Quality checks for SNAC Exiobase 2016

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Monitoring and Evaluation Circular Economy

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1. Introduction

Exiobase (Stadler et al., 2019) is a Multi-Regional Input Output database (MRIO) which contains data describing the global economy. This data is useful for many purposes, such as the calculation of footprints. However, the data for specific countries deviates from the data within the national accounts of those countries. This problem is particularly pronounced for the Netherlands due to its complicated trade relationships (Edens et al. 2015). Accordingly, Statistics Netherlands harmonises Exiobase with the Dutch National Accounts and Dutch trade data. This improves the quality of the data, which means that, for example, the footprint results are of higher quality. The harmonised version of Exiobase is referred to forthwith as SNAC Exiobase (Single-country National Accounts Consistent).

Previously, Statistics Netherlands has harmonised Exiobase 2010 and Exiobase 2014. As part of the current work programme, Statistics Netherlands has harmonised Exiobase 2016. The intention is to use this data to calculate footprints[1] for the first Integrated Circular Economy Report (ICER), to be published in 2020.

There are however concerns regarding the quality of Exiobase. Exiobase 2016 is a "now-cast" which means that part of the data is extrapolated based on incomplete information. Further, Exiobase 2016 is now-casted from the base year of 2010, meaning that the extrapolation is stretched over many years. While significant improvements are made by harmonising Exiobase, the quality of the data for other countries will affect the quality of the footprint results. Shortcomings of the data concerning countries from which the Netherlands imports many goods, such as, for example, Germany are of particular concern. If the manner in which these goods are produced in Germany is not properly represented in Exiobase then, for example, the emissions occurring in Germany as a result of the manufacture of these goods for Dutch consumption will also not be properly represented. It is therefore diligent to carry out an analysis of the quality of SNAC Exiobase before footprints are calculated for use in the ICER.

The purpose of this report is to not decide whether SNAC Exiobase is of sufficient quality for the resulting footprints to be used to in the ICER. All the results which will be published in the ICER will be subject to extensive plausibility analyses, and it is these analyses which will determine whether the footprints are of sufficient quality to be published. This present study therefore focuses on the quality of SNAC Exiobase in general, although it does so in the specific context of Dutch footprints and the ICER.

To understand a little about why we refrain from making explicit quality judgements regarding Exiobase, it is important to understand that all national accounting and especially MRIOs operate in the realm of the second best. Makers of MRIOs must combine multiple datasets which present conflicting information on the nature of the economy and the environment. For example, exports from country A to country B might be different from imports by country B from country A. An important source of data for MRIOs is international trade statistics from the UN, but these do not perfectly conform to the national accounts of a given country. Further, the financial information for industries responsible for substantial carbon emissions may not conform well with other sources of information regarding their emissions. MRIO makers must make trade-offs. It is not possible to judge the quality of an MRIO without evaluating these

[1] The intention is to calculate footprints for greenhouse gases, raw material extraction and land use.

trade-offs on a case-by-case basis. This present study does not consider these trade-offs, and instead it analyses the results of these trade-offs, namely the data itself.

This report contains the results of this quality analysis. Firstly, our method is described in Chapter 2. Chapter 3 makes some preliminary comments regarding the comparability of different data sources and the expectations regarding the results. Chapter 4 presents the results, Chapter 5 provides an evaluation of the differences in data sources and Chapter 6 presents conclusions.

2. Method

The first step is to select countries from which the Netherlands imports many goods. As explained in the introduction, errors in the data of those countries will influence the Dutch footprints most. The following three countries are selected: Belgium, Germany and the USA because of their importance to the Netherlands in terms of trade. The UK is a more important trade partner than the USA but much of this trade with the Netherlands is in services. The USA is a more important trade partner in terms of goods and is therefore included instead of the UK because trade in goods is more important for the calculation of footprints.

For these three countries, we would ideally wish to check the quality of the following statistics derived from SNAC Exiobase:

- Output per industry
- Intermediate use per industry
- Import per industry
- Input-ratios per industry (in other words, from which industries specific industries buy their inputs)

It is preferred to compare SNAC Exiobase to official statistics. Therefore, the first port of call to find data (for the European countries) is Eurostat. Data can be obtained from the Eurostat website[2] for output and intermediate use per industry but the import per industry and input-output ratios are not available for 2016. For the USA, slightly more data is available from the website of the Bureau of Economic Analysis[3] (BEA) . Using their supply and use tables, import per industry is available in addition to output and intermediate use. However, also in this case, the input-output tables are not available and as such, input ratios cannot be derived.

In order to gain insight into the input-ratios, we resort to the use of non-official statistics from the OECD. The OECD produce a MRIO called ICIO[4] which is considered to be of high quality. By comparing ICIO to SNAC Exiobase, we can therefore gain some insight into the quality of SNAC Exiobase, if not as much as with comparison official statistics. Because Germany is the most important trading partner, the input-ratios for Germany from ICIO are compared to SNAC Exiobase. It would also be interesting to do this for other countries, but we refrain from doing so because this analysis is quite time consuming.

In summary the following comparisons are made:

- Output and intermediate use per industry for Belgium and Germany using Eurostat data
- Output, intermediate use and import per industry for the USA using BEA data
- Input-ratios for Germany using ICIO

Unfortunately, all sources of data use different industry categorization systems. It is therefore necessary to aggregate the data such that comparisons can be made. Exiobase has its own

[2] The name of the table is “National accounts aggregates by industry (up to NACE A*64) [nama_10_a64]" https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64&lang=en

[3] https://www.bea.gov/industry/input-output-accounts-data

[4] https://www.oecd.org/sti/ind/analytical-amne-database.htm

categorization of industries which is very detailed (163 industries) but which is different from the 64 industries used by Eurostat, the 72 industries used by the BEA and the 34 industries used by the OECD. For each of the three datasets (Eurostat, BEA and OECD) an aggregation needs to be found which can also be obtained by aggregating SNAC Exiobase. In summary:

- To compare Eurostat to SNAC Exiobase, both are aggregated to 40 industries
- To compare BEA to SNAC Exiobase, both are aggregated to 29 industries
- To compare ICIO to SNAC Exiobase, both are aggregated to 25 industries.

Once the data has been aggregated such that it is comparable, one finds that some industries consist of unusual groupings of industries. This is particularly prominent with the BEA data, which uses a categorization system which deviates from the internationally standard ISIC[5] system upon which Eurostat, OECD and to a lesser extent Exiobase, data are based. One example of this is the treatment of the repair of motor vehicles. The NACE[6] system (NACE is closely related to ISIC) includes repair of motor vehicles under NACE G (retail and wholesale) whereas the BEA data includes repair of motor vehicles under an "Other services" category which also contains services which fall under the NACE categories T (Household services), S (other services) and C33 (repair and installation of machines and appliances). Therefore the resulting industry aggregations contain some very non-homogenous groups and this makes it difficult to make meaningful comparisons. However, even in the case of the USA there are several homogenous categories which can be compared one for one. For example, NACE B (mining) remains unaggregated, as does do several important industrial industries such as NACE C19 (manufacture of coke oven products and oil refining) and NACE C28 (manufacture of machines).

The situation is more favorable for the data from Eurostat and the OECD. In these cases, some aggregation still takes place, but this predominantly occurs for services which are less relevant in the context of footprint analysis. The following section contains the results obtained from comparing the data after it has been aggregated to facilitate comparison.

For the presentation of results, it is preferable to present fewer industries as this eases interpretation of results. Because the services industries are of lesser importance for footprints calculations, several service industries are sometimes aggregated into a single category entitled "Services".

[5] International Standard Industrial Classification of All Economic Activities

[6] *Nomenclature statistique des activités économiques dans la Communauté européenne*. The NACE codes employed in this report are presented in appendix 2.

3. Comparability

Before presenting the results, it is useful to discuss the comparability of SNAC Exiobase with the other data sources. To do so, we must consider two points. Firstly, are we comparing apples with apples? And secondly, what expectations regarding conformity between data sources would be reasonable?

SNAC Exiobase is compiled according to the accounting conventions dictated in the 1993 version of The System of National Accounts (SNA), whereas Eurostat, OECD and BEA data are compiled according to the 2008 version. One important difference between these two versions is that the 1993 version employs the territorial principle and the 2008 version employs the residence principle. These principles determine the location of economic activity and whether international trade has taken place. Under SNA 1993 international trade has occurred if a good crosses an international border. Under SNA 2008 international trade has occurred if the ownership of a good is transferred between residents of different countries. To understand the effects of this difference, consider the example of goods for processing. A Dutch business sends goods to Belgium to be packaged. The Dutch business retains ownership of the goods and buys a service (packaging) from Belgium. Under SNA 1993, this is recorded as the export of goods to Belgium and then the import of more valuable packaged goods into the Netherlands. Under SNA 2008 the only international trade flow is the export of packaging services from Belgium to The Netherlands. This difference also affects how the inputs and outputs of the industries are recorded. Under SNA 1993, the goods for packaging are an input, and the packaged goods are an output. Under SNA 2008, the value of the inputs and outputs are much lower because the goods for packaging never go onto the books of the Belgian company. In this respect, we are not comparing apples with apples. Other large differences between SNA 1993 and SNA 2008, such as considering R&D not as intermediate consumption but as an investment, treatment of military weapons or the measurement of financial services (Van De Ven 2015) are not expected to have large consequences for footprint calculations.

This difference between SNA 1993 and SNA 2008 will affect different countries and different industries to varying degrees. To give an idea of how large this effect will be, let us consider the following example. In the Netherlands, one of the industries which is most affected is manufacture of chemicals and chemical products (C20). Under SNA 2008, both the import and export of goods and services are between 5% and 10% lower than under SNA 1993. There are two reasons for this. Firstly, much production in this industry takes places abroad, meaning that goods cross borders less. Secondly, when goods do move across borders they are not moved as part of changes in ownership but so that businesses in other countries can provide services by modifying those goods. Within C20, this mainly occurs with the processing of petrochemical products, whereby the oil itself is sent for processing in the Netherlands but it is not sold to a Dutch company. In general, we can expect the industries in countries which have many international trade links to be most affected by the difference between SNA 1993 and SNA 2008. The effect on service industries should be minimal.

The above differences regarding SNA versions are one reason to expect deviation between SNAC Exiobase and other sources of data. This means that we are not comparing apples with apples due to underlying conceptual differences in what is being measured. In other cases, despite apples being compared to apples, there are still differences in the data. The most important of these will be mentioned here. The first is that there are multiple sources of data

which may be used to determine values any given MRIO. For example, this study compares the BEA import data to the SNAC Exiobase import data for the USA. However, Exiobase has not been compiled using this data, preferring to use UN data. Even when the original source for the UN data would be the BEA, the numbers could be different because of periodic revisions to the data or conceptual modifications. It can therefore not be expected that Exiobase trade data would always conform 100 percent to the BEA trade data. Further, even if Exiobase did directly employ BEA data, we could still not expect the import and export data to be identical. This is because of the balancing process inherent in MRIO construction. Balancing refers to making adjustments to values in order that the data is internally consistent and conforms to the rules set out in the SNA. In principle, these adjustments should be small, but larger adjustments may be necessary where different data sources causes larger "disagreements" regarding the correct value.

Finally, one of the advantages of making a SNAC version of Exiobase, is that Statistics Netherlands uses granular data on the trade relationships with other countries which is not yet used by third parties. For example, to estimate how much of Dutch imports from China of a given product are used in the domestic economy and how much are re-exported. This is very relevant, since half of Dutch imports and exports of goods concern re-exports. Lemmers and Wong (2019) show that the use of more granular data leads to estimates of Dutch imports from the United States, the United Kingdom and China to be used in the domestic economy that are sometimes more than 15 percent lower than in MRIOs such as Exiobase. Therefore, where the data relates to the international trade to and from the Netherlands, the SNAC process can lead to deviations from other sources. This however, is entirely beneficial to the quality of the dataset in so far as it is applied to questions relating the Netherlands.

So, given all these differences, what expectations regarding conformity between SNAC Exiobase and other data sources would be reasonable? Let us consider each of the data sources to which the SNAC Exiobase data is to be compared in turn. Regarding the Eurostat data on Belgium and Germany, we would expect SNAC Exiobase to be a close approximation of these economies, both in terms of their magnitude and composition. Industries which are relatively more or less important according to Eurostat should also be relatively more or less important. However, we can expect deviations between the output and intermediate use statistics for specific industries between Eurostat and SNAC Exiobase. Larger deviations, which result in a fundamentally different picture regarding the composition of the economy, can be considered unexpected, and we would wish to gain more insight into why such larger deviations have occurred.

Our expectations regarding the BEA data are similar to the Eurostat data. We would thus expect the composition and magnitude of the economies to be similar. Unlike with the Eurostat data, we also analyze the import data for the USA because in this case it is available whereas it is not for the European countries. Regarding the import data, we have somewhat lower expectations. This is for two reasons. Firstly, UN import data for the USA is employed in the making of Exiobase. Any deviations between the BEA data and the UN data will therefore also lead to deviations between SNAC Exiobase and the BEA data. Further, there are differences in the valuation of trade between SNAC Exiobase and the BEA data. The BEA data (specifically, the import matrix) values imported goods at their cif value, where cif stands for costs, insurance and freight. The alternative valuation method, known as the fob value (free on board) is used in SNAC Exiobase. The fob value is the value of the goods being traded. The cif value includes the value of the services provided in the process of trading, such as freight costs. According to the BEA, the cif value of imports was 2.3% higher than the fob value in 2016. However, this

percentage will vary depending on the specific industry and country in question as shown by Miao and Fortanier (2017)[7]. Accordingly, we can expect the import values according the BEA to be greater than the import values according to SNAC Exiobase. Conversely, the use of cif instead of fob values also means that the import of services related to international trade will be less because the value of these services is recorded as part of the value of the good. One would therefore expect that the import of transportation services would be less in the BEA data than in the Exiobase data.

What expectations would be reasonable regarding the comparison of the input ratios for Germany between SNAC Exiobase and the OECD data? The purpose of this comparison is to check the production technology in Exiobase. For a given industry to produce output, that industry requires inputs from other industries according to the methods of production (otherwise referred to as the technology). Accordingly, we are not interested in the value of inputs from a specific industry, but whether the value of the inputs from a specific industry is appropriately proportioned in relation to the inputs from other industries. We would expect the technology in SNAC Exiobase to closely approximate the technology in the OECD data. Some industries receive a large share of their input from a specific industry and we would expect to see that in SNAC Exiobase. For example, the manufacture of machines industry purchases many inputs from the metal industry. Other industries, such as wholesale or retail trade purchase their inputs from a variety of industries, and we would expect to see this in the data.

[7] see https://stats.oecd.org/Index.aspx?DataSetCode=CIF_FOB_ITIC for actual outcomes.

4. Results

This chapter analyses the differences between the data sources but does not seek to explain or evaluate them in detail. This occurs in chapter 5.

4.1 Eurostat vs. SNAC Exiobase

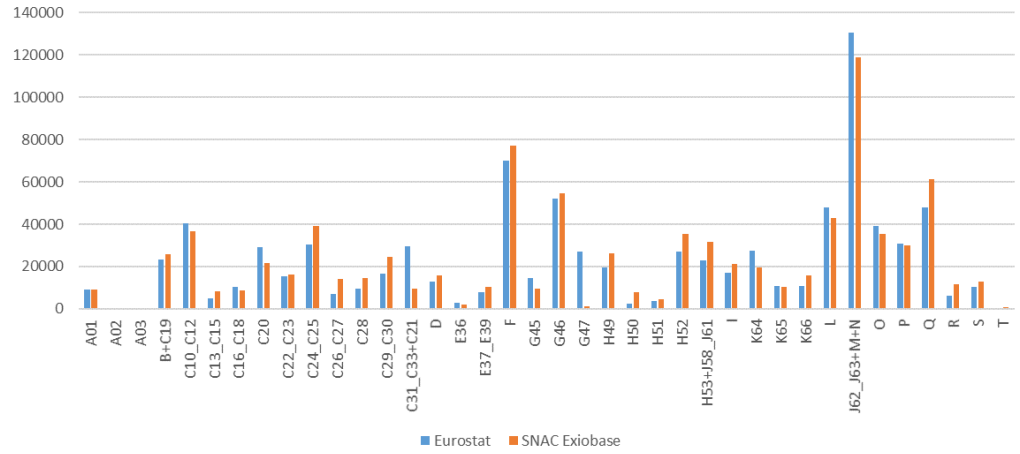
In this section, we shall compare SNAC Exiobase data to Eurostat data for Belgium and Germany in terms of output and intermediate consumption. Figure 4.1.1 and 4.1.2 shows this comparison for Belgium. The total values for output and intermediate consumption are shown below.

	Eurostat	SNAC Exiobase
Output	869	886
Intermediate consumption	485	475

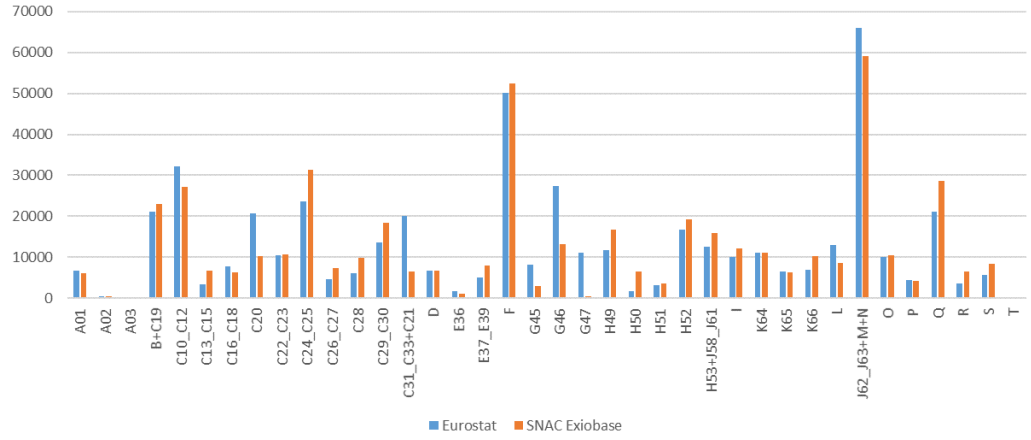
Table 4.1.1. Total values for Belgium (€ billion)

These values show that Belgian output and intermediate consumption are larger and smaller respectively, according to SNAC Exiobase than Eurostat. The difference is however relatively small.

4.1.1 Output per industry in Belgium according to SNAC Exiobase and Eurostat (€ billion)



4.1.2 Intermediate Consumption per industry in Belgium according to SNAC Exiobase and Eurostat (€ billion)



The first thing to note about the above two figures is that they show a similar pattern. In terms of both output and intermediate consumption, the composition of the economies according to the different datasets concur with each other. We see the importance of the service industries in J62_J63+M+N, the construction industry (F), the food and drink industry (C10_C12), the metal industry (C24_C25) and health and social work (Q). However, there are several discrepancies. The greatest discrepancy is found in retail trade G47. This is around 25 times larger according to Eurostat than according to SNAC Exiobase. A difference of similar magnitude is also found when comparing to the original version of Exiobase. Therefore, this discrepancy originates from the original Exiobase data.

There are also several industries with large discrepancies in the industrial industries contained in NACE C. When we consider NACE C as whole (C10 through to C33), we find that the magnitude of these industry is almost precisely the same in both SNAC Exiobase and according to Eurostat. The difference lies in how this activity is divided between the industries within C. Of these 4 industries, 2 have particularly large differences, namely industry C20, chemicals manufacture and the group C21 plus C31 to C33 which consists of pharmaceuticals production, furniture manufacture and repair and installation of machines.

There is also a large discrepancy in industry H50 (transport over water). For this industry, output and intermediate consumption are around 4 times higher in SNAC Exiobase than according to Eurostat.

Let us now proceed to consider Germany, firstly by considering the total values, shown in table 4.1.2 below.

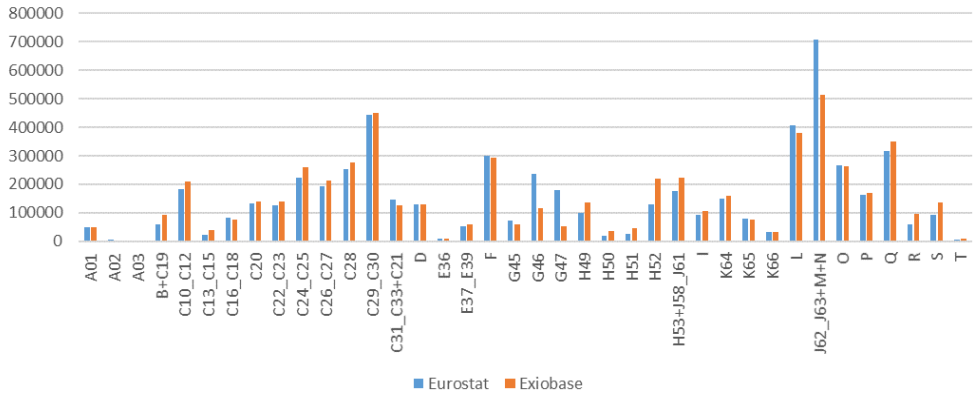
	Eurostat	SNAC Exiobase
Output	5 733	5 758
Intermediate consumption	2 911	2 762

Table 4.1.2. Total values for Germany (€ billion)

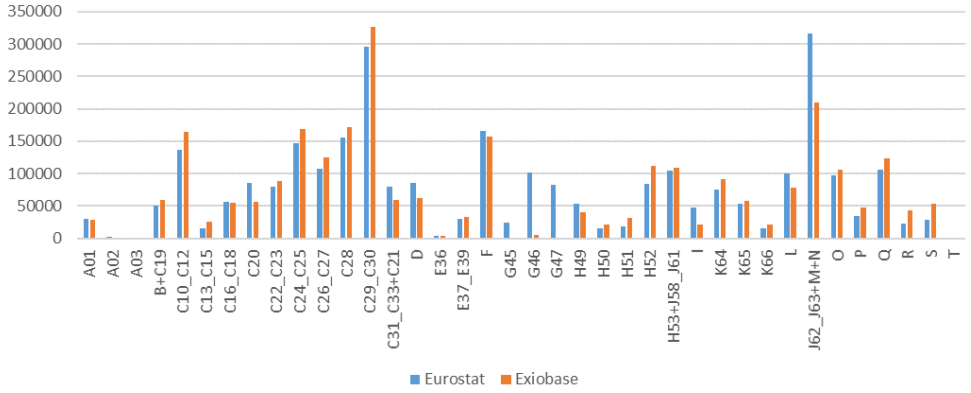
As was the case for Belgium, we see that the magnitude of the Germany economy is similar according to both Eurostat and SNAC Exiobase. However we do see a somewhat larger deviation of 5% for intermediate consumption than for Belgium, where the deviation was 2%.

As shown in the following figures, it again generally holds that the composition of the economies is broadly similar according to SNAC Exiobase and Eurostat. Interestingly, where there are substantial differences, these differences often affect different industries than in Belgium.

4.1.3 Output per industry in Germany according to SNAC Exiobase and Eurostat (€ billion)



4.1.4 Intermediate Consumption per industry in Germany according to SNAC Exiobase and Eurostat (€ billion)



For Germany we see again that the composition of the economy according to Eurostat is mirrored in the composition of the economy according to SNAC Exiobase. Interestingly, we see that the deviation for the industries in NACE C in Germany is less. That being said there are some similarities in the deviations, namely that the industries C24 through to C30 have higher values in SNAC Exiobase for both countries. This suggests that there is a structural reason for the deviations regarding the industries in NACE C, and that this structural reason affects Belgium more than Germany. This may be due to processing trade and the differences between SNAs.

Another similarity between Belgium and Germany is the large deviation regarding industry G (wholesale, retail and repair of motor vehicles). For Germany, as it was for Belgium, the deviation is greatest for the retail industry (G47), although the deviation is greater for Germany. Further, the deviation for Germany is much greater in terms of intermediate consumption than output. The intermediate consumption in industry G47 according to SNAC Exiobase is about €1.4 billion , whereas according to Eurostat, it is €82 billion. We also see substantial differences in intermediate consumption for G45 (trade and repair of motor vehicles), which was €24 billion

according to Eurostat and €1 billion according to SNAC Exiobase. This difference exist to a similar magnitude when comparisons are made between the original version of Exiobase and the Eurostat data. It is also interesting to note that the deviations for intermediate consumption generally mirror those of output, but, in the case of industry G in Germany, the deviation in intermediate consumption is much greater than the deviation in output.

4.2 BEA vs. SNAC Exiobase

The analysis of the BEA data (USA) is carried out in a similar way to the Eurostat data. The difference is that BEA publish import data per industry. Import data is therefore also analyzed. We begin by presenting the total values in table 4.2.1.

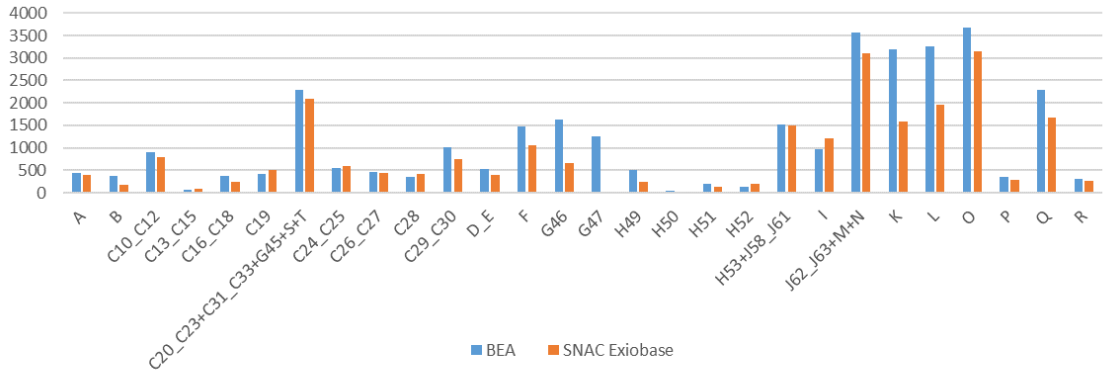
	BEA	SNAC Exiobase
Output	32 170	23 973
Intermediate consumption	14 123	10 276
Imports	1 308	1 060

Table 4.2.1. Total values for the USA (€ billion)

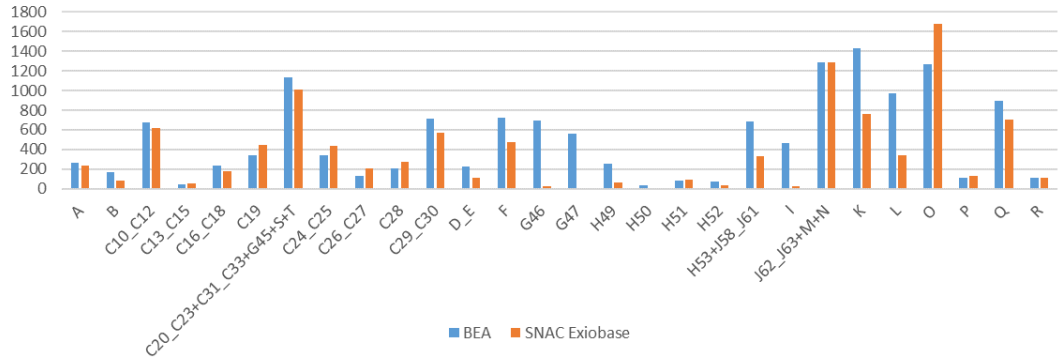
Table 4.2.1 shows larger deviations in the total values than found with the Eurostat data. For the Eurostat data the deviation were less than or equal to 5% whereas with the BEA data, the deviations are consistently greater than 20%. Also, Eurostat output was marginally lower than SNAC Exiobase and Eurostat intermediate consumption was marginally greater. This pattern does not hold for BEA data. In this case SNAC Exiobase values are consistently lower than BEA values.

In general, the same result holds as with the Eurostat data in that both sources of data give the same general picture of the composition of the economy. Again though, there are some large deviations for specific industries.

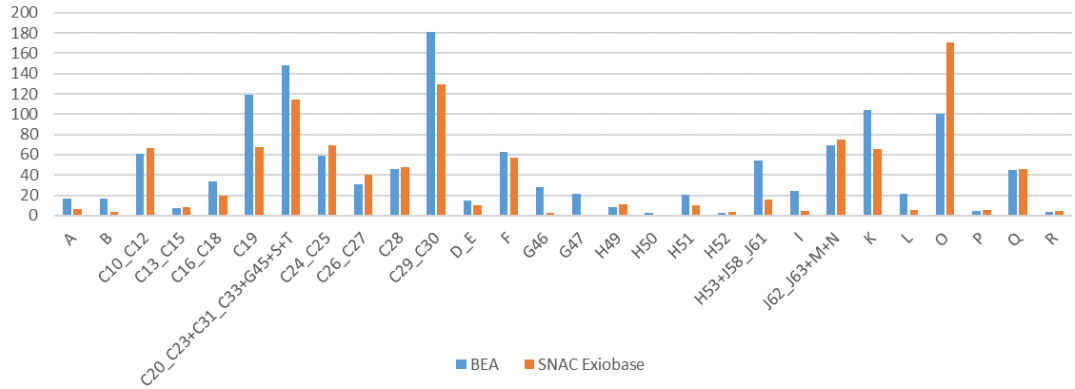
4.2.1 Output per industry in the USA according to SNAC Exiobase and the BEA (€ billion)



4.2.2 Intermediate Consumption per industry in the USA according to SNAC Exiobase and the BEA (€ billion)



4.2.3 Import per industry in the USA according to SNAC Exiobase and the BEA (€ billion)



The larger deviations between the total values as shown in table 4.2.1 are also reflected in the deviations per industry. We see for many industries that the BEA values are higher than the Exiobase values. Despite this, we do still see both BEA and SNAC Exiobase generally concur regarding the composition of the American economy. For example, the distribution of industrial activity across the industries in with NACE C is predominantly similar. As with the Eurostat data, we again see large deviations for wholesale, retail and repair sale of motor vehicles (G), and especially for retail trade (G47). Unlike the Eurostat data, we see larger deviations for service industries. For the Eurostat data, for example the industry L (real estate activities) consistently showed very low deviations with SNAC Exiobase. This no longer holds, with values being between 1.5 and 4 times greater in the BEA data. We also see relatively large deviations with the BEA data for financial services (NACE K), which again is an industry with lower deviations for the Eurostat data.

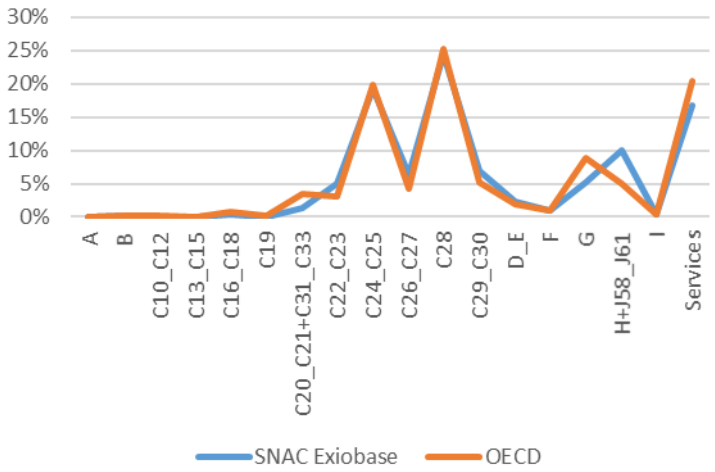
4.3 OECD vs. SNAC Exiobase

In this section, we do not concern ourselves with absolute values, but with proportions. This is because we wish to test if the production technologies according to the OECD, as given by the input ratios per industry, conform with those in SNAC Exiobase. To do this, we take the example

of Germany. Input ratios for a German industry X are calculated as the intermediate consumption of goods and services from all domestic industries divided by the total input of industry X. The total domestic input of industry X is defined as the sum of the inputs to industry X from all German industries including itself. In this way imports are entirely excluded from the analysis. The ratios are graphed per industry. The graphs for each industry are presented in appendix one. In the main body of the text, we will show the graphs for certain industries to illustrate the most interesting results.

An example of an industry for which the input ratios conform very closely is the manufacture of general purpose machinery (C28). This is shown in figure 4.3.1. For example, 20 percent of total inputs for C28 came from C24_C25, both in SNAC Exiobase as in OECD.

Figure 4.3.1 Input ratios for industry C28 in Germany according to the OECD and SNAC Exiobase



The above figure shows the importance of other industrial industries as well as other services. There is some discrepancy, which we have now come to expect, regarding industry G (which includes wholesale). There is also some discrepancy with industry H+J58_J61. Industry H includes transport and storage and industries J58_J61 relate to media and telecommunications.

At the other end of the spectrum is NACE B (mining and quarrying, which includes oil and gas), which has much higher levels of deviation between SNAC Exiobase and the OECD data.

Figure 4.3.2 Input ratios for the industry B in Germany according to the OECD and SNAC Exiobase.

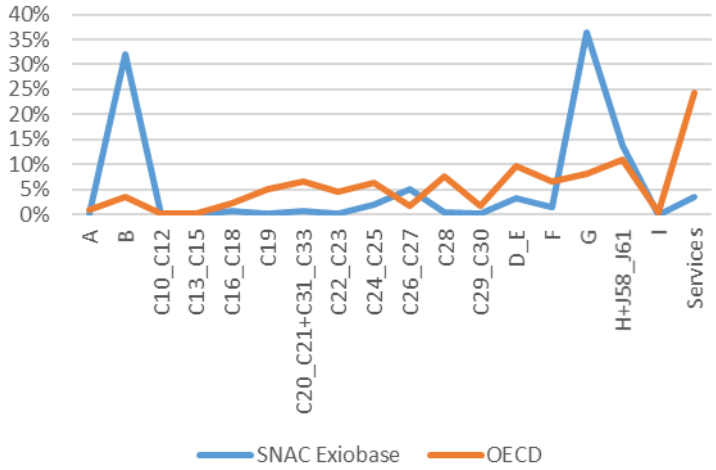
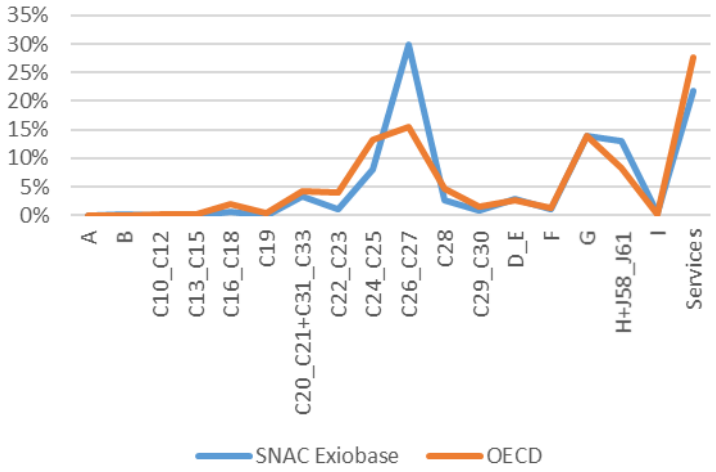


Figure 4.3.2 shows that the production technology for the mining and quarrying industry according to SNAC Exiobase is fundamentally different from the production technology according to the OECD. According to SNAC Exiobase, this industry buys the majority of its inputs from the industry itself and from the retail and wholesale industries (G). According to the OECD, the industry purchases its inputs from a variety of industries, with the most important being the aggregated services category. The industrial industries in NACE C are more important according to the OECD and industries G and B itself are much less important. In this specific case, we see then that the SNAC Exiobase input ratios do not concur with those in OECD, and are in fact fundamentally different. This will be discussed further in chapter 6 (conclusions).

The examples of industries C28 and B are extreme examples. We also considered the other industries but there differences were generally small. To give a balanced picture let us also quickly consider industry C26_C27 which shows an average[8] level of deviation.

Figure 4.3.3 Input ratios for the industry C26_C27 in Germany according to the OECD and SNAC Exiobase.



The industry C26_C27 includes the production of computers and electronic and optical devices. The input ratios show that the SNAC Exiobase and the OECD data generally concur regarding the

[8] Calculated as the sum of squared differences between the input ratio per industry.

production technology. Services, wholesale trade, and the industry itself are the most important suppliers according to both datasets. There is however some disagreement regarding exactly how important specific suppliers are. This is particularly the case for industry C26_C27, which is a more important supplier according to SNAC Exiobase. Conversely, industry C24_C25 (metal and metal and metal products) is more important according to the OECD than according to SNAC Exiobase. However, as mentioned, in general, both sources of data concur regarding the nature of the production technology.

5. Evaluation of differences between data sources

This section will highlight and briefly discuss some of the most interesting results of the comparison between the data in SNAC Exiobase and that from Eurostat, the BEA and the OECD.

The results show that comparison to Eurostat data gives a more favorable impression of the quality of SNAC Exiobase than the BEA data. Generally, the deviation in output and intermediate consumption is small leading to similar representations of the structure of the Belgian and Germany economies. There are substantial differences for the wholesale and retail trade industry and to a lesser extent, the transport industries (NACE H). These deviations are due to the treatment of trade and transport margins over the development of the different versions of Exiobase. Exiobase employs NACE version 1.1, which has the consequence that trade and transport margins are included in the industries which produced them. Other sources of data (BEA, Eurostat, OECD) make use of NACE version 2, which results in trade and transport margins being presented separately. There is therefore a conceptual difference between Exiobase and other sources of data which we did not anticipate. This insight was obtained in discussions with Arjan de Koning and Richard Wood, who are involved with Exiobase. In any case, this issue is likely to have only minor effects on footprint calculations for the Netherlands. This is because these industries in foreign countries are not particularly important to either supply chains emanating from Dutch consumers, or important in terms of carbon emissions or raw material extraction.

More important for Dutch supply chains and footprints are the industrial industries in Germany. There are some differences in the composition of the industries within NACE C but the total values for NACE C as a whole are very similar. Because Germany is such an important trading partner for the Netherlands, some of these differences can be explained by the effects of the SNAC procedure. Other differences can be explained by the version of the SNA which is employed. Despite this, these differences are still greater than one would hope to see, although the differences are not large enough to be particularly concerning.

The comparison between the BEA data and the SNAC Exiobase data produces less favorable results than the comparison to Eurostat data, but overall SNAC Exiobase is still a reasonable approximation of the American economy. Unlike the Eurostat data, the BEA data includes imports per industry. The comparison of the input data shows similar results as the other indicators, in that the composition of the economy is reasonably well approximated but there are several notable deviations for specific industries. Interestingly, there are greater deviations for the service industries (for example NACE K and NACE L) and the government (NACE O) shown in the BEA data than the Eurostat data. These industries are however less relevant in terms of the footprint. Additionally, as with the Eurostat data, we see large deviations for the retail and wholesale industry (NACE G) which is explained by the use of different versions of NACE.

When considering the comparison to the OECD data and the input ratios, the results were generally positive in that the production technologies are similar. However, the results for NACE B (mining and quarrying) in Germany are, at first glance, quite concerning. According to SNAC Exiobase, the industry buys 32% of its inputs from the industry itself, whereas according to the OECD, the industry only buys 3% of its inputs from the industry itself. It is important that the mining and quarrying industry is properly represented in SNAC Exiobase because of its use to

calculate raw material footprints. If SNAC Exiobase overestimates the extent to which the mining and quarrying industry uses inputs from the mining and quarry industry, then the footprint will be an underestimate. Therefore, a third source of data was employed, namely the use tables for Germany (purchaser prices) from Eurostat. These tables are product by industry tables, whereas input-output tables are industry by industry tables and will be in basic prices. Therefore, the data cannot be directly compared. However, the use table states that 22% of the inputs of the mining and quarrying industry come from the industry itself. This supports the proposition that SNAC Exiobase gives a more accurate representation of the production technology of the mining and quarrying industry than the OECD data. Therefore, these results are far less concerning then they at first seem. However, there are still substantial deviations for the industries other than NACE B in the input ratios for NACE B. Given that there also seems to be problems with the representation of the production technology for this industry in the OECD data, it is not possible to draw firm conclusions regarding the quality of SNAC Exiobase in this regard.

6. Conclusions

This study has compared data from Eurostat, the American Bureau of Economic Analysis, and the OECD to SNAC Exiobase in order to provide some insights into the quality of SNAC Exiobase. The results have been generally positive but they are also mixed. There are particular doubts concerning the representation of the USA in general and the production technology of the mining and quarrying industry in Germany. These two quality concerns are highlighted because of the consequences for the quality of the footprints calculated using SNAC Exiobase. The economy of the USA, in terms of output and intermediate consumption is substantially smaller in SNAC Exiobase than in the BEA. Some of this variation may be due to technical differences such as cif/fob pricing and differences between SNA versions. Notwithstanding such technical differences, the underlying differences are still concerning.

Regarding the production technology in NACE B in Germany, SNAC Exiobase estimates the share of the inputs which are supplied by the industry itself at 32% while OECD estimates it at 3%. There is therefore significant variation in the estimates. The best approximation for the share of the inputs in the German mining and quarrying industry comes from the Eurostat use tables, and is equal to 22%. It seems therefore that SNAC Exiobase does overestimate the extent to which NACE B uses its own output as input. This suggests that the share of the raw material footprint pertaining to minerals and fossil energy carriers is an underestimate. The extent to which it is an underestimate depends on the extent to which the share of own output use is overestimated for all regions in SNAC Exiobase.

Less concerning, but nonetheless interesting are the deviations relating to industries which are less important for footprints. The analysis suggests that the retail and wholesale trade industries may be underestimated in SNAC Exiobase. Also there are unusual deviations for the service industries K, L, O between the BEA and SNAC Exiobase data. Gaining a better understanding of these deviations may facilitate a better understanding of the variation in total values for output, intermediate consumption and imports.

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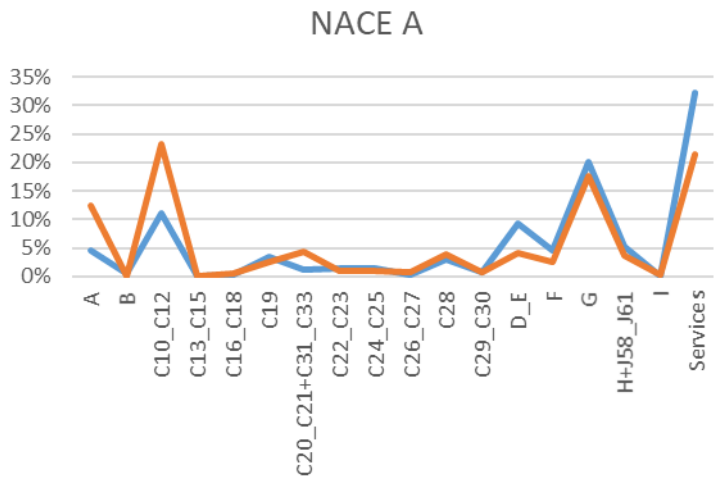
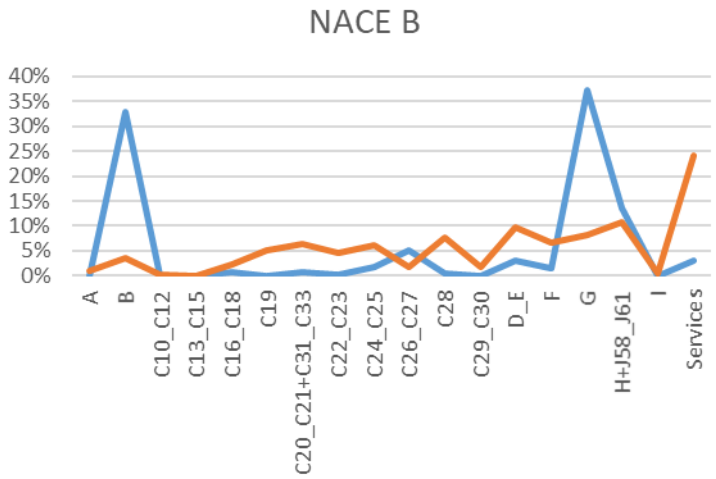
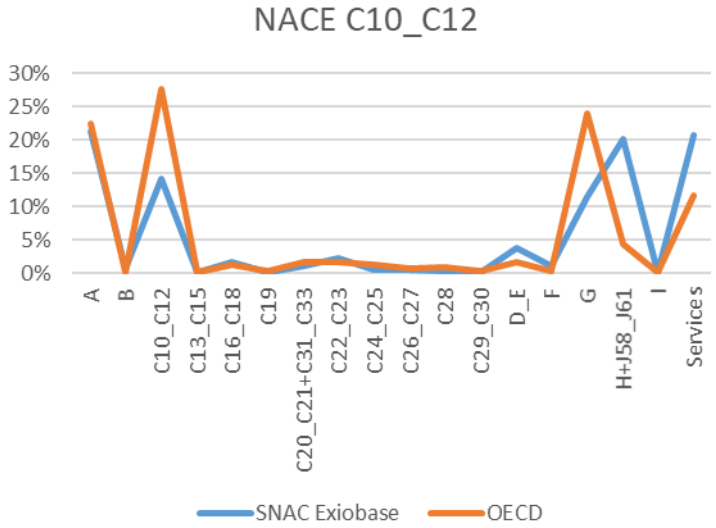
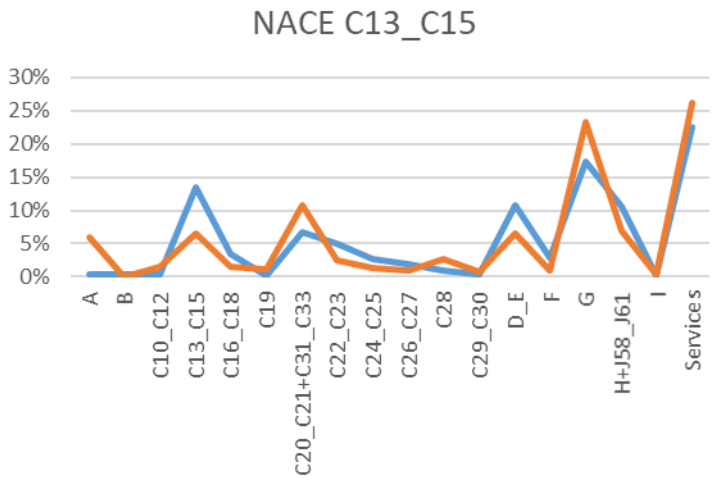
Appendix 1. German input ratios





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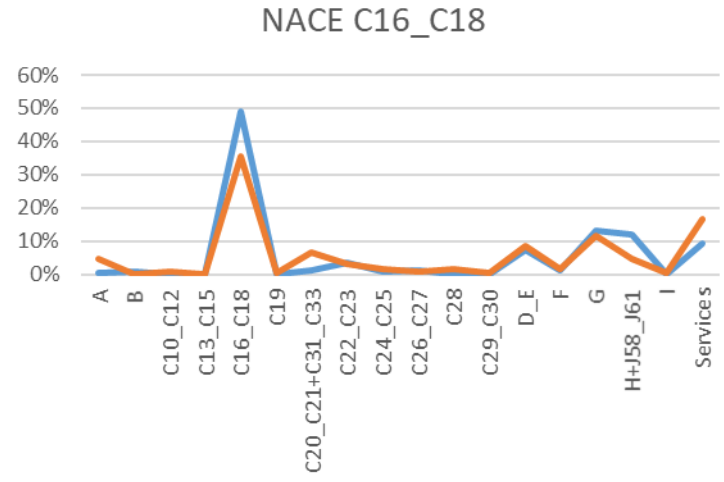
30%
25%
20%
15%
10%
5%
0%
A
B
C10_C12
C13_C15
C16_C18
C19
C20_C21+C31_C33
C22_C23
C24_C25
C26_C27
C28
C29_C30
D_E
F
G
H+J58_J61
I
Services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50%
40%
30%
20%
10%
0%
A
B
C10_C12
C13_C15
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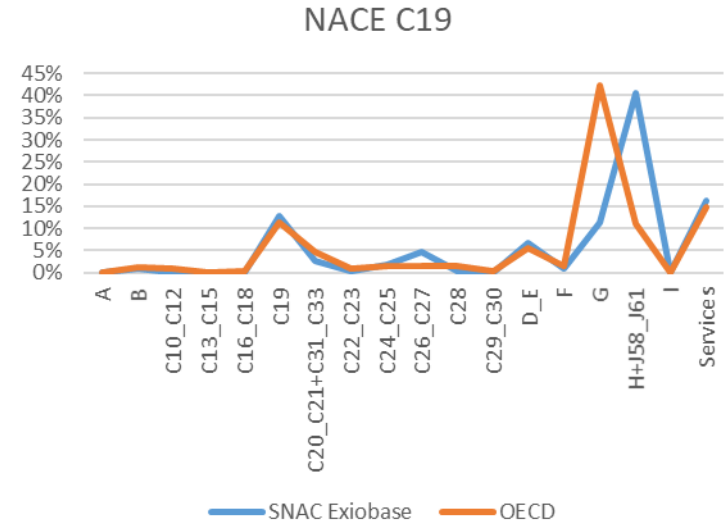
C19
C20_C21+C31_C33
C22_C23
C24_C25
C26_C27
C28
C29_C30
D_E
F
G
H+J58_J61
I
Services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25%
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10%
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A
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C10_C12
C13_C15
C16_C18
C19
C20_C21+C31_C33
C22_C23
C24_C25
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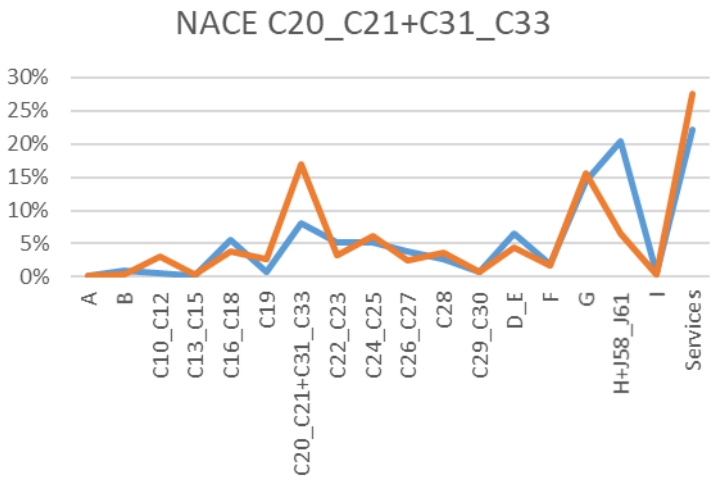
SNAC Exiobase
OECD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30%
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20%
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5%
0%
A
B
C10_C12
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C16_C18
C19
C20_C21+C31_C33
C22_C23
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G
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I
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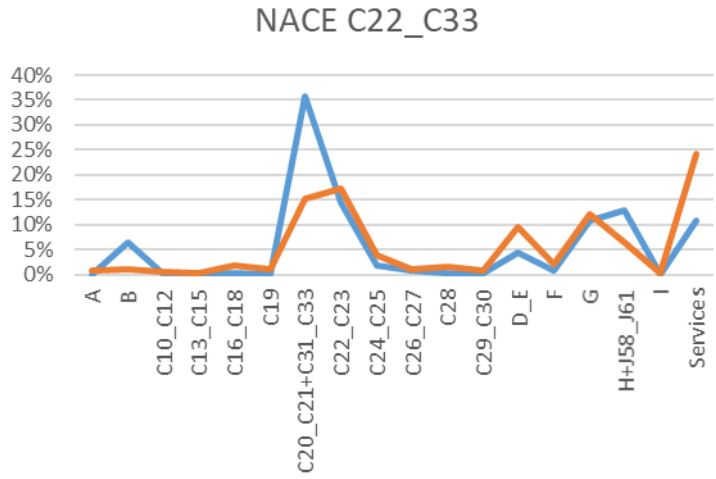
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25%
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10%
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0%
A
B
C10_C12
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C16_C18
C19
C20_C21+C31_C33
C22_C23
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C29_C30
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H+J58_J61
I
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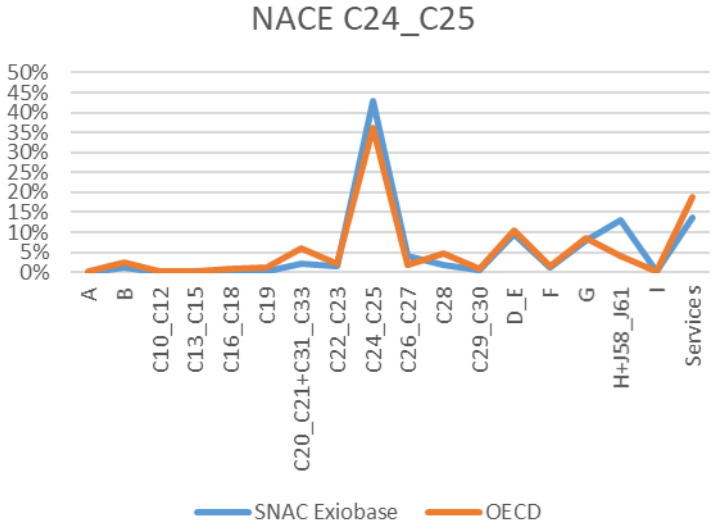
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5%
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C13_C15
C16_C18
C19
C20_C21+C31_C33
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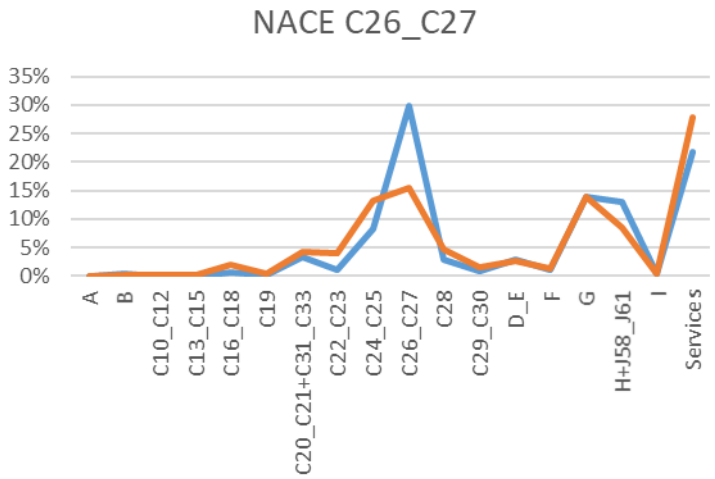
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C16_C18
C19
C20_C21+C31_C33
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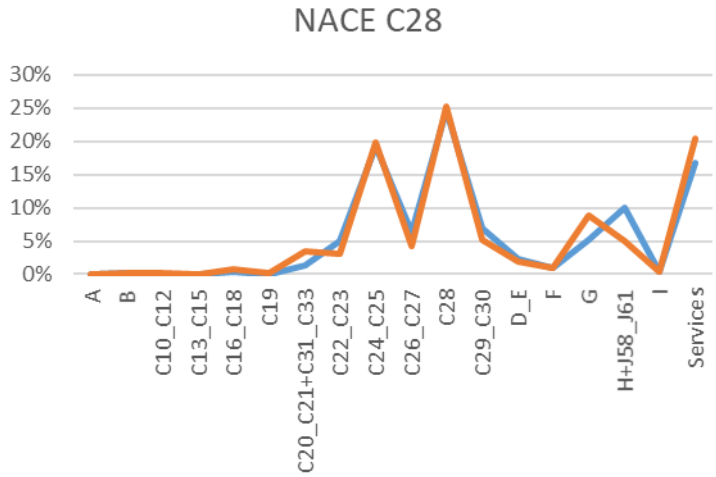
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C20_C21+C31_C33
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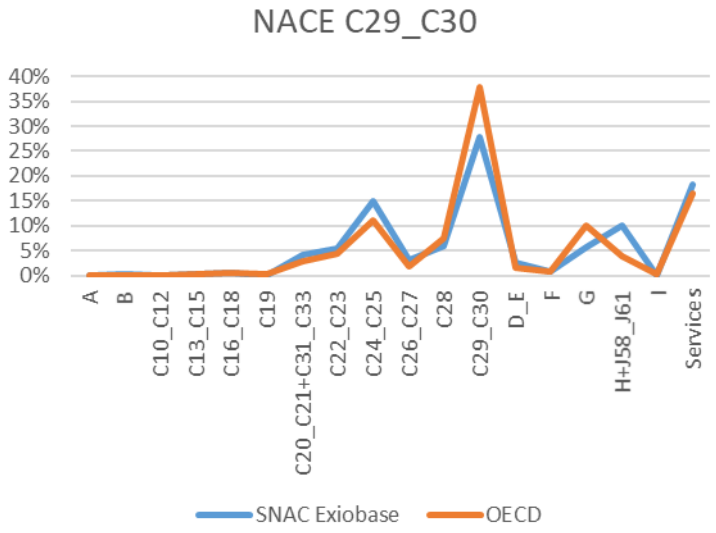
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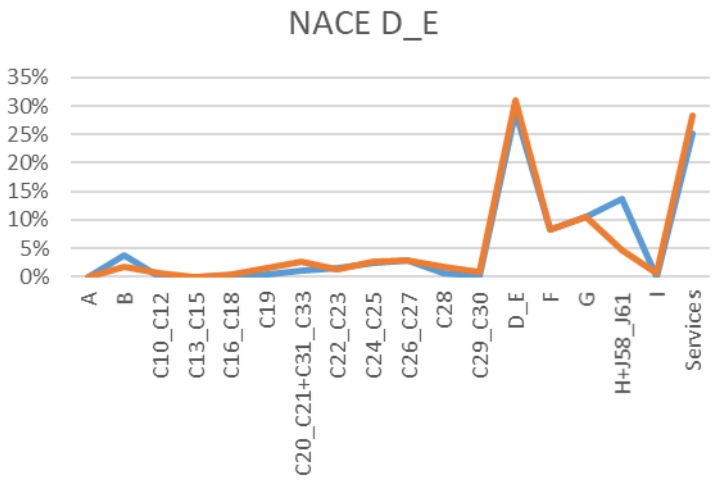
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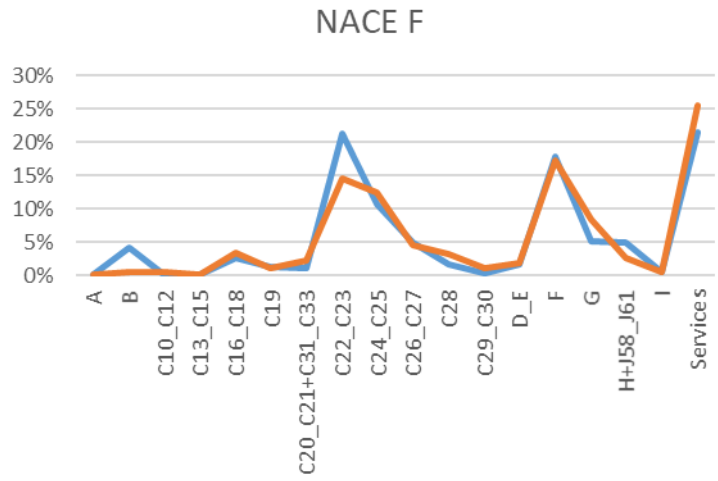
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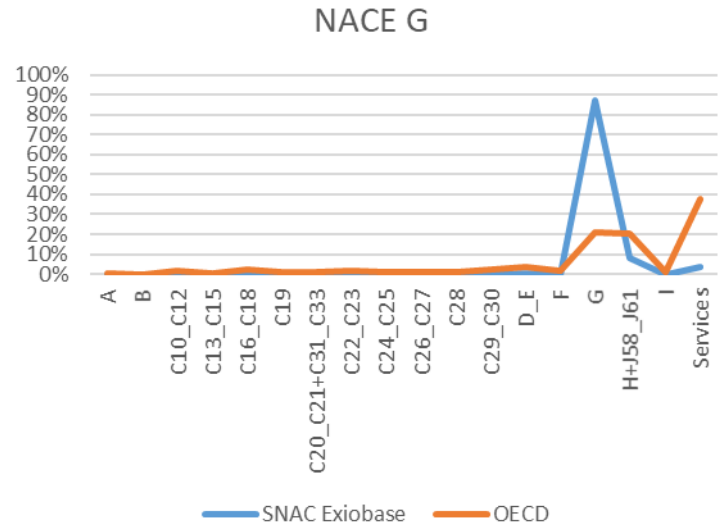
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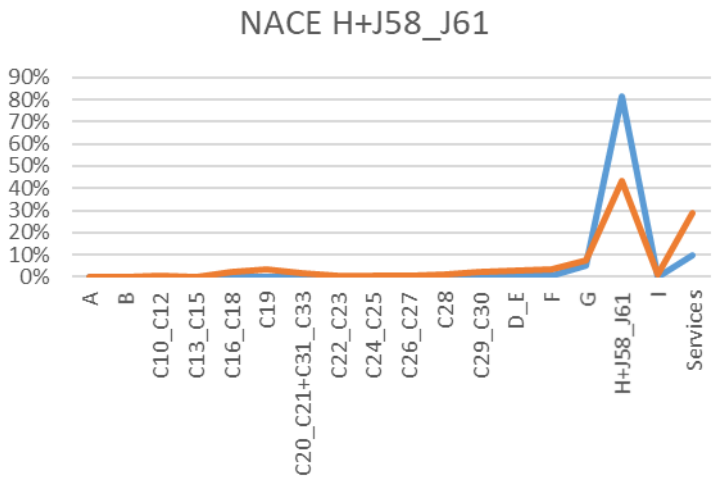
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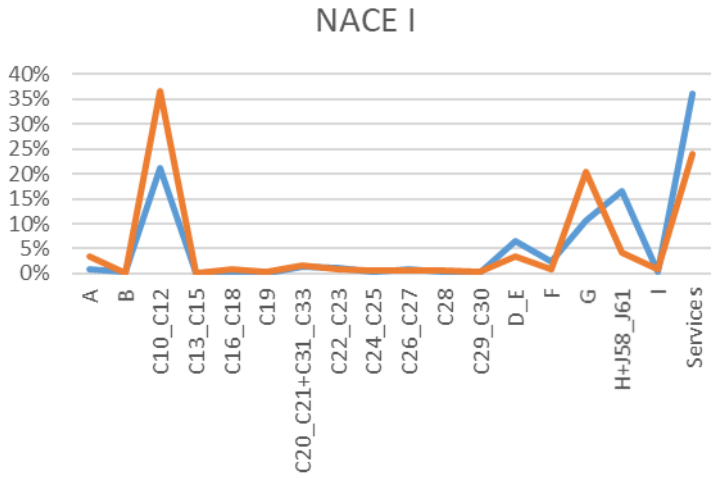
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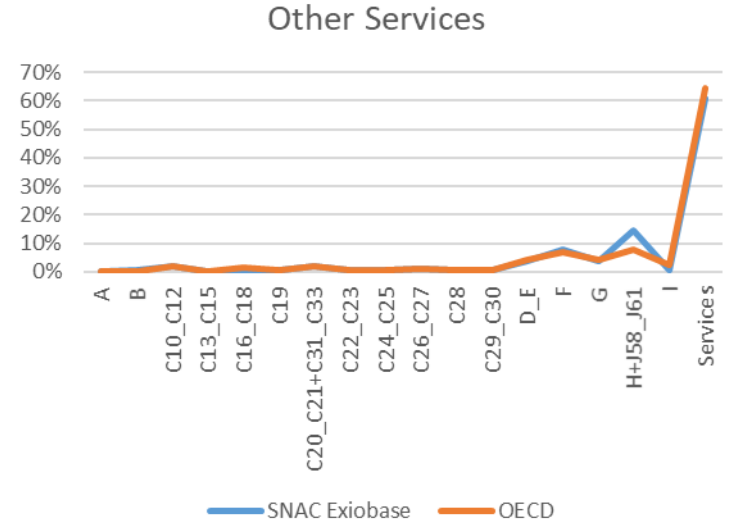
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C28
C29_C30
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Services
SNAC Exiobase
OECD

Appendix 2. NACE Codes

This appendix provides the NACE codes relevant for the analysis in this report.

A - Agriculture, Forestry and Fishing
B - Mining and Quarrying
C - Manufacturing
  C10 - Manufacture of food products
  C11 - Manufacture of beverages
  C12 - Manufacture of tobacco products
  C13 - Manufacture of textiles
  C14 - Manufacture of wearing apparel
  C15 - Manufacture of leather and related products
  C16 - Manufacture of wood and of products of wood and cork
  C17 - Manufacture of paper and paper products
  C18 - Printing and reproduction of recorded media
  C19 - Manufacture of coke and refined petroleum products
  C20 - Manufacture of chemicals and chemical products
  C21 - Manufacture of basic pharmaceutical products and pharmaceutical preparations
  C22 - Manufacture of rubber and plastic products
  C23 - Manufacture of other non-metallic mineral products
  C24 - Manufacture of basic metals
  C25 - Manufacture of fabricated metal products, except machinery and equipment
  C26 - Manufacture of computer, electronic and optical products
  C27 - Manufacture of electrical equipment
  C28 - Manufacture of machinery and equipment n.e.c.
  C29 - Manufacture of motor vehicles, trailers and semi-trailers
  C30 - Manufacture of other transport equipment
  C31 - Manufacture of furniture
  C32 - Other manufacturing
  C33 - Repair and installation of machinery and equipment
D - Electricity, Gas, Steam and Air Conditioning Supply
E - Water Supply; Sewerage, Waste Management and Remediation Activities
  E36 - Water collection, treatment and supply
  E37 - Sewerage
  E38 - Waste collection, treatment and disposal activities; materials recovery
  E39 - Remediation activities and other waste management services
F - Construction
G - Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles
  G45 - Wholesale and retail trade and repair of motor vehicles and motorcycles
  G46 - Wholesale trade, except of motor vehicles and motorcycles
  G47 - Retail trade, except of motor vehicles and motorcycles
H - Transportation and Storage
  H49 - Land transport and transport via pipelines
  H50 - Water transport
  H51 - Air transport
  H52 - Warehousing and support activities for transportation
  H53 - Postal and courier activities

I - Accommodation and Food Service Activities
J - Information and Communication
  J58 - Publishing activities
  J59 - Motion picture, video and television programme production and sound recording
  J60 - Programming and broadcasting activities
  J61 - Telecommunications
  J62 - Computer programming, consultancy and related activities
  J63 - Information service activities
K - Financial and Insurance Activities
L - Real Estate Activities
M - Professional, Scientific and Technical Activities
N - Administrative and Support Service Activities
O - Public Administration and Defence; Compulsory Social Security
P - Education
Q - Human Health and Social Work Activities
R - Arts, Entertainment and Recreation
S - Other Service Activities
T - Activities of Households as Employers
U - Activities of Extraterritorial Organisations and Bodies

Appendix 3. Abbreviations

BEA: Bureau of Economic Analyses (USA)
ICER: Integrated Circular Economy Report
ICIO: Inter-Country Input-Output tables (OECD)
MRIO: Multi-Regional Input-Output database
NACE: *Nomenclature statistique des Activités économiques dans la Communauté Européenne*
OECD: Organisation for Economic Cooperation and Development
SNAC: Single country National Accounts Consistent
SNA: System of National Accounts