense, so is usually calculated on a residual basis, which is not possible when there is no final price due to the absence of market transactions.

2.56 Therefore, most NSAs are currently estimating non-labour expenditure related to own account data by applying a mark-up to the labour cost. These mark-ups are usually derived on the basis of information on specific industries within the annual Supply-Use or Input-Output Tables. **Representing non-labour costs through the use of arbitrary mark-ups, created without any empirical evidence is not recommended.**

2.57 The main assumption associated with such a methodology is that the output of data exhibits a consistent production function, in so much that a consistent amount of non-labour input is

required for each unit of labour input. This is not an outrageous assumption and is considered quite acceptable in lieu of actual data on expenditures on non-labour inputs. Such an assumption has already been recommended for the compilation of other own-account IPP output (Eurostat-OECD, 2019). Due to this, the recommendation regarding a mark-up representing non-labour costs revolves more around the estimation of such a mark-up.

2.58 The default recommendation for NSAs is to select a defined set of industries that are known to contain a large amount of labour costs associated with data producing occupations. While the exact industry classification varies across countries, of the work published so far, countries have used derivatives of "Computer programming, consultancy and related activities" and "Information service activities." These equate to industries 62 and 63 respectively, of the international standard of industrial classification (ISIC Rev. 4).

2.59 As such, **in the absence of more detailed or accurate information on non-labour expenses, a ratio based on total Renumeration of employees for "Computer programming, consultancy and related activities" (ISIC Rev.5, division 62) and "Computing infrastructure, data processing, hosting, and other information service activities" (ISIC Rev.5, division 63) applied against total gross output for these same industries should be used to mark-up all non-labour costs of data production**[23]. A numerical example showing this calculation is provided in Annex 2.6.

2.60 Ideally, NSAs should aspire to have specific information relating to the production of data, including more detail regarding the companies (or industries) producing it. Such information could be added to the labour costs to better represent the costs of producing data. **NSAs are encouraged to investigate potential data sources that may provide more detailed information on the non-labour expenses involved in the production of data. If possible, NSAs are encouraged to incorporate these specific non-labour values or mark-ups into the estimate separately (i.e. one mark up or value for non-labour production costs, another for return on capital) so that differences in COFC and operating surplus across occupations and industries can be applied more accurately and transparently** (see Box 2.3).

2.61 More recent work has focused on better understanding the costs involved in producing data and how these may differ across industries. Such work reflects the belief that the use of capital in data production and the expected return on any capital investment in data may be more closely aligned to the cost of production and asset use in the industry actually creating the data. The proportion of operating surplus is consistently higher for certain industries, reflecting the heavily dependence on capital. The investment decisions of firms in these industries may be different to those in industries where labour costs make up a larger share of value added.

2.62 Such an idea is in contrast to the economic concept put forward by the use of ratios from the information and communication industry which suggest that when producing data, non-labour costs, including the cost of using assets in production are tide more to the asset being created rather than the producer creating it and so are likely very similar regardless of which industry is producing the data. Through its default recommendation to use ratios derived from the

[23] If information is not available at the two-digit ISIC division level, a similar ratio can be created for an equivalent industry at the single digit section level such as Section J Information and communication.

information and communication industries, this handbook implicitly makes a recommendation for the latter. However, the former assumption is not without economic merit and countries may wish to investigate further, if possible.

An undesirable, last-resort alternative, to be used only if specific industry level information is not available, **is to use the same mark-up as that is applied to similar IPP assets in existing methodology**.

Box 2.3. Improving transparency by applying separate and specific mark-ups covering return to capital and depreciation.

The recommendation provided earlier suggests using a single mark-up to cover all non-labour expenses. This includes expenses occurred via actual transactions (i.e., purchase of inputs used in production) and conceptual expenses incurred by the producer but for which no actual transaction takes place. These include depreciation and the return on capital.

The depreciation expense reflects the cost associated with the decline in the value of capital as it is used in the production over multiple accounting periods. While this usually refers to capital items 'wearing out', in the case of data production it may more accurately reflect the obsolescence of the data asset since technological innovation is such an important component of data production. Since it is expected that data producers are heavy users of capital goods in their production of data, it is a fundamental expense for data producers.

The return to capital reflects the opportunity costs of using capital in the production of data, i.e., diverting capital from other uses that yield an economic return. As non-market producers do not aim to maximize their profits, the SNA previously adopted the convention that their cost of capital should not include a return to capital. However, the convention is not being carried forward in the updated SNA2025, meaning that this is being regarded as a relevant component for both market and non-market producers.

While the use of a single mark-up reflecting all three of these expenses as suggested by the default recommendation is an acceptable approach when compiling sum of costs estimates, it is conceivable for the three expenses to be broken down into three separate mark-ups (or additions) reflecting each component so that more nuance can be added at the occupation and industry level. This would not only provide more accurate results but also offer more transparency to users.

Information on the depreciation and the opportunity costs of using capital in the production of output is not usually covered in surveys. Additionally, while business accounts often include entries reflecting depreciation, these amounts are often aimed at maximising profit and so reflect the countries tax policies rather than accurately reflecting the value of the services provided by the capital asset.

Due to this, to derive a mark-up for depreciation and for a return on capital on an industry level, most NSAs rely on ratios for industries derived from SUTs to use as a proxy for inclusion into the estimate. In this way, it is similar to the single mark-up recommended previously. However, since the mark-up is covering more specific expenses, the ratio is calculated using more specific outputs from the SUTs. For example, a ratio representing COFC may be calculated by applying the level of COFC to the amount of current expenditures listed in the SUTs (i.e., intermediate consumption plus renumeration of employees) for specific industries.

Similarly, a ratio representing the return on capital may be calculated by applying the level of operating surplus for a specific industry for a specific year against the capital stock for that specific industry and year. This calculated mark-up would be more reflective of the return to capital for that industry and likely more indicative of the expected return on capital that the producer in that industry might expect from an investment in data.

Chapter 2.5: The use of information on market transactions of data.

2.63 Chapters 2.1 to 2.4 discussed the compilation of own account data. Conceptually this makes up only one portion of expenditure on data within the economy (see Figure 2.2). Purchases, both domestic and cross border, can also contribute to the total estimate of data output and data GFCF.

2.64 Since it has been well established that most data used in production is produced on an own account basis, **information on market transactions in data should be viewed as an additional and complementary data source which can improve a country estimates of data output rather than a fundamental component of the compilation process**. Such a recommendation mirrors one provided by the OECD (2010) for measuring databases, which stated "the focus should be on measuring own-account database GFCF and that purchases of databases or database services only be recorded as GFCF on an exceptional basis, if and when such sales come to light" (OECD, 2010).

2.65 Therefore, while the output of data sold in market transactions can be measured in the same manner as other products (i.e., traditional business surveys), it will cover only a fraction of the total output occurring in the economy.

2.66 To be clear, this recommendation should not be interpreted as a suggestion to ignore information on the purchases of data and databases made via a market transaction. Rather, it is proof that the absence of robust or comprehensive information on the level or growth of purchases of data and databases should not be seen as detrimental to the quality of the overall estimates being produced. Furthermore, since the compilation of own account data production covers the entire economy, it's likely that any data subsequently sold would have already been recorded as own account data production and should be excluded when determining the total value of data in the economy. This is not to say that information on expenditure on data transactions is not a valuable resource, as any information on this can be used to correct for the industry allocation of data GFCF.

2.67 A practical consideration is also prevalent for the collection of market transactions. Currently, International accounting standards do not recognize the capitalization of data in the same way as more traditional corporate assets. The SNA even points out that '*accounting conventions and valuation methods used at a micro level typically differ from those required by the SNA*' (2025 SNA §1.84). One need only look at the large divergences that exist between the calculation of depreciation for corporate tax purposes compared to that used for the SNA to understand that since respective accounting systems serve different purposes, deviations should be expected and somewhat warranted.

2.68 However, while different treatment is not a conceptual concern, it does create a practical challenge. By not specifically identifying data as a capital asset, producers of data would be unlikely to separately identify any expenditure on data. Rather, it would likely be aggregated with other current costs of production and so businesses, when asked, would be unlikely to accurately reflect expenditure on data like they can with other assets captured in both the SNA and international account standards. This combined with the rarity of such transactions means that traditional business surveys are unlikely to capture information on data easily. This difficulty is another reason

why a comprehensive approach to measuring data production via the sum of costs is seen as preferable.

2.69 While there may not be many market transactions, those that are captured should be treated similarly to transactions in other types of IPP (or assets). To do this, it is necessary to determine the length that the data is expected to be used for as well as if the data is purchased on an exclusive basis or not.

2.70 **Data that is purchased and used for less than one year is regarded as being consumed and treated as intermediate consumption.** These costs of intermediate consumption are included as a cost of production as part of the organization's overall output (i.e., logistics, advertising services, etc.).

2.71 **Data that is purchased and used for more than one year is regarded as an asset.** The complete treatment of this expenses within the set of economic accounts depends on if the data has been purchased on an exclusive basis or not. SH

2.72 **Data assets that are purchased with exclusive rights are treated as a purchase of an asset (with an offsetting sale of an asset by the seller). However, assuming that the transaction is not a cross-border one, and that both buyer and seller are in the same sector, this transaction would conceptually net off and not impact the overall level of GFCF.** In this scenario where GFCF is recorded following the purchase of data, if the transaction value is added to the nominal estimate of data output, an equivalent adjustment should be made to reflect the negative GFCF accompanying the sale of the asset. If the transaction is recorded (because it is cross sector or cross border), the value of any adjustment should equal the value of the transaction, this reflects that the transaction was undertaken at arm's length[24].

2.73 **Data that is purchased without exclusive rights is treated as a purchase of a copy and therefore contributes to the GFCF of the purchaser if it satisfies the necessary conditions of GFCF, (i.e., use in production for more than one year)**. Since the seller retains the rights to the original, they have therefore not sold an asset. Rather an adjustment to the aggregate estimate of data output should be made as the additional purchases (if satisfying the necessary conditions) should just be recorded as separate GFCF in addition to the creation of the original. Such a treatment is in line with the standard recording of copies and originals as outlined in the SNA (2025 SNA §11.99)[25]. Conceptually, the expenses involved in producing the many versions of the copy (which have likely be capitalized as part of the sum of cost approach) should be adjusted to reflect a current expense (and output) for the original's owner, and only the creation of the original data asset being considered GFCF[26].

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[24] Conceptually, an adjustment may need to be included in the revaluation account if the transaction value is significantly more (or less) than the valuation of the data asset as calculated via the sum of cost methodology, this would remove the possibility of selling more asset than has notionally be produced. It is expected that this would only be required in exceptional circumstances.

[25] This treatment records any expenses involved in producing the copies as a current expense contributing to the output of the original's owner and only the creation of the original data asset being considered GFCF.

[26] While conceptually clear, it is acknowledged that when compiling estimates of data production using the sum of costs approach the separation between production on an original (which should be capitalized) and

2.74 As such this handbook recommends that **unless the transaction relates to a purchase of a copy, that any information on monetary transactions in data is used primarily as a tool to break up aggregate total into more detailed outputs (i.e. sector and industry) rather than to add additional expenditure to the overall aggregate amount.**

Calculating an estimate of net imports of data for compiling estimates of GFCF.

2.75 Unlike domestic market transactions which should be incorporated with caution to ensure that values are not counted twice, values of data imports and exports must be included to have a truly comprehensive estimate of data GFCF.

2.76 The challenge facing compilers gathering information on exports and imports of data is different to those faced in the recording of domestic transactions. Information on the export and import of IT services is usually already collected by most NSA's as part of the compilation of trade statistics. In this case, the challenge is estimating how much of this relatively broad category relates to data. EBOPS 2010 includes the classification of computer services, which is subsequently broken down into the two categories of 'computer software' and 'other computer services.

2.77 Chapter 11 of BPM7 outlines the various classification contained within the services account. This includes the classification, "computer and information services". Since BPM7 is aligned with EBOPS 2010, it is not surprising that both contain a similar inclusions for this category such as 'Data recovery services, and provision of advice and assistance on matters related to the management of computer resources' and 'Data-processing and hosting services, such as data entry, tabulation and processing on a timesharing basis (UNSD, OECD, Eurostat, IMF, WTO, UNWTO, 2010). Both would appear to be likely places that purchases and sales of data would be placed. However, the broader 'computer and information services' category also includes a large number of other services that goes beyond data itself.

2.78 It is recommended that compilers undertake further analysis to try and ascertain an estimate of how much of the broad 'other computer services' category is likely made up of data. Such an analysis would allow compilers to make regular estimates of imports and exports which can be added to the level of GFCF derived through the sum of costs method. While such a method is unlikely to produce robust estimates of trade in data, it is expected that imported and exported data makes up a relatively small amount of overall investment. Importantly, such an addition will provide comprehensiveness to the final nominal estimate of data GFCF.

2.79 It is worth noting that an adjustment for internationally traded data is required for the compilation of GFCF of data rather than output of data. Since the value of data output produced domestically includes data that is subsequently exported and should not include data produced by the rest of world, no adjustment for trade in data output is required. However, for estimates of data GFCF, an adjustment must be made to include GFCF by domestic firms undertaken by importing data and then exclude data produced domestically but ultimately exported.

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production on a copy (which should be current output) is a tricky split to make with adjustments unliekly. As such, an adjustment could be reflected in the involvement rates of certain occupations that often produce copies for sale.

Summary of outputs of data

- Domestic data output = Own account data production for all domestic industries

Net Imports of Data GFCF = Imports of data GFCF – Exports of data GFCF

- Domestic GFCF of data = Domestic data output + Net Imports of Data GFCF

Chapter 2.6: Additional points of clarification when compiling a nominal estimate of data output.

The potential of data being consumed within one year.

2.80 **It is recommended that no adjustment is made to the nominal estimate of own account data production to represent data that is consumed within one year.** When copies of data are purchased in a transaction at arm's length, the standard capitalisation treatment applied to other products should occur. If the data provides an economic benefit for more than one year, it should be capitalised, if less than one year, it should be classified as intermediate consumption.

2.81 For most assets in the national accounts, respondents will be able to provide a good estimate as to if the purchase is intended to be capitalised on not, and these can be reflected in the survey forms. For assets produced on an own account basis and compiled at an aggregate level by a statistical office rather than based on information provided in survey forms, such a delineation is not always possible to make.

2.82 It is the view of the task team on measuring data that, as a default position, **all expenditure on production of data on an own account basis is capitalised and classified as GFCF, with no adjustment made to represent data consumed within one year.**

2.83 The task team on data accepts that it is not just possible, but likely that some expenditure on data production produces an economic benefit for a period less than one year. The recommendation is made on the basis of two accepted actualities:

I. There is limited empirical evidence which could provide guidance on the proportion of own account data produced that is consumed within one year.

II. Endorsing a recommendation explicitly allowing countries to make subjective adjustments would negatively impact the international comparability of estimates.

2.84 That said, **if NSAs have obtained statistically appropriate information that can provide guidance on the proportion of data that is consumed within one year, they are encouraged to make such an adjustment and reduce the level of capitalised data**. In the absence of information on the capitalisation rate of own account data production, the default recommendation is that all expenditure on production of data on an own account basis is assumed to provide economic benefits of greater than one year and should therefore be capitalised and classified as GFCF. This recommendation is consistent with the view put forward in the 2025 SNA, which points out that "an enterprise's own-account production of data may include both data with a service life shorter than a year and data with a service life longer than a year. In these cases, the information needed to separately identify the costs of producing the short-lived data and the costs of producing the long-lived data is often unavailable. When the separate cost of producing the short-lived data is unknown, a relatively short average service life

that reflects the inclusion of the data with a service life shorter than a year may be used to estimate the value of the combined stock of data assets." (2025 SNA §22.31)

2.85 Following the publication of the 2008 SNA, one particular piece of accompanying implementation guidance suggested that "not all database creation qualifies as GFCF, and as such, in the absence of any information on the proportion that does, it is recommended that it be assumed to be 50%" (OECD, 2010). While not providing any empirical evidence to support this recommendation, it essentially suggests that a 50% capitalisation rate is an appropriate starting point. Following discussions and consultation, the task team on data considers that, in the absence of new information, this starting point for data, should be increased to 100%. This switch reflects the way that data is used in the modern economy. Not only is it cheaper and easier to store and use data in production than it was around the publication of the 2008 SNA, suggesting that data will be used not only more often but also for a longer period of time, the ability to use and re-use data in many different ways has also greatly increased the potential of data use in the economy.

2.86 The 2025 SNA points out that treatment to include all own account production as capital (in the absence of any relevant information) may cause producers GVA to be overstated it believes that "this disadvantage is outweighed by the advantage of capturing the potentially important value of the stocks of data whose useful economic life is a year or less as part of the measure of the stocks of the data assets" (2025 SNA §22.31).

2.87 As was discussed in Chapter 1 and will be elaborated on further in Chapter 4, the 100% capitalisation rate for own account production of data should be complemented with appropriate assumptions on the life length, the depreciation rate and profile when calculating capital stock estimates. A point also made in the 2025 SNA, which suggest that "if the measure of the production of data does not exclude all the data with a service life of a year or less, a relatively short assumption for the service life of data assets is likely to be appropriate" (2025 SNA §22.31).

2.88 While empirical evidence is limited, it is broadly agreed that a relatively larger proportion of data is rendered obsolete earlier in their service life than many other fixed assets in the national accounts. However, in lieu of statistically appropriate information providing guidance on this, the handbook recommends that this phenomena is reflected in the service life applied rather than a potentially unsubstantiated adjustment to the nominal estimate.

Reflecting the incorporation of new data points to existing data assets

2.89 **Expenditure undertaken to update a data asset with newly collected information should be considered as new investment (Gross Fixed Capital Formation - GFCF) rather than repair and maintenance.** The addition of new information likely "enhances [the data assets] efficiency or capacity or prolong their expected working lives, and thus should be treated as new GFCF" (2025 SNA §7.251). This contrasts with just ensuring an asset maintains its current working life (the result of any repair and maintenance).

2.90 From a practical viewpoint this treatment also aligns with the previously discussed assumption that all own account expenditure on data should be considered as GFCF rather than intermediate consumption.

2.91 This recommendation of treating the expenditure as GFCF remains regardless of if the additional information is added to an existing data asset or used to create a new data asset. The conceptual boundaries of a single data asset are inconsequential to the measurement of the level of data from the national accounts perspective. For example, the specific numerical number of cars, computers and new buildings are not recorded in the accounts. Even on survey forms, businesses are not asked how many computer software packages they purchased, instead, they are asked about their expenditure on assets. There is no need to treat data differently. Theoretically, it does not matter if a data producer considers their database a single data asset or millions of data assets joined together. From a National Accounts perspective, it is simply the value of production required to create this volume of data.

Chapter 2.7 The production of quarterly estimates of data output.

Recommendation: **NSAs are recommended to develop quarterly indicators that can be used for both the interpolation and extrapolation of annual estimates. NSAs should aim to minimise revisions when annual data is incorporated into the national accounts.**

Default recommendation: **NSAs are recommended to use already available quarterly information that displays a correlation with annual data investment estimates. No specific quarterly series is recommended as the choice will depend on data availability. Potential proxies include: 1) GFCF on assets relating to data production, such as computer hardware and software, 2) ROE for data producing occupations, or 3) ROE for industries heavily involved in data production. In the interim, NSAs are recommended to extrapolate annual estimates using a trended time series until a more suitable indicator can be identified.**

Aspirational recommendation: **NSAs are recommended to obtain or develop specific quarterly information relating to business expenditure on data production, which can be used to extrapolate the annual estimate.**

2.92 All methods and compilation inputs discussed previously in this chapter have been annual in nature. While some of the inputs contributing to the sum-of-cost methodology may be obtainable on a quarterly basis, for many countries, the fine level of occupation and income data is only available annually, or even less frequently. However, there is a need to produce an estimate of data output and GFCF on both annual and quarterly bases regardless of when input information is available.

2.93 This is not a unique challenge in the compilation of the national accounts. This handbook recommends the standard practice advocated by other manuals in obtaining a quarterly indicator that is then benchmarked to the annual estimate of data. Compilers should strive for a quarterly indicator which is highly correlated with the annual series of data production to minimise revisions. While not always possible, ideally both the quarterly and annual data would come from the same source.

2.94 Currently, there would appear to be three alternatives which could be used as a quarterly indicator to move forward annual estimates:

I. Results from a specific quarterly survey seeking specific information on data production.
II. Quarterly information on labour costs of occupations considered as data producing.

III. An available quarterly indicator highly correlated to data production.

2.95 The first option would consist of a specifically designed quarterly survey that obtains information related to data production. For a range of reasons such as differences in sample size, reduced survey size, etc., it is expected that results from this survey would slightly differ from the annual estimates on a level basis. However, since the specific goal is to derive a correlated growth indicator rather than a level, this is of lesser concern. Indeed, the survey need not even ask expenditure questions, e.g., focusing on other business activity that may correlate with data production. Employee count, hours worked on tasks related to data etc., could be collected, and used if shown that they correlate with annual movements in expenditure on data production. It has been noted that initial discussions with survey responders have shown a lack of clarity surrounding the definition of data. Some approaches to overcome this challenge are discussed in Box 2.4.

2.96 Since many organizations are attempting to reduce respondent burden, this first option may not be desirable. Instead, already collected quarterly data which matches that used in the compilation of annual estimates might be available. For example, if it is assumed that within the sum-of-cost methodology, the choice of occupations, the involvement rates, and non-labour cost mark-up do not change on a quarter-by-quarter basis, the most pertinent quarterly indicator would be the labour costs or labour participation of those occupation defined as data producing.

2.97 Ideally, labour participation or income data for specific occupations may be available on a quarterly basis. If these are not available, labour expenses from the producer side is a potential alternative that is widely available on a quarterly basis. However, due to the different behaviours of labour costs of the data producing occupations compared with economy wide movements in labours costs, it is not recommended to use an aggregate estimate of labour costs (i.e., economy wide ROE). An acceptable alternative would be ROE for the specific industries heavily involved in data production (e.g., ISIC 62, “Computer programming, consultancy and related activities” and/or ISIC 63, “Information service activities”).

2.98 If quarterly labour costs at this lower industry level are not available, the third and final option is to use another quarterly indicator that shows some correlation with output of data. This may be output of software, computer hardware, or output of certain industries. The fundamental requirement is a correlation with the ultimate estimates of data produced on an annual basis. Overall, it is important to develop quarterly indicators of data which allows for both the interpolation and extrapolation of annual estimates. So while potentially at least, the best estimates will come from some form of data-centric quarterly survey, NSAs should ultimately choose, like the extrapolation of other annual estimates in the national accounts, a series which minimises revisions and provides the highest level of correlation.

Box 2.4: Collecting information on data from quarterly business surveys.

Initial testing and engagement with businesses on the topic of data production has suggested that the statistical definition of data provided in Chapter 1 may be unhelpful in obtaining information from businesses on data production. While the definition of data as *"Information content that is produced by accessing and observing phenomena; recording, and storing information elements from these phenomena in a digital format, which provide an economic benefit when used in productive activities"* is suitable for inclusion in a statistical framework such as the SNA, it is likely that other wording will need to be developed in order to obtain information from survey respondents.

At the time of writing, this is a step that has yet to be taken by many statistical organizations and, as such, developing best practices for obtaining information on data production is still a work in progress, although several possibilities exist. These include:

- Testing various wording to achieve a greater response from survey respondents. By removing unnecessary language while still maintaining the critical points of the definition will likely result in a better understanding and response. Examples may include:
    - What was the business's level of expenditure on producing digitalized information content for use in productive activities? (Please include both labour and non-labour costs).
    - What was the business's level of expenditure on digitally recording facts and information, including those created as a byproduct of production in order to use this information content at a later date? This includes both set up costs and costs to maintain any such system (please include both labour and non-labour costs).
- Statistical offices could focus on asking about the inputs contributing to data production rather than expenses related to a data output. Survey questions could focus on expenditure by businesses on completing specific tasks related to data production. It's likely that these tasks may be better understood by survey respondents, although this would need to be tested to ensure that respondents are still able to provide such information.
- Explicitly reach out to large data producers to better understand how NSA's might obtain this information.

An approach which may require more resources, but which would improve respondent understanding would be to tailor questions for each industry by including examples of data production occurring within that industry. Such examples would assist responders' understanding of the questions.

Finally, since any information obtained on a quarterly basis is predominately used to obtain growth indicators, useful information may still be obtained even if it comes with some vagueness regarding the exact conceptual boundary of data from the SNA perspective. Due to this, it may be worthwhile for statistical organizations to simply ask for the level of expenditure on 'data production' and see what corporations are able to provide. A consistent approach, even if not conceptually perfect would still produce results that may be used for extrapolation purposes.

Annex 2.1. Using natural language processing to better understand data intensity for certain occupations.

In 2023, the OECD generated occupation and industry level estimates of data intensity using natural language processing (NLP) (Schmidt, Pilgrim, & Mourougane, 2023). The work built off earlier work by Calderón & Rassier (2022) by expanding the methodology to a range of countries in order to test it suitability over time and location.

The study used NLP to review online job advertisement to derive the share of jobs involved in data production, referred to as "data intensity." The basic methodology, outlined below in Figure 2.5, identified specific text within job advertisements to determine not only if the occupation was data intensive but also the level of data intensity.

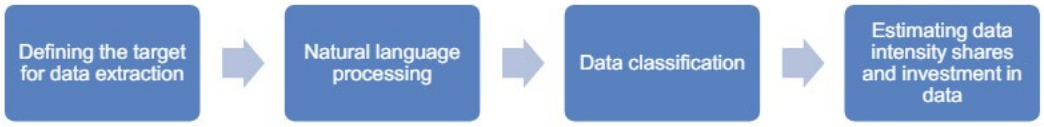
1. Defining data-intensive jobs: Job advertisements are a rich source of information to understand the labour demand. The data value chain put forward by Statistics Canada (Statistics Canada, 2019) and (Corrado, Haskel, Iommi, & Jona-Lasinio, The value of data in digital-based business models: Measurement and economic policy implications, 2022)is used as a conceptual framework to determine whether a job is data-intensive.

2. Deploying Natural Language Processing: The text data are cleaned of noise, and quality and consistency checks are deployed to check the properties of the data. Subsequently, the NLP algorithm performs the text feature extraction, which transforms text data into a mathematical object that can be classified.

3. Classifying data: The parts of the online job advertisement identified as data-related skills and tasks are classified into data entry, database, and data analytics related capabilities to allow for a breakdown by these types of data-related production activities.

4. Deriving the data intensity by occupation and sector and estimates of investment in data: In a final step, the data-intensive jobs are aggregated to derive a data intensity share by occupation and sector and matched onto national accounts data to calculate an estimate of investment in data at sector and economy level.

Figure 2.5: Overview of the NLP approach



Source: (Schmidt, Pilgrim, & Mourougane, 2023)

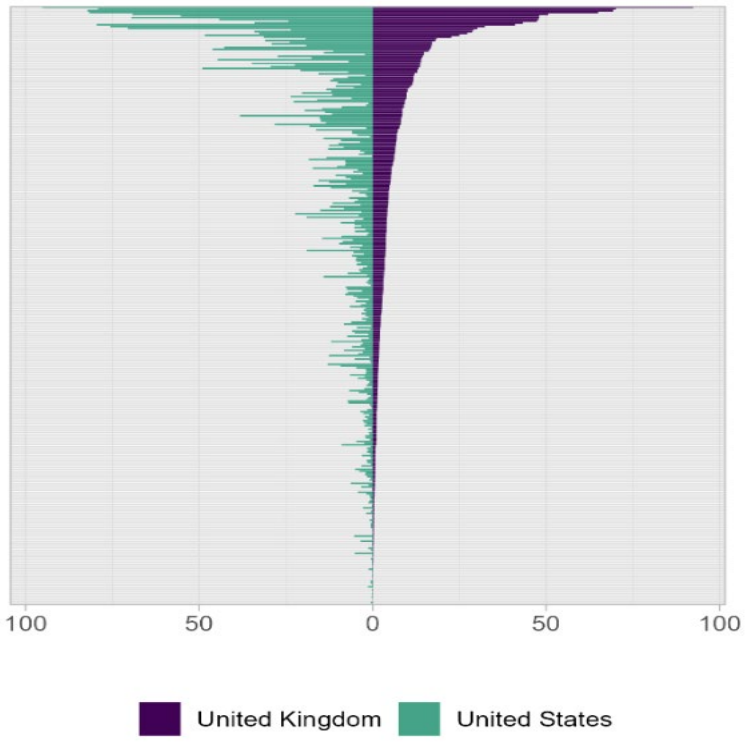
The final step of the project (combining data intensity shares with national account data to derive an estimate of investment in data) uses the same fundamental methodology as advocated in this handbook. Estimates of data investment were broadly in line with those already produced by countries.

Overall, the work found that the high data-intensive occupations were very similar in all three countries for most professions, although these occupations in Canada and the United States

exhibited slightly higher data intensity. Importantly the research supported the idea that data production was occurring across the economy with data intensive jobs found in all industries, albeit at different levels of intensity.

As shown in Figure 2.6 in both the United States and the United Kingdom, the range of occupations that recorded some level of data intensity was significant, however both countries exhibit a long tail, with most occupations displaying a data intensity value of less than 15. These results were similar for Canada. Importantly, the results were relatively stable for the period studied (2012-2020) suggesting that the data source could be considered as suitable for use in compiling national account aggregates.

Figure 2.6: Data intensity across occupation classes; United Kingdom and United States, 2020.



Each row represents a single occupation. A rating closer to 100 suggest that the occupations is quite data intensive, while a rating of 0 reflects minimal data intensity. Source: (Schmidt, Pilgrim, & Mourougane, 2023)

Such evidence is useful for countries when selecting the specific data producing occupations and their involvement rates. This work suggests that while data production may be taking place across a large number of occupations, for many occupations, involvement rates could be quite low, with high involvement rates concentrated in a small number of specific occupations.

Annex 2.2: Production of Special Internet Survey in Japan

In 2022, the Japanese Cabinet Office undertook the first iteration of the 'Special Internet Survey in Japan'. The aim of the survey, which was sent to over 30,000 workers considered as engaging in data related occupations, was to gain greater insight into the characteristics of workers involved in the production of data and data analysis. The survey sought to determine the specific tasks that data producers undertake and how much of their working time is spent on data related tasks. Results from such a survey can prove beneficial to compilers trying to derive an estimate of both the level of capital formation and capital stock of data in the economy.

The survey included questions on the tasks listed below. For each of the eight specific questions regarding data producing tasks listed below, respondents were asked if they were.

a) Engaged in the following tasks in your current job?
b) How long they spent on each task? Please enter the rate for your total working hours (from 0 to 100 %).

1	Develop a plan to collect and utilize internal or external data
2	Prepare environment to produce data (e.g. guide and support the survey respondents)
3	Input or record data generated internally or externally (e.g. record information from business memos, surveys, customer inquiries)
4	Operate an application that collects data automatically (e.g., an app which collects search history or telephone history from smartphones)
5	Arrange and organize collected data for ease of use
6	Develop and operate a database
7	Analyse data (e.g., statistical analysis, create company management indicators)
8	Develop, manufacture, or maintain infrastructure or system to collect data automatically

The Cabinet office considers tasks 1-5 as contributing to the production of data, task 6 as contributing to the production of databases. Task 7-8, the analysis of data and tasks involved with data collection tools data are, by themselves, conceptually outside of the conceptual framework of data used in the SNA and may be considered as involved in the production of other services related to data but not considered as involved in producing data itself. That said, the information is still worth obtaining to assist in clarifying the line between data producing and data using occupations.

Many occupations may undertake several (or even all) task and so obtaining results from the survey do not answer all questions involved in the compilation of data output, however the survey goes a long way in providing valuable information that can be used to provide more confidence in the estimate being compiled.

Initial Results from Japanese special internet survey

Responses to the following questions

a) Have you engaged in the following tasks in your current job?
b) How long have you spent on each task? Please enter the rate for your total working hours (from 0 to 100 %).

Develop a plan to collect and utilize internal or external data			
Planning		No.	%
Total		30,295	100.0
1	Yes	5,846	19.3
2	No	24,449	80.7
If yes, % of Time spent on task			
Responses		5,846	
Average %		24.63%	

Prepare and maintain environment for producing data (e.g. sending request and follow-up to the survey respondents, etc., process for rewarding points to respondents)			
Preparing and maintaining environment		No.	%
Total		30,295	100.0
1	Yes	5,004	16.5
2	No	25,291	83.5
If yes, % of Time spent on task			
Responses		5,004	
Average %		16.77	

Entering or recording various types of data generated internally or externally (e.g. recording information from surveys or experiments, reading from store registers, entering business data, recording inquiries)			
Entering or recording		No.	%
Total		30,295	100.0
1	Yes	8,494	28.0
2	No	21,801	72.0
If yes, % of Time spent on task			
Responses		8,494	
Average %		25.07	

Operating applications where various types of data are automatically collected (e.g. search log aggregation tools for smartphone applications, applications for collecting order and communication records)			
Operating automated application		No.	%
Total		30,295	100.0
1	Yes	4,063	13.4
2	No	26,232	86.6
If yes, % of Time spent on task			
Responses		4,063	
Average %		12.61	

Database development or operation			
Database		No.	%
Total		30,295	100.0
1	Yes	3,236	10.7
2	No	27,059	89.3
If yes, % of Time spent on task			
Responses		3,236	
Average %		12.93	

Arrange and organize collected business data (e.g. data related to sales performance, production runs, customers, comments on Social Media, web access logs) in a user-friendly manner			
Arranging and organizing data		No.	%
Total		30,295	100.0
1	Yes	6,865	22.7
2	No	23,430	77.3
If yes, % of Time spent on task			
Responses		6,865	
Average %		16.93	

Analysis of data (e.g. statistical analysis, creation of various management indicators, analysis of big data)			
Data analysis		No.	%
Total		30,295	100.0
1	Yes	5,228	17.3
2	No	25,067	82.7
If yes, % of Time spent on task			
Total		5,228	
Average %		17.35	

Either develop, manufacture, or support and maintain equipment and systems to automatically collect data (e.g., POS, search history, movement information)			
Developing automated systems		No.	%
Total		30,295	100.0
1	Yes	2,925	9.7
2	No	27,370	90.3
If yes, % of Time spent on task			
Total		2,925	
Average %		11.20	

Annex 2.3: Key words used for web scrapping job vacancies.

Statistics Canada

Data processing
Data hosting
Data entry
Statistical routines
Monitor trends
Data compilation
Data Integration
Data preparation
Charts
Graphs
Data summaries
Data Reports
Data Support
Data Survey
Data clerk
Data input
Data analysis
Data Analytics
Machine Learning
Predictive Modeling
Data automation
Database analysis
Data Administration
Database design
database development
Data management
Data mining
Data monitoring
Data Science
Survey Interviewing
Data recording
Research Support
Data communication
Optical scanning
Spreadsheet
Data operation
Data evaluation
data transformation
data manipulation
time series
data wrangling
data cleaning
statistical analysis
financial trading
satistical consulting
data coding
database tuning
oracle database administration

Big data analysis
Data visualization
statistical knowledge
data dashboards
data models
regression testing
data reporting
Econometrics
aerial survey
remote sensing
Data Informatics
Deep learning
Big data
Programming languages
NoSQL database
analytic tools
Quantitaive analysis
Business analytics
Forecasting
Data collection
Data Architecture
Data warehouse
Data Archiving
Big data engineering
Data Security
Data Queries
Database Performance
Database migration
Market analysis
Data training
Business Intelligence developing
Data advertizing
3D Seismic Data
Accenture Data Governance Framework
Advanced Data Entry
Assessment Data
Billing Data Analysis
Biological Database Search
Business Intelligence Data Modeling

relational database management system
electronic data interchange

Cascading Big Data Applications
Climate Data Analysis
Clinical Data Abstracting
Clinical Data Analysis
Clinical Data Exchange
CDISC
Clinical Data Management
Clinical Data Review
Clinical Data Understanding
Clinical Database Development
Clinical Research
Data Accuracy and Integrity
Cloud Security Data Protection And Privacy
Columnar Databases
Conceptual Data Models
Customer Data Integration
Customer Service Database
Data Acquisition
Data Acquisition Systems
Data and Safety Monitoring Board
Data Buffers
Data Capture
Data Center Hardware
Data compression
Data Conversion
Data Dictionary System
Data Documentation
Data Encryption
Data Exploitation

activex data object
database upgrade
relational databases

DFHSM
Data Governance
Data Integrity
Data Lakes
Data Loss Prevention
Data Management Platform
Data Mapping
Data Migration
Data Mining Industry Knowledge
Data Modeling
Data Modeling Star
Data Multiplex System
Data Munging
Data Operations
Data Platform as a Service
Data Pre-Processing
Data Privacy
Data Protection Industry Knowledge
Data Protection Planning
Data Protection Strategy
Data Quality
Data Quality Assessment
Data Security Classification
Study Data Tabulation Model
Clinical Data Interchange Standards Consortium
Snowflake Schema
Data Reservoirs
linear regression
logistic regression
supervised learning
teradata
metadata

ibm infosphere datastage
database partitioning
data acquisition

database schemas
data access object
open database
connectivity (odbc)
fiber distributed data
interface (fddi)
master data
management (mdm)
Amazon Elastic map
Data Frame
Informatica
Teradata DBA
Economics
panel data
OLS
ordinary least
squares
statistical
visualization
data officer
census
data scientist
wellhead plumbers
Amazon web service
AWS
hearing aid specialist
bioinformatics
specialist
Landfill meters
data structure
linkedlist
Descriptive Analytics
Diagnostic Analytics
Predictive Analytics
Prescriptive
analytics
Data Exploration
5500 reporting
8d problem solving
accident analysis
accident reporting
audit data analytics
activity based
costing
ad hoc analysis
ad hoc marketing
ad hoc market
research
ad hoc reporting
adabas
adaptable database
system
advanced encryption
standard (aes)
advanced statistics
analysis of variance
(anova)
artificial intelligence
audit reports
balance sheet
balance sheet
analysis
bayesian networks
benefits analysis
benchmarking
bill of lading
biostatistics
bookkeeping
budget forecasting
budgeting
business analysis
business impact
analysis
business intelligence
business intelligence
reporting
business metrics
business modeling
business process
modelling
business systems
analysis
call-recording
call volume/time
analysis
climate analysis
clinical data
interchange
standards
consortium(cdisc)
cluster analysis
clustering
competitive analysis
correlation analysis
data-driven testing
data
communications
data engineering
data flow diagrams
(dfds)
data management
platform (dmp)
data services
industry knowledge
data taxonomy
data trending
data validation
data verification
data warehouse
development
data warehouse
processing
database activity
monitoring
database
administration
database
architecture
database cloning
database
consolidation
database conversion
database
information
accessing
database
maintenance
database
management
database marketing
database modeling
database
optimization
database
performance
management
database
programming
database
responsibilities
dataflux
dataloggers
demand analysis
demand forecasting
economic analysis
economic
development
economic
forecasting
economic models
enterprise data
management
enterprise data
services
environmental data
analysis
environmental data
management
environmental
economics
epidata
factor analysis
financial data
interpretation
financial forecasting
flight data analysis
gooddata
gps data
health data analysis
health data
management
health databases
high-level data link
control (hdlc)
industry analysis
market data
market research
metadata design
metadata standards
qualitative analysis
qualitative data
analysis
quantitative analysis
quantitative data
analysis
quantitative research
regression analysis
regression
algorithms
sales database
sales metrics
social data
statistical
forecasting
statistical methods
statistical modeling
statistical process
control (spc)
statistical reporting
statistics
supplier database
maintenance
supply chain data
analysis
syndicated market
data
test data
management
time series analysis
time series
forecasting
time series models
variance analysis
Data Center
Data Center
Technicia

Annex 2.4: Using the CROM for Selecting Data-Relevant Occupations and Computing Involvement Rates

Introduction

As part of the research into which occupations may be considered as data producing, The Federal Statistical Office of Germany (FSO) developed the Competence-Relevant Occupation Methodology (CROM) to select data-relevant occupations and compute involvement rates. This methodology was in response to potential weaknesses observed in occupation lists derived through expert knowledge or machine learning. This approach aligns with the recommendation in the handbook, that *"countries should look to develop a list of occupations through an objective and systematic approach to better determine which occupations are most likely to be involved in data production."* The approach outlined below present a good example of how countries might use relevant skills, tasks or competencies listed within the occupation classification to derive a list of data producing occupations as well as determine an appropriate involvement rate based on the prevalence of the skills, task, or competencies assigned to that occupation.

Pleasingly, the results obtained from the CROM has produced a similarly shape curve of occupation involvement rates as other work. This curve displays a long list of data producing occupations but with only a small percentage (around 11% in this methodology) having involvement rates of greater than 10% (See Figure 2.8). This is similar to the results obtained in Japan where only around 10% of occupation had an involvement rate greater than 10%.

It should be noted that thorough testing of this methodology has not been fully completed as the list of occupations and involvement rates have not yet been applied to relevant wage rates to compile an estimate of data output. The work so far has focused purely on developing an occupation list and involvement rate which can be compared with those compiled through other sources such as machine learning or surveys.

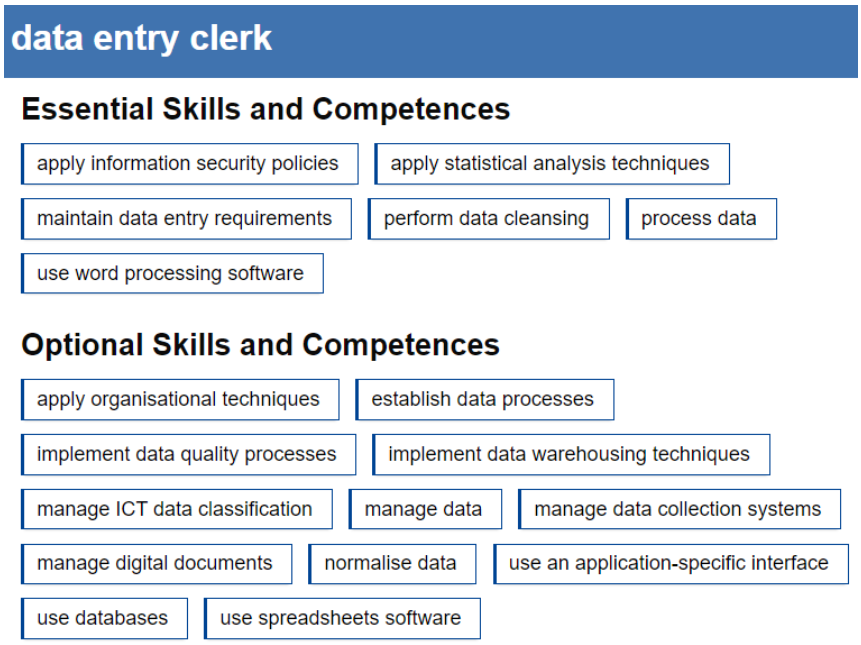
The CROM methodology follows five steps:

Step 1: Find Occupational Information System

The first step in applying the CROM is to identify an appropriate occupational information system. Examples include ESCO, BERUFENET, or O*NET, which offer comprehensive data on occupations and their associated competences, skills, or tasks. The FSO primarily uses BERUFENET due to its relevance in the German context. However, for this explanation, ESCO is used because of its broader applicability across countries.

ESCO links 13,939 competences to 3,039 occupations. Competences are categorized as essential or optional. Figure 2.7 illustrates the type of occupational information needed to apply the CROM, using the example of a "data entry clerk" from ESCO.

Figure 2.7: Competence breakdown for "data entry clerk" in ESCO.



Step 2: Identify Data-Relevant Competences

Out of ESCO's 13,939 competences, 80 were identified as relevant for data and database activities (Table 2.1). For example, for the occupation "data entry clerk," the following data-relevant competences were identified:

- Essential: *maintain data entry requirements, perform data cleansing, process data*.
- Optional: *establish data processes, implement data quality processes, implement data warehousing techniques, manage ICT data classification, manage data, manage data collection systems, normalize data, use databases*.

Other competencies listed, such as *'use of spreadsheet software'* may have some implications for the production of data. However, consistent with what is presented in the handbook recommendation it was considered that only those competencies that are *likely* in the production of data should be included rather than competencies that are *possibly* involved.

Table 2.1: Competences used for selecting data-relevant occupations and calculating involvement rates.

Out of ESCO's total of 13,939 competences, the following 80 were identified as relevant for data and database activities:

- Record test data
- manage findable accessible interoperable and reusable data
- obtain financial information
- process data
- collect biological data
- manage data
- keep records on sales
- record survey data
- use data processing techniques
- use databases
- maintain customer records
- analyze big data
- synthesize financial information
- manage database
- migrate existing data
- collect healthcare user's general data
- gather data

- document interviews
- create data models
- maintain credit history of clients
- manage data collection systems
- process collected survey data
- establish data processes
- perform data cleansing
- implement data quality processes
- manage ICT data architecture
- design database scheme
- maintain veterinary clinical records
- perform data mining
- manage cloud data and storage
- collect geological data
- design database in the cloud
- design cloud architecture
- collect mapping data
- analyze data about clients
- integrate ICT data
- normalize data
- record data from biomedical tests
- create data sets
- write database documentation
- balance database resources
- handle data samples
- maintain database security
- collect data using GPS
- collect weather-related data
- collect customer data
- maintain data entry requirements
- maintain warehouse database
- collect financial data
- create database diagrams
- manage standards for data exchange
- operate relational database management system
- collect healthcare user data under supervision
- maintain database performance
- supervise data entry
- manage quantitative data
- compile GIS-data
- implement data warehousing techniques
- manage ICT data classification
- tabulate survey results
- compile statistical data for insurance purposes
- explain interview purposes
- gather data for forensic purposes
- analyze large-scale data in healthcare
- collect ICT data
- record malting cycle data
- use questioning techniques
- conduct public surveys
- design questionnaires
- store digital data and systems
- define database physical structure
- design database backup specifications
- maintain logistics databases
- manage data
- information and digital content
- collect cyber defence data
- compile data for navigation publications
- create freight rate databases
- maintain pricing database
- develop geological databases
- interview focus groups

Step 3: Select Data-Relevant Occupations

Occupations are considered data-relevant if they include at least one data-relevant competence, whether essential or optional. Using this approach, the FSO identified 641 data-relevant occupations in ESCO.

Step 4: Calculate Involvement Rates

Involvement rates are computed by translating competences into a numerical value, with double weight given to essential competences. The formula used is:

$$IR_i = \frac{2 \times DE_i + DO_i}{2 \times E_i + O_i},$$

Where:
$IR_i =$ Involvement rate of occupation i.
$DE_i =$ Number of data-relevant essential competences for occupation i.
$DO_i =$ Number of data-relevant optional competences for occupation i.
$E_i =$ Total number of essential competences for occupation i.
$O_i =$ Total number of optional competences for occupation i.

For the data entry clerk in 2.7, the formula results in an involvement rate of

$$IR_i = \frac{2 \times 3 + 8}{2 \times 6 + 12} = 58\%,$$

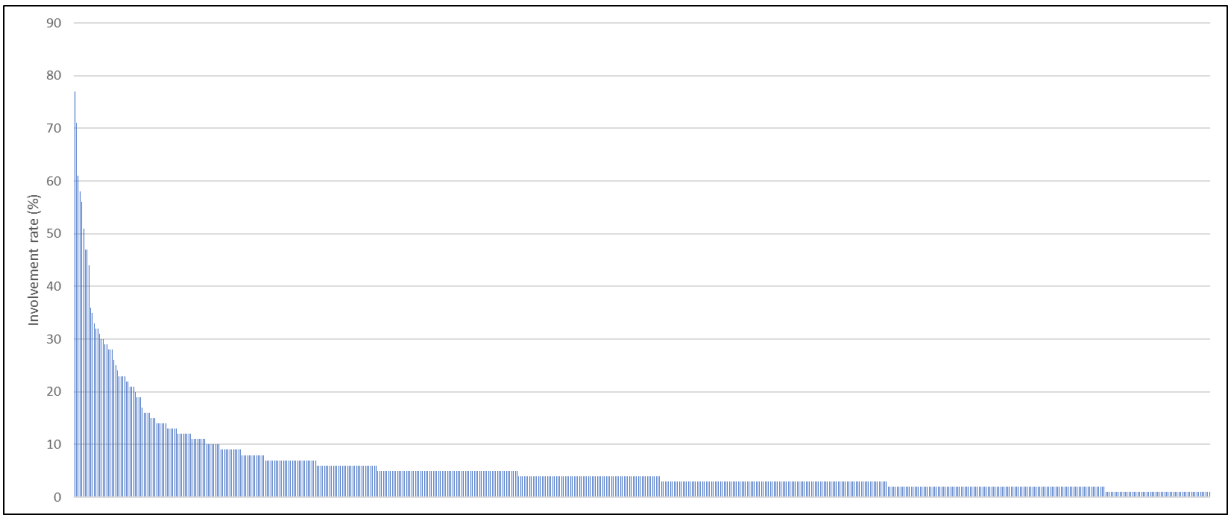
meaning they spend approximately 58% of their time on data-related activities. Using this formula, Table 2.2 ranks the top 5 occupations based on the ESCO dataset.

Table 2.2: Top 5 occupations in data-related tasks

ESCO	Occupations	Involvement rate
251120	Data Engineer	77%
25113	Data Analyst	71%
25191	Data Quality Specialist	61%
41321	Data Entry Clerk	58%
34332	Big Data Archive Librarian	56%

The 641 occupations identified as involved in data production ranged from data engineers, with an involvement rate of 77%, to specialized sellers, with a rate of 0.4%. Overall, the distribution of involvement rates across the occupations (see Figure 2.8) was similar to the results obtained through other compilation methodologies such as machine learning and survey job holders.

Figure 2.8: Distribution of involvement rates across data producing occupations



Step 5: Averaging Involvement Rates Across Occupational Groups

The formula above is applied to narrow occupations, and the rates are then averaged (with equal weighting) across broader ISCO-08 groups. This process helps to determine data relevance at the unit group level, even when detailed statistics at the occupation level are unavailable. For example, as shown in Table 2.3, the involvement rates of ESCO occupations 25211 to 25215 are averaged to calculate the rate for ISCO-08 group 2521. This aggregation results in 146 data-relevant occupational groups at the four-digit ESCO level. Table 2.4 ranks the top 5. This consolidation makes it more likely that the occupations and their respective involvement rates can be applied to occupation-based employment and wage data.

Table 2.3: Averaging involvement rates for ISCO-08 group 2521

ESCO	ISCO-08	Occupation (Groups)	Involvement rate
25211		Database Administrator	44%
25212		Database Designer	51%
25213		Database Developer	24%
25214		Database Integrator	47%
25215		Data Warehouse Designer	47%
	2521	**Database Designers and Administrators**	**43%**

Table 2.4: Top 5 occupational groups in data-related tasks

ISCO-08	Occupation Unit Groups	Involvement rate
4132	Data Entry Clerks	58%
2521	Database Designers and Administrators	43%
3511	Information and Communications Technology Operations Technicians	33%
4227	Survey and Market Research Interviewers	29%
3314	Statistical, Mathematical and Related Associate Professionals	25%

Annex 2.5: Default list of data producing occupations and involvement rates.

ISOC code	Occupation	Proposed involvement rate	ISOC code	Occupation	Proposed involvement rate
4132	Data entry clerks	**64%**	3339	Business services agents not elsewhere classified	**4%**
4227	Survey and market research interviewers	**52%**	4214	Debt Collectors and Related Workers	**4%**
2521	Database designers and administrators	**32%**	4229	Client information workers not elsewhere classified	**4%**
2120	Mathematicians, actuaries and statisticians	**25%**	2132	Farming, Forestry and Fisheries Advisers	**3%**
3314	Statistical, mathematical and related associate professionals	**25%**	2133	Environmental protection professionals	**3%**
3511	Information and communications technology operations technicians	**25%**	4110	General office clerks	**3%**
2511	Systems analysts	**20%**	4221	Travel Consultants and Clerks	**3%**
4131	Typists and word processing operators	**18%**	4222	Contact Centre Information Clerks	**3%**
2165	Cartographers and surveyors	**16%**	4225	Inquiry Clerks	**3%**
2529	Database and network professionals not elsewhere classified	**16%**	4411	Library Clerks	**3%**
3513	Computer network and systems technicians	**16%**	4415	Filing and Copying Clerks	**3%**
2512	Software developers	**15%**	4416	Personnel Clerks	**3%**
3312	Credit and loans officers	**14%**	1212	Human Resource Managers	**2%**
2164	Town and traffic planners	**12%**	2211	Generalist Medical Practitioners	**2%**
2514	Applications programmers	**12%**	2212	Specialist Medical Practitioners	**2%**
2519	Software and applications developers and analysts not elsewhere classified	**12%**	2422	Policy administration professionals	**2%**
2522	Systems administrators	**12%**	2423	Personnel and Careers Professionals	**2%**
2523	Computer network professionals	**12%**	3230	Traditional and Complementary Medicine Associate Professionals	**2%**
3315	Valuers and loss assessors	**12%**	3333	Employment Agents and Contractors	**2%**
3433	Gallery, Museum and Library Technicians	**12%**	3334	Real Estate Agents and Property Managers	**2%**
1330	Information and communications technology service managers	**10%**	3344	Medical Secretaries	**2%**
2160	Architects, planners, surveyors and designers, nos	**10%**	3353	Government Social Benefits Officials	**2%**
2513	Web and multimedia developers	**10%**	3359	Regulatory government associate professionals not elsewhere classified	**2%**
3211	Medical imaging and therapeutic equipment technicians	**10%**	4212	Bookmakers, Croupiers and Related Gaming Workers	**2%**
3212	Medical and pathology laboratory technicians	**10%**	4224	Hotel Receptionists	**2%**
3213	Pharmaceutical Technicians and Assistants	**10%**	4226	Receptionists (general)	**2%**
3252	Medical records and health information technicians	**10%**	7233	Agricultural and Industrial Machinery Mechanics and Repairers	**2%**

4311	Accounting and bookkeeping clerks	**10%**	7543	Product Graders and Testers (excluding Foods and Beverages)	**2%**
4312	Statistical, finance and insurance clerks	**10%**	1114	Senior Officials of Special-interest Organizations	**1%**
1211	Finance managers	**8%**	1223	Research and Development Managers	**1%**
1346	Financial and insurance services branch managers	**8%**	1321	Manufacturing Managers	**1%**
2412	Financial and investment advisers	**8%**	1411	Hotel Managers	**1%**
2413	Financial analysts	**8%**	1431	Sports, Recreation and Cultural Centre Managers	**1%**
2621	Archivists and curators	**8%**	1439	Services Managers Not Elsewhere Classified	**1%**
2622	Librarians and related information professionals	**8%**	2140	Engineering professionals (excluding electrotechnology), nos	**1%**
2631	Economists	**8%**	2141	Industrial and Production Engineers	**1%**
3114	Electronics engineering technicians	**8%**	2142	Civil Engineers	**1%**
3115	Mechanical engineering technicians	**8%**	2143	Environmental engineers	**1%**
3116	Chemical engineering technicians	**8%**	2144	Mechanical Engineers	**1%**
3117	Mining and metallurgical technicians	**8%**	2145	Chemical Engineers	**1%**
3119	Physical and engineering science technicians not elsewhere classified	**8%**	2146	Mining Engineers, Metallurgists and Related Professionals	**1%**
3141	Life science technicians (excluding medical)	**8%**	2149	Engineering professionals not elsewhere classified	**1%**
3311	Securities and finance dealers and brokers	**8%**	2166	Graphic and Multimedia Designers	**1%**
3321	Insurance representatives	**8%**	2230	Traditional and Complementary Medicine Professionals	**1%**
3341	Office Supervisors	**8%**	2250	Veterinarians	**1%**
3512	Information and communications technology user support technicians	**8%**	2262	Pharmacists	**1%**
4211	Bank tellers and related clerks	**8%**	2264	Physiotherapists	**1%**
2111	Physicists and astronomers	**6%**	2269	Health Professionals Not Elsewhere Classified	**1%**
2112	Meteorologists	**6%**	2310	University and Higher Education Teachers	**1%**
2113	Chemists	**6%**	2351	Education Methods specialists	**1%**
2114	Geologists and geophysicists	**6%**	2421	Management and Organization Analysts	**1%**
2131	Biologists, botanists, zoologists and related professionals	**6%**	2619	Legal Professionals Not Elsewhere Classified	**1%**
2411	Accountants	**6%**	2643	Translators, Interpreters and Other Linguists	**1%**
2632	Sociologists, anthropologists and related professionals	**6%**	3118	Draughts persons	**1%**
2633	Philosophers, historians and political scientists	**6%**	3122	Manufacturing Supervisors	**1%**
2634	Psychologists	**6%**	3123	Construction Supervisors	**1%**
3342	Legal secretaries	**6%**	3133	Chemical Processing Plant Controllers	**1%**
3352	Government tax and excise officials	**6%**	3139	Process Control Technicians Not Elsewhere Classified	**1%**
3514	Web Technicians	**6%**	3142	Agricultural Technicians	**1%**
4213	Pawnbrokers and Money-lenders	**6%**	3153	Aircraft Pilots and Related Associate Professionals	**1%**
4313	Payroll clerks	**6%**	3154	Air Traffic Controllers	**1%**

4321	Stock clerks	**6%**	3240	Veterinary Technicians and Assistants	**1%**
4322	Production clerks	**6%**	3255	Physiotherapy Technicians and Assistants	**1%**
4323	Transport clerks	**6%**	3257	Environmental and Occupational Health Inspectors and Associates	**1%**
1213	Policy and planning managers	**4%**	3259	Health Associate Professionals Not Elsewhere Classified	**1%**
1219	Business services and administration managers not elsewhere classified	**4%**	3313	Accounting Associate Professionals	**1%**
1342	Health Services Managers	**4%**	3323	Buyers	**1%**
2152	Electronics Engineers	**4%**	3324	Trade Brokers	**1%**
2153	Telecommunications engineers	**4%**	6221	Aquaculture Workers	**1%**
2431	Advertising and marketing professionals	**4%**	7231	Motor Vehicle Mechanics and Repairers	**1%**
2432	Public relations professionals	**4%**	7232	Aircraft Engine Mechanics and Repairers	**1%**
2642	Journalists	**4%**	7321	Pre-press Technicians	**1%**
3111	Chemical and Physical Science Technicians	**4%**	7421	Electronics Mechanics and Servicers	**1%**
3112	Civil Engineering Technicians	**4%**	8111	Miners and Quarriers	**1%**
3113	Electrical Engineering Technicians	**4%**	9216	Fishery and Aquaculture Labourers	**1%**
3214	Medical and Dental Prosthetic Technicians	**4%**			

Annex 2.6: Numerical example of default non-labour cost mark up

Due to the absence of specific information on non-labour costs involved in data production, the recommendation in this handbook is for Non-labour costs to be incorporated into the final estimate of data production via a single mark-up applied to labour costs. Such a mark-up represents the costs of inputs, depreciation used in production, as well as a return on capital (operating surplus).

The default recommendation for calculating such a mark up is to base it on the ratio of total Renumeration of employees for "Computer programming, consultancy and related activities" (ISIC Rev.5, division 62) and "Computing infrastructure, data processing, hosting, and other information service activities" (ISIC Rev.5, division 63) applied against total gross output for these same industries. The numerical example below shows such a calculation.

The weighted average of the two industries is used to generate a ratio which can be applied as a mark up. In this example the weighted mark-up of 2.46 is calculated from dividing the sum of gross output (62,677) by the sum of renumeration of employees(25,461). The mark up is then applied to the data labour costs (15,000), calculated through steps described in this chapter.

This creates a final nominal estimate of data output of 36,925.30

Figure 2.9: Numerical example of default non-labour cost mark up

Row #	Economic activity	Computer programming, consultancy and related activities	Information service activities	Sum of both industries
1	Output, Basic prices	53,498.00	9,179.00	62,677.00
2	· Intermediate consumption, Purchasers prices	21,731.00	4,135.00	25,866.00
3	· Value added, gross, Basic prices	31,766.00	5,044.00	36,810.00
4	· · Renumeration of employees	22,252.00	3,209.00	25,461.00
5	· · Other taxes less other subsidies on production	251.00	-7.00	244.00
6	· · Operating surplus and mixed income, gross	9,262.00	1,842.00	11,104.00
7	Non-labour mark-up ratio (Ouput {row 1} / Renumeration of employees {row 4})	**2.40**	**2.86**	
8	Weighted average mark-up	**2.46**		
9	Value of labor costs of data output	15,000.00		
10	Total data output (labor costs {row 9} * non-labour mark-up ratio {row 8})	36,925.30		

Annex 2.7: Summary of recommendations for compiling nominal estimates of data.

Measurement step	Broad conceptual recommendation:	Default recommendation:	Aspirational recommendation:	Additional considerations
Valuation approach	Data produced on an own account basis is valued using the already established sum-of-cost methodology.			
Choice of occupation	NSAs should use a list of occupations as the foundation for deriving an estimate of labour costs involved in producing data. This list should remain broadly consistent across periods and be compiled in a transparent manner.	In the absence of other sources, NSAs should use the list of occupations provided in this handbook for the compilation of data output. If the default list of occupations is applied, these must be used in unison with the default involvement rates also applied. As these have been compiled in unison. It is not recommended to apply new or different involvement rates to the default occupation list.	NSAs are encouraged to derive a list of occupations through a objective and systematic approach to better determine which occupations are most likely to be involved in data production.	Occupations should be considered for the list if the occupation involves tasks which explicitly contribute to adding value to the production of data and the worker undertakes these tasks in a proactive and calculated manner.
Estimation of Labour costs	The final nominal estimate of output associated with data must reflect non-direct labour costs as well as traditional wages and self-employed income.	Use average annual wages for each of the occupations selected. For annual estimates of labour costs outside of periods when this data is collected and in the absence of occupation specific labour cost information, use an appropriate indicator to move forward the nominal labour costs at the aggregate level.	Use the average wage for each of the occupations selected. Ideally, for annual estimates of labour costs outside of periods when wages rates are explicitly collected, labour costs are moved forward with an appropriate indicator at the individual occupational level.	The sum of costs methodology includes the labour costs of all specified occupations regardless of the industry or unit they are working in. This may include workers employed by units that predominately produce data for sale.
Involvement rates	Involvement rates, representing the amount of time an employee actually spends producing data are applied at the occupation level	If using the default occupation list provided in this handbook, NSAs are recommended to apply the same or very similar involvement rates to those listed in this handbook.	NSAs are encouraged to develop and use involvement rates derived through an objective and more systematic approach commensurate with the methodology to	Default involvement rates provided in the handbook should be used only with the default occupation list.

			select a list of occupations	
Estimation of non-labour costs	Non-labour costs are incorporated into the final estimate via a single mark-up applied to labour costs. Such a mark-up represents the costs of inputs, depreciation used in production, as well as a return on capital (operating surplus).	A single mark-up, based on the ratio of renumeration of employees applied against total gross output from the "Computer programming, consultancy and related activities" (ISIC 62) and "Information service activities" (ISIC 63) – or similar available aggregate - is applied to total labour costs	NSAs are encouraged to apply specific non-labour information (including mark-ups) into the estimate separately so that differences in COFC and operating surplus across occupations and industries can be applied more accurately and transparently.	NSAs are encouraged to investigate potential input information that may provide more detailed information on non-labour expenses involved in the production of data.
Compilation of Quarterly estimates	NSAs must apply quarterly indicators in order to interpolate and extrapolate annual estimates. Countries should aim to seek to minimise revisions when annual data is incorporated into the national accounts.	NSAs are recommended to use already available quarterly information that displays a correlation with annual data investment estimates. No specific quarterly series is recommended as the choice will depend on data availability. Initially, NSAs are recommended to extrapolate annual estimates using a trended time series until a more suitable indicator is identified.	NSAs are recommended to obtain or develop specific quarterly information relating to business expenditure on data production.	
Adjustment for short lived data		No adjustment is made to the nominal estimate of own account data production to represent data that is consumed within one year. All data produced on an own account basis is capitalised.	NSAs should seek to obtain appropriate information that can provide guidance on the proportion of data that is consumed within one year, in order to make such an adjustment	

Additional recommendations

Expenditure undertaken to update a data asset with newly collected information should be considered as new investment (Gross Fixed Capital Formation - GFCF) rather than repair and maintenance.

The default list of involvement rates should be applied only when the default list of occupations is also used to produce estimates of data. NSA should not apply one aspect of the default methodology (occupation list or involvement rates) and combine them with a list or set of rates obtained separately as this significantly impact the international comparability of the estimates.

Treatment of Market transactions

Unless it is clear that the transaction relates to a purchase of a copy, any information on domestic transactions in data should be used primarily as a tool to improve the accuracy of industries and sector estimates rather than to add additional expenditure to the overall aggregate estimate of data GFCF.

Data that is purchased and used for less than one year is regarded as being consumed and treated as intermediate consumption.
Data that is purchased and used for more than one year is regarded as an asset.
Data assets that are purchased with *exclusive* rights are treated as a purchase of an asset (with an offsetting sale of an asset by the seller). However, assuming that the transaction is not a cross-border or inter-sector one, similar to sales of other secondhand assets, this transaction would net off and not impact the overall level of GFCF.
Data that is purchased without exclusive rights is treated as a purchase of a copy and contributes to the GFCF of the purchaser if it satisfies the necessary conditions of GFCF, (i.e. use in production for more than one year).
A copy of a data asset or access to a data asset under a license to use may also be treated as a purchase of a fixed asset if it meets the necessary conditions.

Chapter 3 – Creating volume estimates of data.

Introduction

Overall recommendation: **Any price index used to deflate nominal estimates of data reflects the price change observed in both the labour and non-labour costs involved in data production as well as appropriately accounting for the technological and quality improvements that have been observed in the production of digital products over the past several years**.

Default recommendation: **Chain volume estimates of data are compiled using an output price index based on an alternative but similar product.**

Aspirational recommendation: **Chain volume estimates of data output, are compiled using a 'pseudo' output price index. This can be created by aggregating appropriate input price indexes and weighted to reflect the actual input costs included in the sum of cost calculation. An adjustment to reflect quality and productivity improvements made to the final output would be added to transform the input price index into a pseudo-output price index.**

3.1 In the System of National Accounts (SNA), certain high-profile indicators are presented in volume terms as well as nominal terms. In fact, in many cases, such as estimates of production, output and gross fixed capital formation, the movement in the volume series is considered the figure of "principal focus" and importance for users (2025 SNA §18.110). Until now, this handbook has focused only on the production of a nominal estimate of data output and investment.

3.2 This chapter will discuss the creation of chain volume estimates of data allowing for data output to be incorporated completely and consistently within the SNA. The chapter will begin from a conceptual perspective, explaining why deflation through a pseudo-output price index is considered the most practical option of those presented by the SNA. The chapter will then provide more specific recommendations regarding the choice of price index used when compiling chain volume estimates.

Deflation options presented in the SNA.

3.3 When producing outputs in line with the SNA, countries apply several methods to compile volume estimates of production. The choice of which one is usually determined based on the characteristics of the good or service being produced as well as the availability of appropriate price or quantity data associated with the product.

3.4 The most popular way for nominal estimates to be represented on a volume basis is to be deflated based on an output price index. Such an index is constructed by recording the market price of the good or service in the current period and the previous period. This allows for an index of the change in the output price to be calculated and applied against the nominal estimate of output produced. Obtaining this price change information is relatively easy for most market transactions, as the collection of prices of good and services on a regular basis is a fundamental data collection in almost all countries.

3.5 However, when estimates are calculated as the sum of the costs, as is recommended for data, it is normally reflective of the fact that there is an absence of market prices available or when there are, they are not fully representative of all data production. Therefore, while there is no conceptual concern with deflating a nominal estimate of output compiled using a sum of costs methodology with an index compiled on market prices of output[27], the very fact that a sum of cost methodology is being used usually implies that a true output price index is not able to be easily generated.

3.6 The SNA acknowledges this problem when it addresses the compilation of own account volume measures of computer software and databases. Advising two alternatives, an input price index, created by weighting together price indices of the inputs, or a pseudo-output price index. (2025 SNA 18.227).

3.7 Input price indexes is an established practice in the compilation of the national accounts, for example, they are used heavily in the compilation of volume estimates of non-market output, since this production also exhibits a lack of output prices. While the creation and use of input price indexes is well established, they also have a well-documented weakness. Since the value of the output is continually equal to the value of the inputs, there is no additional value associated with the production itself. In other words it is not possible to have any value created (or added) by the producer associated with improvements in efficiency or productivity of production reflected in the price index.[28] This well-documented weakness means that the SNA explicitly recommends to not use unadjusted input price indexes (2025 SNA §18.227). This recommendation against input price indexes was supported in the follow up manual on compiling capital measures of Intellectual Property Products (IPP) (OECD, 2010).

3.8 This leaves a pseudo-output price index as the final remaining option. The SNA makes two suggestions on how this can be put together(2025 SNA §18.125).

I. By using a similar product(s) where market prices are available to derive an output price index which can then be applied to the output of data.

II. by adjusting the calculated input price index to incorporate the observed productivity growth of a related production process.

Additional consideration in identifying a price index for data measurement.

3.9 When choosing between the two options, an output price index for a similar product or an adjusted input price index calculated on the actual production of data, there are several considerations to determine which might be more suitable. In fact, the Eurostat handbook on

[27] Indeed, it is recommended in the SNA (2025 SNA §18.227) that ideally the nominal sum of cost estimate representing own account capital formation is deflated using an output price index, compiled using market prices.

[28] An additional issue, although of slightly less concern is the that the use of input prices often means that the price index is calculating changes in the basic price rather than purchasers' price. As pointed out in the Eurostat manual on price and volume, measurement on this basis assumes that "taxes, transport, installation and the other costs of ownership remain constant in volume terms." The appropriateness of such an assumption can vary depending on the asset and industry, however at this point no adjustment is suggested to account for this assumption (Eurostat, 2016).

prices and volumes outlines four criteria that a price index must meet to be considered an 'A method'. These include[29],

I. it is an index with a coverage of exactly that (group of) product(s).

II. it takes proper account of changes in quality of the product(s).

III. it is valued in purchasers' prices including non-deductible VAT; and

IV. the concepts underlying the index correspond to those of the national accounts. (Eurostat, 2016)

3.10 Choosing an established price index or Implicit Price Deflator (IPD) would mean that the last three criteria are likely automatically being met including the requirement to properly account the changes in quality. However, by definition, the fact that the established price index or IPD is for a *similar* product rather than the actual product being deflated results in this option not meeting the first criteria.

3.11 Conversely, the use of the actual inputs into data production to calculate an adjusted input price index would certainly cover the "exact group of products" but the subsequent adjustment to the index means that the other criteria are met only through the use of assumption or estimation.

3.12 Since both options are not perfect NSA's should consider which option comes closest to meeting all four criteria on a regular basis. If the establish price index for the similar product contains inputs that are extremely similar to those used in the production of data, this may prove a superior option. However, if the adjustments made to the input price index are considered accurate and reflective of the quality change occurring, then this option may provide more accurate results. Often, the choice between the two will come down to data availability which may not be consistent across countries. As will be presented later in the chapter, **the use of an output price index based on an alternative but similar product is considered the default recommendation to produce chain volume measures of data. Although NSA's should aspire to compile a pseudo' output price index based on changes to actual input costs and including an adjustment to reflect quality and productivity improvements.**

3.13 Regardless of which option is chosen, **volume estimates of data should not be compiled via an unadjusted input price index**. Advancement in technology used to produce data is on clear display throughout the economy, creating both higher quantities of more granular and accurate data. While the connection between any increase in output and higher quality or value associated with the data is not always linear (see Box 3.2), the volume estimates of data within the national account should offer some acknowledgement of these developments. Concerns regarding capital going unaccounted for, in particular assets created as part of the digitalisation of the economy was one of the central user concerns that the revised SNA was hoping to address. As such, it is important that the volume estimates of data assets reflect the improved

[29] In the Eurostat manual "A methods" are considered the methods that "approximate the ideal as closely as possible".

efficiency or quality with which they were produced even if such a consideration is introduced in a generic way and/or are limited to conservative 'best guesses'.

3.14 In the preliminary work compiling estimate of data output, NSA's often created volume estimates of data by deflating the nominal estimates of data with the existing price index for other IPP. This is understandable as this initial work was considered experimental and it was deemed that such price indexes would exhibit similar behaviour as those compiled based on inputs to data production. Importantly however, in this initial work, the price indexes chosen represented not simply the market price of other IPP such as Computer Software or Research & Development, but rather the change in price observed for *own account production* of computer software and R & D. This meant that the index contained both a labour and non-labour component. This is an important consideration since as shown by the ABS (and others) the trends exhibited by different price indexes (purchased software vs cost of labour) can be quite different (See Box 3.1) resulting in the choice of price index having a significant impact on the final chain volume output estimate.

3.15 Due to the high amount of data production occurring on an own account basis, the cost of the labour used in the production must be incorporated into the price index used. Therefore, regardless of if the chosen price index is an output price index for a similar IPP or an adjusted input price index associated with the production of data it is recommended that **any price index used to deflate nominal estimates of data reflects the price change observed in both the labour and non-labour costs involved in data production as well as appropriately accounting for the technological and quality improvements that have been observed in the production of digital products over the past several years.**

Box 3.1: Key inputs into data production display significant variances in price change.

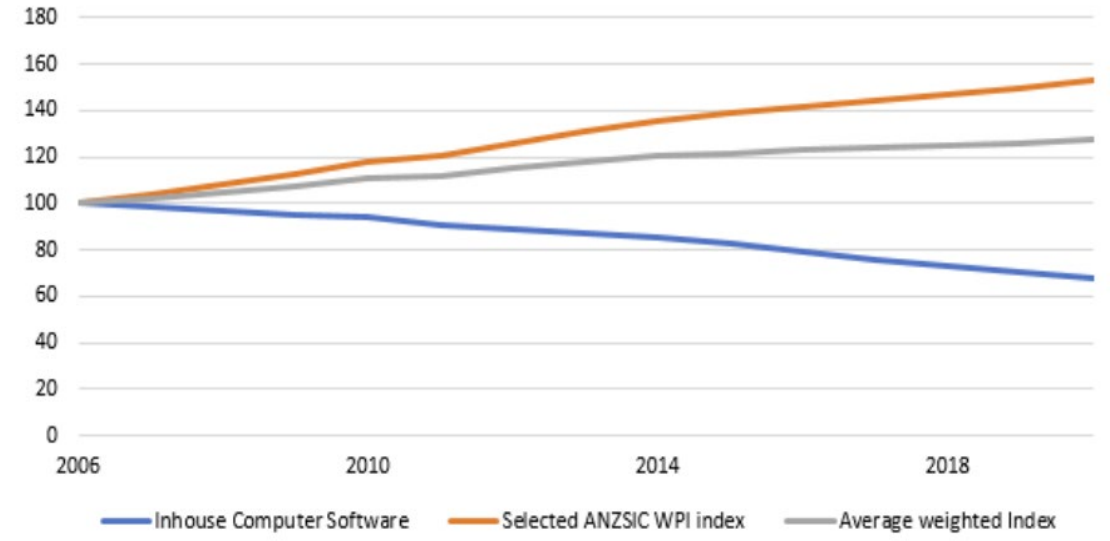
In their initial work of compiling volume estimates of data investment, the Australian Bureau of Statistics (ABS) tested several different plausible index options that could be used to deflate the nominal estimate.

Since the starting point of the nominal estimate of data was labour costs for specific occupations, option 1 involved a wage price index which covered the industries considered as primary data producers. At the same time, aware that such an input price index would not represent any of the productivity or quality improvement that have been so prevalent in the IPP space, Option 2 consisted of a price index representing the cost of in-house computer software was tested.

As displayed in figure 3.1, these two indexes, both considered relatively acceptable options, displayed extremely different trends. The price of labour consistently increased in cost over the time period while the price of software reduced by around 40% over the same time.

With such divergence the ABS ultimately decided the most appropriate option was a weighted mixture of the two, represented by the grey line. Such a decision is in line with the recommendation contained within this handbook.

Figure 3.1: Price index for data related activity: Australia, 2006 - 2020



Source: (Smedes, Nguyen, & Tenburren, 2022)

Use of an established output price index covering similar product(s) or producing industries

3.16 In line with the aforementioned criteria, NSA's, if choosing an established output priced index to deflate data, should look for price indexes that cover production as similar as possible to that observed in the production of data. Understanding which type of output is most closely aligned with the production of data is still a work in progress since the nominal estimates of data are still under development in most countries. However, once a country has compiled a nominal estimate, it is a relatively straightforward to compare the split of labour and non-labour inputs as well as the specific types of occupations and capital services used as inputs to determine which production process most closely mirrors the production of data. In the initial work in this area, countries have used output price indexes associated with own account production of IPP assets, since the production of these exhibit similar characteristics.

3.17 Alternatively, the IPD associated with the output of the relevant data producing industries such as ISIC categories "Computer programming, consultancy and related activities" (ISIC 62), "I Computing infrastructure, data processing, hosting, and other information service activities" (ISIC 63) or similar available aggregate is also acceptable, however this is considered inferior to the IPD for a specific product since the production of data is unlikely to be concentrated in these few industries.

3.18 **The use of an output price index based on an alternative but similar product is considered the default recommendation to produce chain volume measures of data. In particular, the Implicit Price Deflator (IPD) associated with own account capital formation of computer software, research and development or broader IPP category, and taken from the compilation of the Supply-Use tables is considered an appropriate default option.**

Use of an input price index specific to data production.

3.19 The production of two assets is never completely alike, therefore while the use of price index based on the production of an alternative product(s) or an aggregate industry is an acceptable default option, NSA's should strive to create a 'pseudo-output price index' for data in its own right.

3.20 In line with the recommendation in the SNA this could be created by 'adjusting the calculated input price index to incorporate the observed productivity growth of a related production process' (2025 SNA §18.125). Such a data specific index, even if based on input prices would provide a better reflection of the change in costs associated with producing data output. Furthermore, such an index could have the weighting updated on a regular basis (i.e. annually) to ensure that it continues to reflect any changes to the proportion of labour and non-labour inputs, or the types of inputs used in the production of data. This is a superior option than the assumption that any compositional input changes occurring in data production are also occurring in the relevant product or industry used as a proxy to deflate data.

3.21 The level of detail that such a weighted index may cover largely depends on the information and resources available to the compiler. Ideally, the input price index should reflect as much as possible the full range of costs involved in the production of the data output and importantly, it should be applied at the most detailed level of these underlying costs. For example, rather than applying a single labour cost index representing changes to the cost of labour for the whole economy or industry, the labour cost indexes used should reflect, as much as possible, the wide range of occupations contributing to the labour costs amount as well as the weight that each of these occupations contributes to the overall labour cost amount[30].

3.22 While the creation of an initial index may involve additional resources, similar to price indexes used to deflate other components in the national accounts, ongoing work related to the index will likely consist of weighting changes only. These are often undertaken automatically, reflecting the compilation of the nominal estimate. Importantly, such a process will likely bring the deflation of data output in line with the compilation practices already in place for the deflation of other own account IPP.

3.23 Therefore, **the aspirational recommendation is that chain volume estimates of data output, are compiled using a 'pseudo' output price index. Created by aggregating appropriate input price indexes and weighted to reflect the actual input costs included in the sum of cost calculation. An adjustment to reflect quality and productivity improvements made to the final output would be added to transform the input price index into a pseudo-output price index.**

[30] It considered that the cost of producing data should change relatively consistently across countries, so it should be acknowledged that by applying more detailed occupation based labour index, this may be exacerbating difference in the change in price between countries. If NSA's have chosen different occupations when compiling their nominal estimate, this may lead to a divergence across countries. Despite this, it is still seen as reflective of the economic situation and therefore preferable to apply a labour cost index at the most detailed level available.

Incorporating a quality adjustment to price index.

3.24 While the quality of some data produced today has declined (i.e., the production of big data sets, requiring a large amount of cleaning) the accuracy, timeliness and granularity of other data is significantly greater than previously produced. Of even less dispute, is the fact that the sheer quantity of data being produced has increased significantly relative to the number of inputs being used. This is almost certainly due to the larger presence of automatic collection tools which have greatly improved the productivity of data collection, and thus data production. Therefore, while the practical implementation and micro measurement of quality and productivity adjustments are not always clear. To ignore these productivity increases when compiling volume estimates of data output would appear to be inconsistent with outcomes experienced in the real economy.

3.25 That said, although the concept of including an adjustment to the price index to represent quality improvements to own account GFCF is often discussed in statistical circles for a range of reasons, there is no definitive advice on its implementation. For example, in the final report of the joint Eurostat – OECD task force on land and other non-financial assets (Eurostat-OECD, 2019), the prospect of including quality adjustments to the price indexes used was largely absent, perhaps an acknowledgement of the conflict that exist between their conceptual reasoning with practical implementation.

3.26 The most prominent of the implementation challenges is the absence of an agreed method on where or how to source this adjustment. For brevity, this handbook will not re-litigate discussions that have already occurred in other guidance on specific technical aspects of hedonic pricing or the best ways to estimate quality and productivity changes when compiling an index. However, for the purpose of an aggregate adjustment, which might be made to the aggregate price index used to deflate nominal estimates of data, some potential starting points for a *simple* aggregated adjustment include.

I. The calculated difference in growth between the input price index for data and the output price index for a similarly produced product where market prices are available.
II. The calculated difference in growth between the input price and output price index for similarly produced products where market prices are available.
III. The total factor productivity estimates for industries that contain a large amount of the occupation identified as data producers.

3.27 None of these options are perfect and countries should research their own compilation methods based on data availability and user feedback. **NSA's must be transparent regarding the source of any adjustments that they make to the price indexes to reflect productivity and quality improvements.**

3.28 Due to the lack of agreed consensus regarding its implementation, no default recommendation specific to quality adjustment is provided in this handbook. This is one reason why the default recommendation regarding deflation is to use an established output price index so that no explicit quality adjustment is required. However, if countries compile a data specific price index, then **the handbook recommends including an aggregate adjustment based on one of the aforementioned methods to reflect quality and productivity improvements made to the final output.**

Final considerations on the compilation of volume estimates.

3.29 Due to the impact that any such quality adjustment may have on the final chain volume estimates, some countries have resolved to not make any such adjustment to improve the comparability of results. **The intention of any recommendation in this handbook is not to overrule any such regulations, rather the handbooks' goal is to assist countries compile the most accurate or reliable estimates of data output possible. It is the view of the task team that the introduction of a quality adjustment on top of an input price index is conceptually appropriate and would improve the accuracy of the final estimate. It is accepted that countries will continue to adhere to other frameworks and standards that oversee the compilation of their national accounts.**

3.30 While it is not recommended, it should be noted that an alternative to using a price index to generate volume estimates is to undertake a process called quantity revaluation. This process measures the quantity (or volume) of output first and then applies a price index to derive the nominal value second. While rarely used in the compilation of national accounts, it is sometimes considered more accurate for certain agriculture or mineral products where the output exhibits consistent quality and characteristics. However, as pointed out by the SNA, in most cases it is "preferable and more practicable to use price indices to deflate current value [estimates]" (2025 SNA §18.111).

3.31 It is conceivable to measure the quantity of data produced and to therefore derive a volume measure of data independently of the compiled nominal estimate. This could in theory be used to derive chain volume measures or use such quantity measure as an output indicator for extrapolating forward the chain volume measure, however, for many reasons the approach of quantity revaluation is not recommended for data (See Box 3.2).

Box 3.2: Why using quantity estimates to derive chain volume estimates of data is not recommended.

Within the national accounts, volume estimates are occasionally calculated based on an output indicator which often represents a quantity of the good or service produced. This is usually for estimates of production that are relatively homogeneous, and quantity counts are relatively easy to obtain.

In one regard the quantity of data is relatively easy to measure. The bits and bytes that make up data when saved to a computer take up a specific amount of memory. Due to this, it should be, theoretically, possible to measure the additional quantity of data produced each accounting period when compared to the previous period. In fact, this undertaking has already been done by several organizations who estimate that around 2.5 quintillion bytes are created every day with the overall amount of data doubling every two years1. However, despite the presence of this estimate there are several reasons why such an estimate of quantity cannot be used for compiling volume estimates of data in the SNA.

The first reason is that this incredible number includes a large amount of data that is *not* data as defined within this handbook and the 2025 SNA. Rather it is closer to an alternative definition of data as Internet Protocol (IP) traffic, or the volume of digitised information stored on servers and other hardware. A large amount of these bits and bytes includes digital activity such as photos, text messages, email and other communications that fail the 2025 SNA data definition. These digital files are usually not produced by accessing and observing phenomena and are not used in productive activities. Rather they reflect the nature of the digital service delivery used by business and consumers alike.

Even if a quantity of data was able to be separated between that used repeatedly in production and that not meeting the SNA definition. There still exists an inconsistent relationship between the quantity of data within data assets and their subsequent value. Much of the data value comes from the content of the information and the context that it has been gathered or could be used. Both these factors are often unrelated to the size of the data. While it is true that data that contains more information is likely to be worth more than data with less information, the relationship is not consistent enough to create any form of reliable value based solely on quantity. Proof of this is the evidence that the huge increase in data production observed over the recent years is driven more by the declining cost and increasing efficiency of data storage than by a positive liner relationship between the amount of data produced and its explicit value.

Overall, while a quantity estimate of data production may be achievable, **the use of a direct volume measure within the National Accounts is deemed inappropriate due to the heterogeneous nature of data as well as the volatility and treatment of prices applying in different markets.** Interestingly, data is not the only good that falls into this category, with the 2025 SNA pointing out that the volume estimates of electricity (as well as other utilities) should not be derived through quantity, even though it appears relatively feasible, due to the difficulty in capturing a single representative price. (2025 SNA §18.111).

Annex 3.1: Volume estimates of data asset: The case of Pakistan

Pakistan Bureau of Statistics (PBS) has compiled both nominal and volume estimates of data asset. Overall the PBS compiled five aggregates of data assets using two broad assumptions i.e. i) by using aggregate price changes from industry shares and ii) by deflators. These are discussed below:

Industry based shares of nominal estimates:

1) The first step is to derive nominal estimates of data asset through sum of cost approach including labour and non-labour components following the guidelines presented elsewhere in this handbook.
2) The second step is to deflate these estimates based on the Implicit Price Deflator (IPD) from industry-specific GVA at constant prices and nominal prices. The industries used reflect those contributing to the production of data. These industry based volume estimates of data assets are then aggregated to have a measure of data asset at the total economy level.

Using Input based Deflators:

PBS specifically compiled four different price indices for data assets based on different aspects of production.

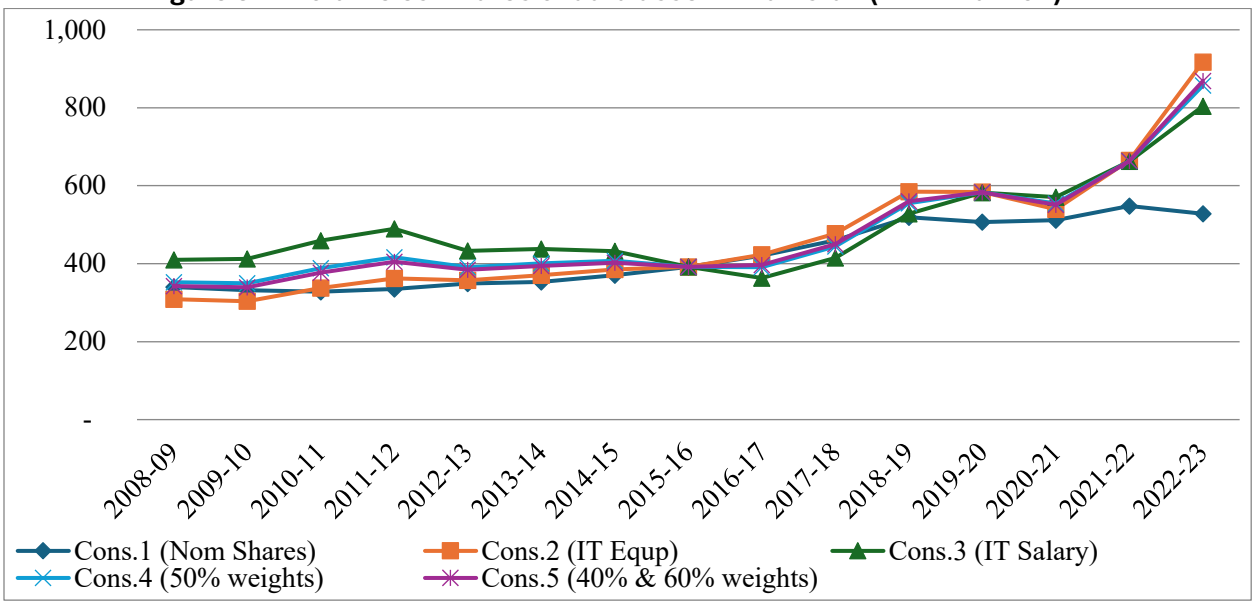
i. IT equipment index. The only available items in the CPI (2015-16 base) relating to IT equipment in Pakistan are personal computer and laptop having equal weight (See Table 3.1). It is pertinent to mention that base of price indices and national accounts are the same in Pakistan i.e. 2015-16.
ii. IT salary index. A wage index in Pakistan is not compiled formally. Therefore, PBS has specifically derived an IT Salary wage index by using data from IT-Salary Surveys conducted by Pakistan Software Houses Association (PASHA). Twelve (12) data related occupations were selected (See Table 3.1). The weights of these occupations were derived by using employment from Labor Force Survey (2014-15). The fixed weights have been used to compile IT Salary Index with 2015-16=100.
iii. Weighted Index: PBS has attempted two specification of weighted index. In the first specification an equal 50% weight was assigned to both salary index and equipment index. In the second specification, 40% weight was assigned to Salary Index and 60% to equipment. The reason behind using 40% weight for salary is the share of labour component in the nominal estimates of data asset for four labour force surveys for 2014-15, 2017-18, 2018-19 and 2020-21.

Table 3.1: Summary of items and weights for data asset in Pakistan

IT equipment items		Weight (CPI)
1	Personal Computer with LED Monitor (17") DELL/HP/ACER CORE i5	0.0489
2	Laptop DELL/HP/ACER Core i5, Display (14'-15')	0.0489
Total		0.0978
IT Salary Occupations		Weight (Labor Force Survey 2014-15)
1	Programmer (IOS)	1.4478

2	Quality Assurance	2.4144
3	Graphics Designer	0.8272
4	Technical Writer	1.5663
5	Product Manager / Business Analyst	10.7004
6	Development Manager	1.5727
7	Project Manager	12.1220
8	Architect	1.5663
9	Database Administrator	3.8942
10	System Administrator	1.2657
11	Sales & Marketing Manager	33.8469
12	Manager/Finance Manager	28.7763
Total		100.000

Figure 3.2: Volume estimates of data asset in Pakistan (PKR in billion)



Source: PBS Compilation

Results and compilation limitations

As shown in Figure 3.2, the different price indexes produce broadly similar growth rates in volume terms regardless of the specific price index being applied when viewed over a 5 – 10 year period however in specific years (2016-17, 2022-23) large divergences are observed between the price change in IT salaries compared to IT equipment. This flows through into different growth rates for the volume estimate of data.

These results are still in their preliminary stage of development as information on IT salaries is not regularly compiled and published, meaning that additional assumptions are required for certain years. Additionally PBS has not made any quality based adjustments to the price indexes due to limited data in this area being able to guide decisions on this subject. Despite these limitations, important first steps have been made using the data already available.

Annex 3.2: summary of recommendations

Subject	Overall Recommendation for deflating data	Default	Aspirational
Price index used	Any price index used to deflate nominal estimates of data reflects the price change observed in both the labour and non-labour costs involved in data production as well as appropriately accounting for the technological and quality improvements that have been observed in the production of digital products over the past several years.	Chain volume estimates of data are compiled using an output price index based on an alternative but similar product. The Implicit Price Deflator (IPD) associated with own account capital formation of computer software, research and development or broader IPP category, and taken from the compilation of the Supply-Use tables is considered an appropriate default option.	Chain volume estimates of data output, are compiled using a 'pseudo' output price index. This can be created by aggregating appropriate input price indexes and weighted to reflect the actual input costs included in the sum of cost calculation. An adjustment to reflect quality and productivity improvements made to the final output would be added to transform the input price index into a pseudo-output price index.
Quality adjustment applied to price index			The handbook recommends including an aggregate adjustment based on one of the aforementioned methods to reflect quality and productivity improvements made to the final output. The calculated difference in growth between the input price index for data and the output price index for a similarly produced product where market prices are available. The growth between the calculated difference in Input price and output price index for similarly produced products where market prices are available. The total factor productivity estimates for industries that contain a large amount of the occupation identified as data producers.
Additional considerations			

	While the introduction of a quality adjustment on top of an input price index is conceptually appropriate and would improve the accuracy of the final estimate. It is accepted that countries will continue to adhere to other frameworks and standards that oversee the compilation of their national accounts.
	Volume estimates of data should not be compiled via an unadjusted input price index.
	The use of a direct volume measure within the National Accounts is deemed inappropriate due to the heterogeneous nature of data as well as the volatility and treatment of prices applying in different markets.
	NSA's should be transparent and consistent regarding any adjustment made to the price index to account for quality and productivity improvements.

Chapter 4 – Creating Capital Stock estimates.

Introduction

4.1 So far, this handbook has focussed on compiling the economic flow of data, that is, the production of data, which usually manifests itself as investment in data, or gross fixed capital formation (GFCF) to use the SNA parlance. These estimates contribute to the compilation of an accurate estimate of GDP, however due to the linkages that exist between the capital services that are an input into production and the subsequent income derived from this production, the SNA expands beyond the production and income account to also include a capital account, other changes in assets account, and balance sheet. The links between the accounts demonstrate the fundamental relationship between the stock of assets and income derived from the economy. As such, an awareness of how much capital stock is available to an economy is a key indicator for forecasting future production and thus income.

4.2 This chapter will discuss the transformation of estimates of data output and data investment into an estimate of the capital stock of data. This estimate along with estimates of depreciation[31] are usually compiled through the Perpetual Inventory Method (PIM).

Background and guidance on the PIM and compiling capital stock

4.3 The SNA in its discussion on the compilation of balance sheets includes several key requirements for compiling estimates of capital stock and depreciation of fixed capital. Primarily that "depreciation *must be valued with reference to the same overall set of current prices as that used to value output and intermediate consumption*" (2025 SNA §7.272). In simple terms this suggests that the same prices used to derive output (such as GFCF) should be considered when deriving estimates of depreciation.

4.4 The prices used by statistical offices to compile output are often different to those subsequently used to derive depreciation within corporate business accounting. Corporate accounts are usually compiled based on international corporate accounting standards which when combined with respective countries' taxation rules, create estimates that often have minimal linkages to the actual economic service being provided by the asset. Because of this, the SNA correctly points out that "depreciation as recorded in business accounts may not provide the right kind of information for the calculation of depreciation [in the SNSA]." (2025 SNA §7.273). Furthermore, since data has not yet been recognized as assets according to the current international accounting standards it is likely that NSA's would find it difficult to collect capital stock and depreciation information on data regardless of the established valuation differences.

4.5 In the SNA, estimates of capital stock should reflect the current market price of the asset, which is theoretically associated with its potential future income streams. However, since there is limited information on the market price of second-hand assets, the SNA promotes a more theoretical approach to determining the price of an asset as it ages (2025 SNA §7.274). The

[31] The 2025 SNA has altered the terminology for the amount recorded as declining of the value of an asset over a specific period. Previously this was referred to as Consumption of fixed capital, however the updated SNA now refers to this by the more mainstream terminology of depreciation. Conceptually there has been no change.

theoretical approach subsequently described includes capital stock estimates being "*built up from data on gross fixed capital formation in the past combined with estimates of the rates at which the efficiency of fixed assets declines over their service lives' (2025 SNA §7.273)*. This Perpetual Inventory Method (PIM) has now become the default method used by statistical agencies to estimate the level of capital stock and depreciation in the economy.

4.6 A simple diagram representing the PIM is provided in Figure 4.1. This shows the inputs and processes required to calculate estimates of capital stock and depreciation. The inputs into the calculation of capital stock using the PIM are a mixture of compiled outputs (GFCF) as well as assumed parameters. The OECD manual on measuring capital (OECD, 2009) covers these inputs in great detail but a summary is provided below.

4.7 The primary input into the PIM is.

- Gross fixed capital formation time series: The level of new investment in the asset occurring each period. This is the output created in the first 3 chapters of the handbook.

4.8 The next four points are assumed parameters required to compile the PIM outputs.

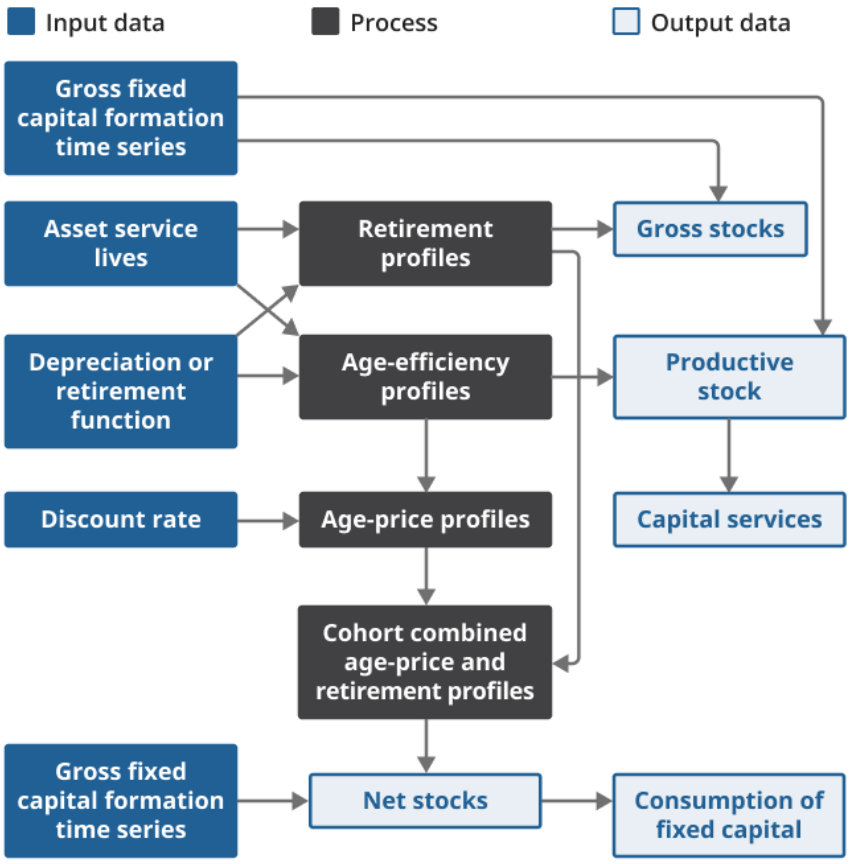
I. Average service lives – An estimate of the average length of time that the asset is retained in production.
II. Retirement profile – an estimate of the level of "retirements" or "discards" each period, which is the number of assets removed from the capital stock each year[32].
III. Age – efficiency profile: The age-efficiency function of a single asset reflects losses in productive efficiency due to wear and tear.
IV. Age – price profile: The age-profile represents the price of a capital good with regard to its age. The age-price profile compares identical capital goods of different age at the same point in time. Typically, this is a declining value, which due to an absence of source data, is often associated with the long-term government bond rate.

4.9 These first two points are combined to provide a retirement function, representing an estimate of how much of the initial cohort of assets are still in productive use. The next two points are combined to create a depreciation profile providing an estimate of the current value of a single asset each period which is usually expressed as percentage of the value of a new asset.

4.10 The combination of the depreciation profile and the retirement function allows for an estimate of the remaining value of the initial investment based on how many of the assets are still in service and the level of productive services coming from those still in service. This amount is supplemented each year with new investment in the form of gross fixed capital formation, resulting in an ongoing (*or perpetual*) inventory of capital stock.

Figure 4.1: simplified diagram of Perpetual Inventory Method (PIM)

[32] This does not include disposals of non-financial assets to other enterprises or sectors as these are recorded as transactions in nonfinancial assets within the capital account.



Source: (ONS, 2022)

4.11 This handbook will not cover the specific concepts and practical implementation of each PIM input as this is a considerably detailed and technical endeavour. Furthermore, existing works such as the OECD manual on measuring capital (OECD, 2009) are already in place that cover these topics at length.

4.12 In addition, since the PIM is used by the vast majority of NSA's, including being the required method of countries that adhere to the European System of Accounts (European Commision , 2010), it is seen as redundant to discuss the generic concepts beyond the simple summary provided. Rather this chapter focusses on the specific assumptions that NSA's will make within the PIM when calculating depreciation and capital stock estimates of data.

Extending countries current approach to PIM parameters to Data assets.

Default recommendation**: Countries should apply the same parameters in the compilation of depreciation and net capital stock of data as applied currently to other IPPs.**

Aspirational recommendation: **Countries should aspire to continually collect additional information on different assumptions and parameters to refine and improve the estimates of depreciation and capital stock being compiled**

4.13 Focusing on the four 'ingredients' that make up the assumptions used in the PIM (Age-efficiency profile, age-price profile, average service life and retirement profile) it is unlikely that

any two countries apply exactly the same assumptions for any single asset. That said, there is a lot of similarities between countries for some assumptions, while others show only slight differences.

4.14 For example, while not absolute, many NSA's apply some version of a bell-shaped retirement profile for a majority of assets. Additionally, many NSA's use similar assumptions regarding the discount rate used to represent the age-price profile, while the age-efficiency profile is usually one of three; hyperbolic, linear, or geometric. Importantly, since retirement functions and the PIM are compiled for a cohort of assets rather than a single one, the final rate of depreciation, which combines the retirement and depreciation function together often resemble a geometric pattern (OECD, 2009), resulting in more conformity between countries, even if slight difference between inputs exist. As such it is the average asset life applied to each asset that usually makes the most significant difference to capital stock values. A view that has been reaffirmed by recent testing of data capital stock compilation, using experimental data GFCF estimates (See Box 4.1).

4.15 Fundamentally, the PIM involves certain assumptions for which empirical evidence is difficult to find. Information on the parameters used for the compilation of data are equally difficult to find. The OECD manual on measuring capital recommends various approaches for obtaining information on asset lives and other parameters, this includes those prescribed by tax authorities, company accounts, statistical surveys, administrative records, expert advice, and other countries' estimates (OECD, 2009). However, not all of these are applicable for data. For example, currently no government or international accounting standard recognises data as an asset for which depreciation can be claimed to reduce a tax liability, therefore immediately ruling out several potential sources.

4.16 In the absence of new available source data, NSA's can look to apply the same parameters as already used for other assets. This is useful as recommendation regarding the PIM should not only promote consistency across countries but also, unless clear evidence suggest otherwise, consistency with the parameters used for other assets.

4.17 This is not to say the depreciation of data is the same as a dwelling or motor vehicle, they certainly are not in terms of length of service or retirement profiles. However, for the more general, theoretical assumptions covering the age-efficiency and age-price profiles, there is value for both compilers and users in being consistent across different asset classes. In fact, as alluded to previously, due to the absence of data, many NSA's are already holding these two parameters (age-efficiency and age-price profiles) constant within the PIM regardless of the asset being measured (Eurostat, 2024). Even for retirement profiles, the Eurostat report noted that "Only one country uses more than one [type of] retirement profile for the various assets" (Eurostat, 2024) implying that for most NSA's the same retirement pattern is used regardless of the asset type retiring. Overall, it clear that in a vast majority of countries, for the compilation of depreciation and capital stock NSA's hold most assumptions constant across different asset.

4.18 A similar approach has been undertaken in the already compiled experimental estimates of depreciation and capital stock of data. In many cases the average service life for the asset was the only parameter which countries considered changing, preferring to maintain consistency with other assets in the application of age-price, age-efficiency, and retirement profiles rather than trying to determine what was suitable specifically for data.

4.19 Overall, the PIM is the standard approach to compiling estimates of depreciation and capital stock estimates across countries. While there are some differences across countries in the parameters used[33], on most occasions NSA's apply a consistent age-price, age-efficiency, and retirement profiles regardless of the asset, with only the average service lives changing across assets (Eurostat, 2024). Although on some occasions, there does appear to be some alternate parameters used in the compilation of depreciation and capital stock of IPP when compared to other fixed assets.

4.20 As such, in the absence of empirical evidence suggesting otherwise i**t is therefore recommended that except for average service lives, a default starting position for NSA's is to apply the same parameters in the compilation of depreciation and net capital stock of data as applied currently to other IPPs.**

Box 4.1: Recent testing of different parameters when compiling the capital stock of data in Germany

As part of the research and testing of a proposed data measurement methodology, the Federal Statistical Office of Germany (FSO) produced estimates of depreciation and net capital stock for data under several different scenarios. This was undertaken using an experimental set of data investment, compiled via the sum of cost methodology recommended by this handbook.

This work specifically tested different age-efficiency profiles and different average asset lives. Conversely, the bell-shaped density function of the gamma distribution used for the retirement profile and the initial age-price profile were kept consistent. Both were in line with the depreciation and capital stock calculated for other assets within the German wealth accounts.

Three different age-efficiency profiles were tested: linear, and two different geometric curves, one with a declining balance rate of 2 and another with a declining balance rate of 1.65. From a service life perspective, averages service lives of of 2, 5 and 10 years were tested.

The results show that the choice of retirement and depreciation functions have only a minor impact of the final estimate, while the assumed average service life has the biggest impact on results. For example, the estimate of depreciation for all three depreciation approaches are similar in size and while the difference between the three are larger for net capital stock, these are minor compared to the increases observed in net capital stock that comes with the increasing length of service life. To this point, the FSO specifically advocated for a default agreement on the average service life to be applied as this would provide the most significant benefit in attempting to achieve consistency in methodology across countries.

Estimating average asset lives of data.

Default recommendation**: In the absence of other information, countries should apply a default average service life of 5 years for data assets.**

[33] For example, the report from the Task Force on fixed assets and estimation of consumption of fixed capital under European System of Accounts 2010 showed that across EU countries, there are at least 10 different retirement functions currently in use (Lognormal, Normal, Weibull, Truncated-normal, Quasi-logistic, Gamma, Linear, Delayed linear, Simultaneous Exit, Geometric).

Aspirational recommendation: **Countries should aspire to break up the estimate of data investment by industry in order to allow for different service lives to be applied based on the industry producing the data.**

4.21 As explained, of the various parameters, the average service life has the largest impact on the final estimate of depreciation and capital stock. Therefore, several countries have attempted to obtain information on the service life of data. This included Japan, who used the special internet survey to ask firms on how long they intended to use the data asset in production. While the results of the survey would need to be supported with more data, the initial results seem to support the average service life survey proposed in this handbook. More information on the survey included the preliminary results are shown in Annex 4.2.

4.22 Countries' efforts to obtain information on this is vital, as due to the almost unfathomable range of data being collected, trying to estimate how long the *average* piece of data is used in production for is a near impossible. There is countless anecdotal evidence of collected data being useful for only a few minutes or days. Conversely, most people have provided information to both private and public organizations that have been used by the organization for years. Organizations will frequently make business and production decisions based on data collected over an extended period of time. While the production of artificial intelligence, including the data sets required to train large language models provides another avenue for certain types of data to be used in production repeatedly.

4.23 The acknowledgement that some data is kept for a long time for a specific purpose, need not be dealt with by increasing the average service life but potentially with a change in the retirement profile applied. Within the task team, it was discussed the possibility that data does not follow a symmetrical bell-shaped retirement profile. It was theorised that a small amount of data collected is likely used for a *very* long time (i.e., static personal information, or production data points that contribute to a time series) which is then offset by a large amount of data collected which is ultimately used for less than the average service life (preferential or variable information with a clear point in time where it becomes obsolete). While there is not empirical evidence supporting this theory, if proven accurate, it would suggest that a traditional bell-shaped retirement profile with a maximum age as double the average age is not suitable for data. Rather a positively skewed bell with an exceptionally long "tail" might better reflect a cohort of data investment.

4.24 In the absence of empirical evidence to support this theory, the task team acknowledged that compilers and users' preference is likely to maintain a connection with the estimation of depreciation and capital stock of other fixed assets rather than applying stand alone experimental assumptions. That said, **NSA's should aspire to continually collect additional information on the average length of time that data is used in production as well as testing different assumptions and parameters to refine and improve the estimates of depreciation and capital stock being compiled.**

4.25 Due to the absence of empirical evidence suggesting otherwise, most countries in their initial estimates of data decided to implement an average service life similar to other IPP such as

computer software. This is seen in table 4.1 which lists the average service life applied for data in a range of countries.

Table 4.1: Average service life applied in preliminary estimates of capital stock and depreciation of Data.

Country	Asset life applied
Australia	Average 3 years (max 5 years)
Canada	7 years
Germany	2 / 5 years
USA	5 years

Source : (Smedes, Nguyen, & Tenburren, 2022) (Amegble, Bugge, & Sinclair, 2023) (Calderón & Rassier, 2022)

4.26 Overall, it is recommended that **in the absence of other information, NSA's apply a default average service life of 5 years for data assets.** Such a recommendation takes into consideration feedback from the task team, the small amount of empirical information available as well as a desire to maintain some consistency with the compilation of depreciation and capital stock estimates of other assets (especially IPP).

4.27 If relevant source data is made available, suggesting a longer or shorter service life, countries should look to implement a revised average service life. Furthermore, if dictated by the source data, **NSA's should aspire to break up the estimate of data investment by industry to apply more nuance to the estimate by allowing for different service lives to be applied based on the industry producing the data** (See Box 4.2)

Box 4.2: Creating more detailed asset cohorts to improve data outputs from the PIM.

The PIM calculates depreciation and capital stock estimates for all assets used in the economy, however it is not feasible to measure the depreciation and capital value of each asset individually. Rather, the PIM groups together cohorts of assets based on their characteristics and use in production. Therefore, GFCF is grouped together and placed into the PIM in cohorts, representing a set of similar kind assets, which have entered production at the same time.

There are no set rules regarding the size or make up of these cohorts, theoretically, the more cohorts there are the more accurate the outputs of the PIM should be. The methodology of the PIM lends itself to cohorts being made up of assets with similar expected service lives. In some case this means that two identical assets may be placed into different cohorts if they are used differently in production. For example, in Italian national accounts, a building or industrial structure in the mining and quarrying industry is expected to have an average life of 35 years, considerably less than the building or industrial structure used within the wholesale and retail trade industry which is expected to be used in production for 65 years (OECD, 2009). In practice due to the source data and methodologies that exist in most countries, this means that cohorts are usually broken up by the type of asset that they are (transport equipment, machinery, dwellings, buildings) and by the industry in which they operate.

On occasions, countries have decided to break down assets even further than what is typically published in the break down of expenditure on GFCF. An example of this is dwellings. While some countries will simply include all residential property into a single cohort, some countries will break it down further based on material or dwelling type. In the United States, the BEA applies different average service lives to the following categories, all of which contribute to a single dwelling GFCF number (OECD, 2009).

- 1-to-4-unit structures–new
- 1-to-4-unit structures–additions and alterations
- 1-to-4-unit structures–major replacements
- 5-or-more-unit structures– new
- 5-or-more-unit structures–additions and alterations
- 5-or-more-unit structures–major replacements
- Manufactured homes

Similarly, the Australian Bureau of Statistics breaks up its dwelling investment number into the following categories, each with a different average service life but while maintaining the other parameters (ABS, 2021).

- Private brick homes
- Private timber, fibro, and other houses
- Private non-house dwellings (units, flats, etc.)
- Private alterations and additions
- Public

Since it is considered that each category has a slightly different asset life, it is seen as advantageous to try and separate them and apply a separate asset life in the calculation. Alternatively, countries can attempt to apply an average life to the total that covers the different composition of the diverse types of assets.

Data assets could potentially benefit from a similar more detailed breakup. It is well established that some data will be used repeatedly for many years while other data may be more time sensitive, either because the information it contains is constantly being updated or because more detailed data has become available. The way that differing types of data is collected by different industries would suggest that they are likely to be used for differing lengths of time. Certain industries leverage time sensitive and continually changing data, such as consumer preferences, location dynamics etc. Conversely, other industries tend to rely on the collection of data that remains unchanged or that gets modified only sporadically over the course of a lifetime. As such these two distinct types of data may necessitate two different service lives.

Such an additional break up for data is conceptually possible and would likely create a more accurate estimate. There already exists numerous typologies of data, however none that have become internationally authoritative. Furthermore, since the depreciation of data represents obsolescence rather than physical wear and tear, the “type” of data matters less compared to the information that the data holds, information which is likely highly dependent on the industry creating the data. Finally, since an industry split of data investment is likely already being compiled as part of the overall industry estimates of GFCF, it is likely that these input series are already being produced by countries. Due to this a breakdown based on industry that is producing the data would appear an attractive and obtainable option for deconstructing data to a more granular level to improve the accuracy of depreciation and capital stock estimates.

Annex 4.1:Capital stock estimates of data asset: Case of Pakistan

Pakistan Bureau of Statistics (PBS) has compiled capital stock estimates of data asset using the Perpetual Inventory Method (PIM) following linear and geometric models. While the application of linear model requires fewer assumption i.e. nominal and volume estimates of data asset, asset life, price indices, the application of geometric model require additional assumptions i.e. retirement pattern (cut-off values), age-efficiency and age-profiles of assets. PBS has valued the capital stock of data asset at prices of base year i.e. 2015-16, the reference year of national accounts. PBS has also used capital stock estimates of data asset to derive estimates of consumption of fixed capital (CFC) under both linear and geometric methods.

Assumptions

Both CFC and capital stock have been estimated at constant prices of 2015-16. The nominal estimates have been derived by using weighted index for data asset assuming 40% weight for salary index and 60% for equipment index, while applying a service life of 5 years.

A simplified form of geometric model has been used as given below:

$$X \times p^L = X \times C$$
$$p^L = C$$
$$p = C^{1/L}$$

where

X = Gross Fixed Capital Formation at constant prices of the base year

p = geometric parameter (0<p<1)

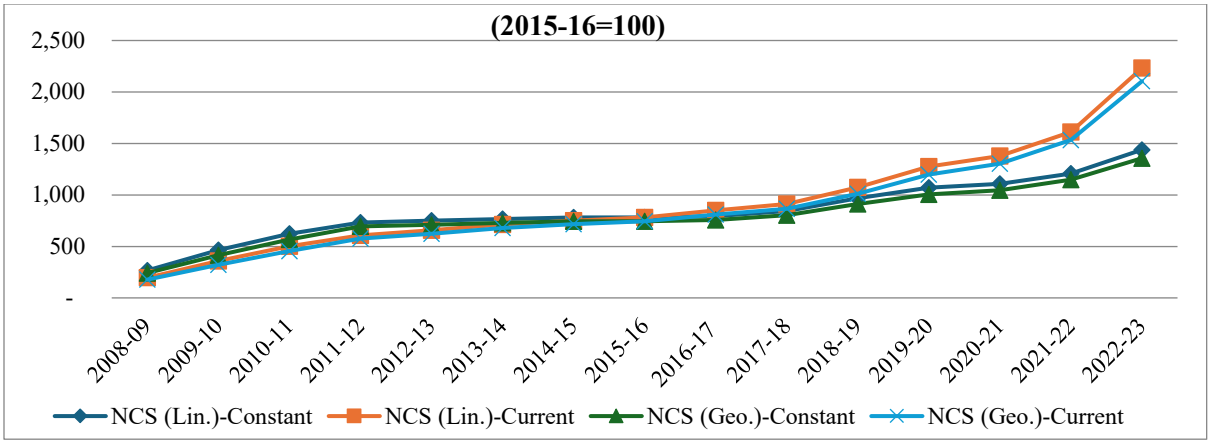
L = service life

C = Cut-off point (Residual value), 0<C<1, e.g. if 15 %, C = 0.15)

The exact cut-off-point of data asset was not known. Therefore, a sensitivity analysis for geometric estimates of data asset has been conducted for three values i.e. 10%, 15% and 20%. Stock of data asset has been valued at the prices of base year of national accounts of Pakistan i.e. 2015-16

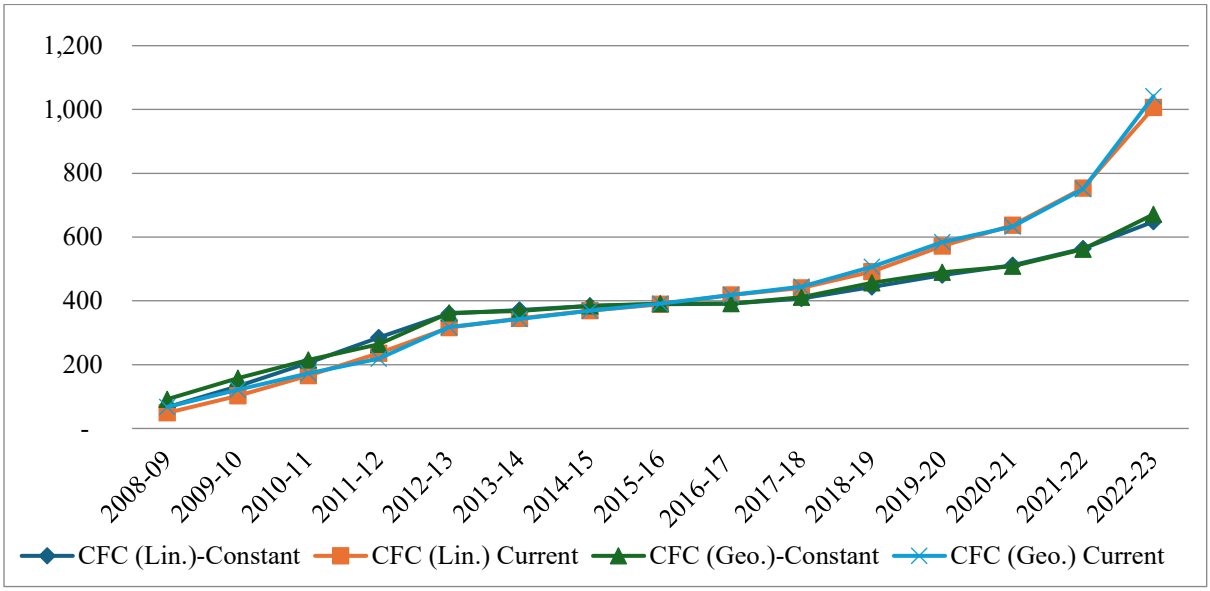
The estimates of net capital stock at current and constant prices under linear and geometric models are presented in Figure 4.2.

Figure 4.2: Estimates of net capital stock of data asset in Pakistan (PKR in billion)



The estimates of CFC at current and constant prices under linear and geometric models are presented in Figure 4.3.

Figure 4.3: Estimates of CFC of data asset in Pakistan (PKR in billion) (2015-16=100)



Results of the testing show that estimates of both capital stock and CFC remain similar regardless of the is the linear or geometric models are used. Further confirming that the choice of service life remains the most impactful assumption of those made when using a PIM. Since there is an absence of information on the service life of data in Pakistan, the 5 year service life was applied, similar to the service life used for other IPP. Similarly no new information on other assumptions required (retirement distribution) on data is available so the same assumptions as used in other IPP capital stock compilation have been used.

Annex 4.2: Obtaining information on asset life via surveys: the experience in Japan

In 2022 and 2023 the Economic and Social Research Institute (ESRI) within the Japanese Cabinet Office undertook surveys of individuals focussed on their production of data in their employment. Questions were asked regarding the type of data they produce and the amount of time spent producing data, this information is extremely useful for assumptions dealing with the compilation of a nominal estimate of data output. In addition, the survey also asked responders to estimate how long the data they produced was used by the company or organisation.

Specifically the respondent was offered the following choices in order to estimate the "usage period" for the data they produced, there are presented along with the percentage of respondents who answered that option.

Total		
1	Most usage periods are 1 year or more but less than 3 years	35.9%
2	Most usage periods are 3 year or more but less than 5 years	20.4%
3	Most usage periods are 5 year or more but less than 7 years	8.7%
4	Most usage periods are 7 year or more but less than 10 years	7.2%
5	Most usage periods are 10 year or more but less than 15 years	5.0%
6	Most usage periods are 15 year or more	13.5%
7	Don't know	9.4%

This question followed one under taken in the previous years survey were respondents could choose simply between producing data that was used for less than or more than 1 year. When these two information points are combined, an average asset life of data was able to be estimated. Both for all data produced as well as an average life of data only expected to be used for more than one year, that is data considered data assets. The results were

Type of data	Average service life
For all data output	3.63
For data output expected to be used for more than 1 year	7.05

While the survey sample size was relatively large, there is a few caveats attached to this work beyond the standard statistical noise. As may be expected when obtaining information on a new subject, the respondents interpretation of the question and subsequent answer may be quite subjective or based on imperfect knowledge that a respondent might have about how their company or organisation manages and uses the data.

Despite this, in an area where source data is severely lacking, this information is extremely useful. For instance at first glance it seems to support the theory that while a majority of data is used relatively soon, the decline is not linear and there is a non trivial amount that is kept for a long time, in other words the retirement profile is not evenly distributed and likely to have a long tail, both of which a different to the retirement profile normally used in the PIM.

Annex 4.3:Summary of recommendations

Subject	Default	Aspirational
Parameters used in PIM (Excluding Average service life)	Countries should apply similar parameters in the compilation of depreciation and net capital stock of data as applied currently to other IPPs.	Countries should aspire to continually collect additional information on different assumptions and parameters to refine and improve the estimates of depreciation and capital stock being compiled
Average service life	In the absence of other information, countries should apply a default average service life of 5 years for data assets	Countries should aspire to break up the estimate of data investment by industry in order to allow for different service lives to be applied based on the industry producing the data

Chapter 5 Incorporating estimates of data production into existing national account outputs, including backcasting.

Introduction

5.1 This chapter discusses additional compilation aspects not addressed in the previous chapters 1-4. This includes the presentation of data within the accounts, back casting estimates of data output and investment, and a further clarification on the conceptual split between data and other assets.

5.2 Several items in this chapter discuss how estimates of data production and investment are incorporated into the existing national account statistical outputs. While perhaps not scrutinised as much as the compilation of the estimate itself, countries should carefully consider how this is done and be pro-active in explaining it to users.

5.3 The introduction of data into a countries national accounts output reflects the altering of the production boundary in the System of National Accounts (SNA), which is just one of many changes being introduced in the revised version of the 2025 System of National Accounts (2025 SNA). Therefore, while the introduction of data into a country's official economic statistics will likely be done at the same time as other changes brought on by the revised SNA, the revisions, and changes to headline indicators due to the introduction of data should not be concealed amongst other changes. On the contrary, countries should be transparent regarding both the compilation of the estimates of data production and their impacts (regardless of the size) on national account aggregates such as total Intellectual property products, total gross fixed capital formation (GFCF), and Gross domestic product (GDP).

5.4 Official economic statistics are vitally important and changes to them need to be done appropriately to maintain their value as a significant knowledge asset. The trade-off between the options discussed in this chapter regarding how estimates of data are disseminated and back casted needs to be managed carefully to maintain the trust that users have in the set of accounts. Doing so will ensure that the value of the statistical output to the community at large is conserved.

Reporting of data within the national accounts

5.5 From a production point of view, it has already been established that data can be produced by all industries and sectors within the economy. Therefore, estimates of data output should simply be incorporated into existing output series within the SNA production and income accounts. There will be no specific series identifying data within these tables as the tables are usually presented on an aggregate industry or sector basis.

5.6 When the output of data is capitalised (as will often be the case) data will be separately identifiable within the SNA capital account[34]. As noted in the 2025 SNA, "despite their

[34] Countries will disseminate GFCF from many different perspectives. By industry, by asset by sector, or even a combination of both. It is not expected that data will be reported any differently from the manner which existing assets are reported.

conceptual difference, *data and databases are difficult to measure separately because they are produced with similar inputs and because transaction prices generally reflect the combined value of the database and the data. Therefore, it is recommended that data and databases are combined and reported in a specific single detailed intellectual property (IP) product called data and databases."(2025 SNA § 11.115)*

5.7 This handbook advocates this approach, meaning that any published series would incorporate values associated with the production of data covered in this handbook and capitalised for the first time as a produced asset, alongside the existing values associated with the production of databases already recorded as a produced asset and published in an existing series (most likely with computer software).

5.8 The 2025 SNA further suggests that this detailed product is then combined with "software including artificial intelligence to form a higher-level class of IP product" *."(2025 SNA § 22.25)*. This statement should be viewed as a suggestion, as the actual dissemination and reporting of asset classes is a decision for each NSA based on data availability, user demand or any reporting requirements that they are aligned to, such as transmission to an international organization.

5.9 While undeniably intertwined and often used in correlation, 'software' undertakes many tasks and roles beyond creating data, likewise a single software asset can be used repeatedly in the production of multiple data assets. Additionally, data and computer software exhibit many distinct characteristics, in both the way they are produced and used. As has been discussed in previous chapters, it is these types of characteristics that determine some of the assumptions and methodology used for deflating and depreciating nominal estimates of IPP. If different assets are exhibiting distinct characteristics, ideally compilation should be undertaken separately to improve the accuracy of the final estimate. The accuracy of chain volume and capital stock estimates of data and databases investment will be improved if the nominal estimates are separated from computer software. Likewise, decisions on the compilation of capital stock and chain volume estimates of software will benefit from not needing to take into consideration the life cycle and input costs of data and databases.

5.10 From a user perspective, or when considering the extended time series of both assets, the evolution of investment in software and data are likely to deviate at certain points reflecting the various innovations at specific points in time. The benefits and use of software in production were established significantly earlier than the incorporation of data as a fundamental input into production. By delineating the two series, the rise of each asset can be better observed from a user perspective while also helping to alleviate concerns regarding double counting or missing values (See Box 5.1).

5.11 Therefore, for this handbook, **the default recommendation is that for the purposes of the SNA capital accounts, investments (GFCF) in data and databases should be reported separately from computer software.** This is strongly recommended so that the conceptual changes introduced into the 2025 SNA can be fully realised and observed by users. This is in regard to noth data and databases but also the estimate of software which will now contain a greater focus on software associated with artificial intelligence. If such a deviation is simply not possible **then a less desirable fall back proposition is to publish estimates of data and database GFCF alongside computer software in a combined higher-level category of IP.**

While the dissemination of data and databases together with computer software as a single asset category may be considered a preliminary step in the publication of data output, NSA's should strive to separate the two types of output as soon as practically possible.

Box 5.1: Separating Computer Software, Data and Databases, when reporting Gross Fixed Capital Formation

Data in the SNA refers solely to digital data. This results in almost all (currently produced) data being constructed in unison with software and subsequently stored on a database. At face value this makes the three asset categories are inextricably intertwined.

The small but clear difference between data and databases is best represented in Figure 1.1 shown in chapter 1. This outlines that the production of data focuses on the act of accessing and digitally recording information elements of observable phenomena. Conversely, the production of databases focuses on the act of organizing this data into a structured format, making it possible to analyse, draw conclusions and use in the production of other goods and services.

The obvious link between data and databases is explicitly noted in the SNA that states that *"Despite their conceptual difference, data and databases are difficult to measure separately because they are produced with similar inputs and because transactions prices generally reflect the combined value of the database and the data. For reporting purposes, data and databases are therefore combined into a single detailed intellectual property (IP) product called data and databases"* (2025 SNA §11.115). This passage outlines the fundamental relationship between data and databases in the SNA. That while they do represent two distinct assets, they will most likely always be measured and reported as a single item.

The SNA also acknowledges the link between software and databases by noting that "*a computerized database, including the relevant data, cannot be developed independently of a database management system (DBMS), which is itself computer software"* (2025 SNA §11.111). However, the SNA still advocates that the expenditure on the two distinct assets should be separated if possible, suggesting that the cost of the database management system (DBMS) used should *"not be included in the costs of creating a database, but be treated as a computer software asset."* (2025 SNA §11.116) In this way the SNA is outlining an aspirational goal of separately identifying the expenditure on the different assets, in line with their conceptual differences, while acknowledging that this may not always be achievable.

This convergence of multiple assets becoming more intertwined leading to the production of multiple outputs has become more common in recent times, such as when software is added to vehicles and machinery. Likewise, from the perspective of data, the development of new production tools, such as online platforms and applications, which while usually developed to assist with other facets of production, are also designed with data production very much in mind.

For example, social media, online commerce and on-demand service platforms very rarely derive revenue directly from selling data, however the data that these applications and platforms capture is fundamental to their owners' overall production strategy, and in fact their ability to harvest data from their software can often provide a competitive advantage regardless of the underlying service being offered. At face value this would then appear that the development of these platforms and

applications is an extension of the production of data and should be included in the value of the asset. This is not the case for the SNA.

Despite the consideration on data capturing when developing the platforms, the platforms are first and foremost a computer program and from an SNA perspective any expenditure on their production should be considered the production of computer software rather than data. Therefore**, even if the software is integral to the production of data (which in many cases it is), this does not mean expenditure on it should be considered GFCF of data asset**. Many other assets are involved in the production of data (computer hardware, sensor equipment, etc.) however from the SNA perspective, these are individual capital assets used as an input into the production of another asset (Data).

In much the same way, cranes, cement trucks and construction equipment are all used to construct a high-rise building. Although the building could not have been produced without these inputs, and certain construction equipment cannot be used for anything other than constructing a building it is not suggested that the value of these should be added to the value of the building. Rather when measured via the sum of cost, a value associated with using these capital assets (depreciation) is included, but the overall value of the input remains separate from the final output.

Such an approach should be followed for measuring data. Ideally, countries would be able to separate the expenditure on producing data and databases from the expenditure on the assets used to produce data including expenditure on software. Doing so would allow for a more accurate recording of the evolution of the data economy, whereby to produce data assets to use as an input into their production, companies and organization must initially invest in other assets, which in turn allow for the production of data to occur. Separately reporting these different assets will provide users with the tools to better understand this evolution.

Backcasting

The need for backcasting.

5.12 Chapters 1-4 have focussed on producing an estimate of data output and data investment in both current price and chain volume terms. These have covered both the flow of data investment and the capital stock of data assets; however, they have focused on producing an estimate for the current period only.

5.13 While most users will have upmost interest in the most recent period, the movement observed in the current period or current business cycle must be presented within the context of a full time series. Those responsible for forecasting the economy or to evaluate any appropriate policy reactions are dependent on the use of long time series to estimate and project the dynamics of the economy. As such, most NSA's have national account outputs that extend back many years. Therefore, for data to be appropriately incorporated into the System of National Account framework, estimates for an extended time series must be compiled.

5.14 The inputs and methodology described in previous chapters should allow NSO's to compile more than a single year's worth of estimates. However, it is unlikely that countries will have the required information for an extended period of time, or at least for the period of which digitalised

data was considered a productive asset in the economy. As such it is likely that some form of back casting will be required prior to officially publishing estimates.

How long should digital data be back cast for?

5.15 A fundamental requirement in the backcasting of any statistical output is a decision on how far back the series should go. Often when NSO's introduce a new concept or classification, it is agreed that the change should be observable for the entire time series. While it depends on the length of the existing series, conceptually from the perspective of the SNA, data may not have been produced for the duration of the entire time series. Although numerous examples exist of non-digital data being collected and organized to be a fundamental input into production throughout history[35], these do not meet the criteria of data used in the SNA. As outlined in chapter 1, from the perspective of the SNA, data refers to *"Information content that is produced by accessing and observing phenomena; recording, and storing information elements from these phenomena* ***in a digital format,*** *which provide an economic benefit when used in productive activities."* (2025 SNA 22.22) With this in mind, the output of this type of "SNA data" should certainly not predate the emergence of digitisation in the economy.

5.16 Using a strict interpretation of digitisation, there are clear examples of rudimentary digitisation assisting with economic production as far back as population census's in the 1890's (Columbia University, 2023; United States Census Bureau, 2023) and even simple digitalisation[36] within the 1950 airline industry (Sabre, 2024). However, these and other preliminary examples should generally be considered outliers and not representative of the level of data being produced by the economy at large. Rather the creation of systematic data, produced to provide an economic benefit, is generally considered a more recent phenomenon. Beginning first with data that business and organizations produced about themselves and their own business practices before turning their attention to producing data based on the (incredibly significant) increase in user generated information elements following the widespread take up of the internet and social media.

5.17 While it is broadly agreed that the take up in data production has been exponential, there is no clear agreement as to the specific point in time when digital data first began being regularly produced, and thus should be included as a sperate asset in the system of national accounts.

5.18 As such this handbook does not recommend a specific year when data should be back casted to. Rather this decision should be made on an individual basis based on the economy in question, user demands for the data, available information, as well as the existing start data for other comparable series, such as other IPP asset classes. However, to promote some form of consistency across countries, and **in the absence of additional information to the contrary, this handbook recommends incorporating a time series to at least the period covering 1985 – 1995.** It's considered that this would appropriately reflect the emergence of data production for a majority of countries.

[35] Examples include the formation of the first modern insurance fund in 1740's **Invalid source specified.** to the Feist publications court decision in 1991 **Invalid source specified.**

[36] As outlined by the OECD**Invalid source specified.**, Digitisation is the conversion of analogue data and processes into a machine-readable format. Digitalisation is the use of digital technologies and data as well as interconnection that results in new or changes to existing activities.

5.19 If length of the back series currently published begins after 1995, then it is likely that the back casting of data need not be reduced to zero and estimates of data production will exist for the entire time series. In this case, to accurately estimate the capital stock of the data within the economy using the PIM, estimates of GFCF will need to extend beyond those published. Put simply, if the service life of data is T and capital stocks need to be published from date t onwards, the corresponding GFCF series should start at date t-T (at least) (Eurostat, 2023).

Types of backcasting potentially suitable for estimates of data output and investment.

5.20 Several different methods are available for back casting national account outputs. The choice of which is most suitable will likely depend on the series being back casted, the availability of source data and how the back cast series interacts with other aggregates in the accounts. The methods listed below are included in the preliminary draft of the UN handbook on back casting (UNSD, 2018). They are not an exhaustive list but are those most likely to be used by compilers of data output and data GFCF.

5.21 **Bottom-up estimation**. This method refers to compiling a back casted series by building up source data components, in the same or similar method to what is done for the current period estimates, at least for periodic benchmark levels. Since it is somewhat a continuation of the method used for the current period, the bottom-up approaches usually produce the most robust results. However, bottom-up estimation is also the most data intensive, requiring the same or similar source data for the whole period required by the back casting.

5.22 **Retrapolation.** This approach uses growth rates from the currently compiled series to project backwards. There is no minimum or maximum number of periods required to determine the applied growth rate, however it would usually match the number of years for which information is available for. The overriding assumption of this method is that growth observed in the recent period is consistent with previous periods. As such, the implication is that the periods used to determine the back cast growth rate is representative of the growth rate for the entire series. Such an assumption can be misleading if the recent period picks up only one portion of the business cycle or the specific series is heavily impacted by innovation or structural changes in the economy which is likely for the production of data. However, retrapolation is arguably the easiest back casting methodology to implement as it requires no new data sources. Rather the already compiled growth rate is applied backwards to 'guide' the series to a previously decided upon point in time.

5.23 **Modelling the back series using a proxy indicator.** This method relies on the assumption that the relationship of an indicator or indicators to the estimate are stable over time and can be applied to the back period. Back casting using this method does not need to mean that movements in the newly compiled back series are identical to the proxy indicator. Rather the indicator can be used to "guide" the back series to a previously decided point in time or estimate, which may or may not be zero. Such a method has already been recommended for compiling data in the periods (both annual and quarterly) where the source data contributing to the sum of cost approach is unavailable (See chapter 2).

Applying back casting methods to data series.

5.24 In the case of data, it is likely that NSA's can use a mixture of the above methods, depending on the length of time series desired. Some of the fundamental data sources used in the compilation of data production such as average wage and number of workers in certain occupations likely have relatively long availability due to them often being sourced from population census data. As such, it's likely that the bottom-up approach is a viable solution for many NSA's, even if estimates are only produced for the years aligned with the population census.

5.25 An important consideration if applying the bottoms up approach is that the default occupations and involvement rates provided in chapter 2 are based for the compilation of data in the current period. They are based on current data production and likely do not reflect the occupations and involvement rates of data producers in historical periods. This is due to both the fundamental shift across the economy, whereby businesses and organizations are devoting more resources to the production of data but also due to the micro changes occurring at the occupational level. For example, data focused occupations such as 'Computer systems technicians' or 'Medical records and health information technicians' have likely always been involved in producing data. However, for other occupations, the production of data as a standard task within the job is a more recent phenomenon. This assumption is not only a logical conclusion based on the innovation of data over recent years, but also reflects the evidence obtained by the Japanese statistical office in their special internet survey which obtained some information on historical production of data (See Box 5.2).

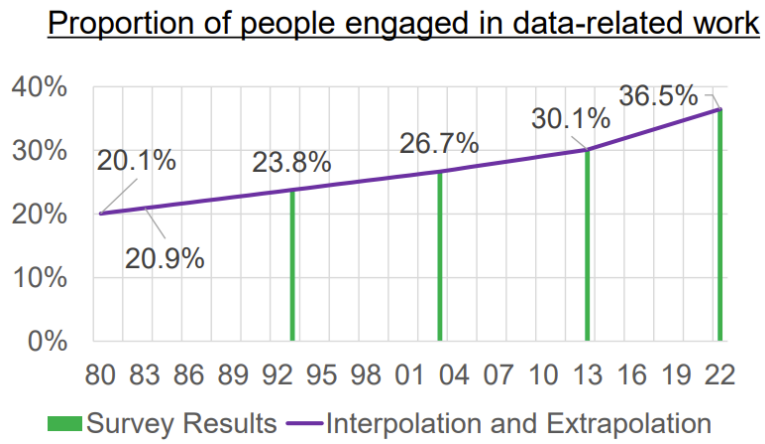
5.26 As such, **it is recommended that if the required data sources are available, NSA's should compile a back series via the bottom-up approach. However it is not recommended to replicate the current period compilation method exactly using earlier iterations of the same data source. Rather adjustments should be made to the chosen occupations and involvement rates over time to reflect the evolution of data production over the previous periods.**

5.27 If data is not available to build up an estimate in previous periods, then a default solution is the same as that recommended to populate quarterly and annual periods where data is not available (See chapter 2). That is, **the default recommendation is to populate the back series with an already available series that displays a correlation with the growth observed in the compiled annual estimates of data output and GFCF.** No specific proxy indicator is recommended as the choice will depend on data availability. Potential options include, 1) Renumeration of employees for data producing occupations, 2) Renumeration of employees for industries heavily involved in data production, or 3) GFCF on assets relating to data production, such as computer hardware and software. Importantly it is not recommended for the newly constructed series to mirror the indicator series exactly as the end points are likely different between the two. Rather a decision should be made as to when the production and GFCF of data should commence and the indicator series used to 'guide' the back series to this point.

Box 5.2: Japanese survey on historical data production.

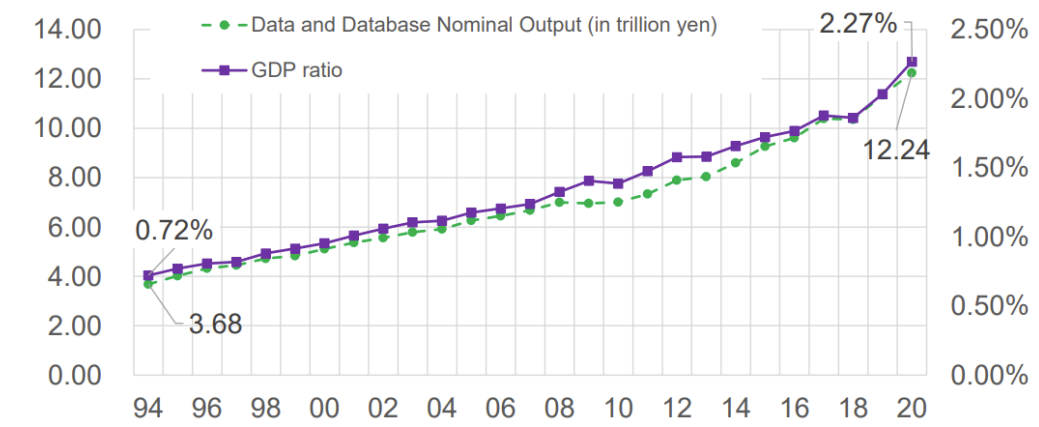
It is unusual for NSO's to use survey data to estimate back series within the national accounts. However, as part of their 'special internet survey' (Japanese Cabinet Office, 2024), the Economic and Social Research Institute (ESRI) within the Japanese Cabinet Office obtained information that would assist them to do exactly that. Based on a sample from a previous internet survey, respondents were asked to retrospectively provide information on the proportion of people and time engaged in data-related work in their past organizations. This was done for four time points; 1 year, 10 years, 20 years, and 30 years. Estimates for the years not covered by the survey were estimated via linear extrapolation between the obtained values.

The proportion of people involved in data production has increased over time, as might be expected. In 1980 around one fifth of people were involved in data production in some form. This increase to just above one third in 2022 (see figure below). Similarly, the proportion of their working day that these people spent on data production (a similar concept to the involvement rate used in this handbook) also increased over time.



Importantly, as well as asking about their role and time spent on data production, the survey also asked what methods were used to store and use the data created. In response to this question, a considerable number of respondents reported storing data on paper. Based on this, it was identified that a number of respondents had answered the question in relation to all data including the production of non-digital data, which is excluded from the SNA definition of data. Such a revelation allowed for an adjustment to be made to the back casting estimates to remove the production of non-digital data.

Based on the results from the survey, the Japanese cabinet office was able to compile a back series for data production in the Japanese economy which showed that data production grew from 0.7% of GDP in 1994 to 2.27% in 2022 (See below). This novel way of obtaining information on historical data production has not been further reviewed to determine its accuracy or comparability but provides an alternative solution to back casting estimates of data that can be independent of other IPP assets.



Source: (Japanese Cabinet Office, 2024)

Annex 5.1: Summary of recommendations for Incorporating estimates of data production into existing national account outputs.

Issue	Aspirational recommendation	Default recommendation	Additional considerations
Reporting of data in capital account		For the purposes of the SNA capital accounts, investments (GFCF) in data should be reported together with databases as a single IP product, but that this should be reported separately from computer software.	If data and databases are unable to be separated a final least desirable option is to publish estimates of data and database GFCF alongside computer software.
Backcasting – length of series		In the absence of additional information to the contrary, this handbook recommends incorporating a time series to at least the period covering 1985 – 1995.	If the back series for currently published IPP estimates does not extend to 1995, then data should be back cast until the beginning of published estimates
Backcasting – choice of methodoloy	If the required data sources are available, NSA's should compile a back series via the bottom-up approach.	The default recommended is to populate the back series with an already available series that displays a correlation with the growth observed in the compiled annual estimates of data output and GFCF.	It is not recommended to replicate the current period compilation method exactly using earlier iterations of the same data source. Rather adjustments should be made to the chosen occupations and involvement rates over time to reflect the evolution of data production over the previous periods.

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