Feasibility study on linking ownership information to Exiobase

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Executive summary

Understanding globalisation requires new statistics which give insights into the workings and significance of social, economic and environmental phenomena across borders. Such new statistics can be created by combining existing datasets. This study examines the feasibility of combining Exiobase: an environmentally extended multi-regional input-output database, with information on the ownership of enterprises. Should such a link be feasible, then it becomes possible to analyse the extent of ownership throughout supply chains and to analyse the relationship between ownership and the CO_2 emissions or resource use. This allows one to determine the actors from particular countries (domestically or foreign) that actually control and decide upon activities and thus affect emissions and resource use. This in turn shows what the balance is in domestic versus foreign control of activities and environmental and resource burden. This opens up the opportunity to look at emissions with a different conceptualisation, namely by looking beyond just emissions from within a nation's territory or by its (economic) production activity and instead with which country the responsibility for the emissions lie. This would provide policy makers additional tools necessary to establish educated policies with respect to the economic aspects of value chains connected to the country in conjunction with the resource and environmental aspects and impact.

This study analyses data on ownership that is internally available at Statistics Netherlands as well as the external database known as ORBIS. These databases can be used to establish span of control per industry sector. This study explains these different datasets in terms of their contents and the geographical scope. The study then briefly analyses the feasibility and the technical aspects of linking Exiobase to the databases on ownerships. Both the internally available and the ORBIS data can be linked to Exiobase via the industrial classification of the enterprise. However, the system of sector classification in the data is different to the system used in Exiobase. The feasibility of linking Exiobase to the databases on ownership therefore depends on the feasibility of constructing a table which accurately links the two sector classifications. To this end, we construct a preliminary linking table to judge the feasibility of constructing a sufficiently accurate complete linking table.

Based on these analyses, we conclude that sufficient data exists and that that data can be linked to Exiobase. We therefore propose a future study to link data on ownership to Exiobase. We recommend the use of internally available statistics augmented with ORBIS. One shortcoming with the internally available data is that it does not contain data for the agricultural sector. ORBIS however does contain this data. Therefore, a combination of internally available statistics and ORBIS can provide a comprehensive view of company control, the role of the Netherlands therein, and the impact of the Netherlands on the environment and resource use. We finish the report with several recommendations on regarding future research on this topic, with the aim of maximising the applicability of the results in terms of the insights that they can create into global enterprise control, and environmental and resource issues.

1. Introduction

Understanding globalisation requires new statistics which give insights into the workings and significance of social, economic and environmental phenomena across borders. New information can often be produced by linking existing statistics together, providing novel indicators for measuring and evaluating emerging aspects of globalisation. We describe in this report in brief a preparatory study in which we test whether it will be possible to link the information of 'ownership' or 'span of control' (ultimate controlling institution, UCI) of individual enterprises to the database Exiobase, a global environmentally extended input-output database (see Chapter 2), or Multi-Regional Input Output (MRIO) database. First, the usability of readily available databases will be explored, namely the UCI and the associated FATS (Foreign AffiliaTed Statistics) databases. Next, we will give an indication of the usability of the ORBIS database, a database that contains detailed information on ownership in enterprises across the globe[1]. As ORBIS is not available for free, we should first ask ourselves whether it can make an insightful addition to the information we can extract based on databases that are available within Statistics Netherlands (CBS) and Eurostat.

The results of the study are thus a first step towards linking data on the span of control to Exiobase. Should this linking be feasible, then a database can be constructed which describes the global economy and its environmental and resource effects (Exiobase) with information on which nation's businesses are engaging in given activities. Such a database creates many possibilities for analysing globalisation. For example, it can be seen in which supply chains and related environmental and resource burden, the Netherlands have the least or the most influence as well as to which regions income transfer are linked, influencing Dutch National Income vis-a-vis National Income elsewhere. Insights can also be gained into in which countries and industries Dutch controlled businesses emit greenhouse gasses or use particular resources.

This research has been commissioned by the Ministry of Economic Affairs as a first step towards a better understanding the role of Dutch enterprises in the global economy. This includes the monitoring of the environmental and resource impacts of Dutch enterprises. In accordance with the Dutch government program for a circular economy[2], it is becoming increasingly important to understand these impacts in order to inform policy decisions. This policy aims to cut the use of raw materials in the Netherlands. Exiobase is set up to facilitate analysis of raw materials and can thus identify how raw materials are used in the supply chains upon which the Dutch economy depends. Combining Exiobase with ownership or 'company control' information thus facilitates the analysis of not only the supply chains which emanate from the Netherlands, but also the role of Dutch businesses in those supply chains.

The outcome of this feasibility study will be input to the decision whether the linking of Exiobase to ownership data is feasible. The report will introduce the different data sources which can be used to this end. Further, this report will provide information on the ideal mix of

[1] ORBIS is a database with information of over 200 million companies globally being collected by Bureau van Dijk (www.bvdinfo.com), while for 126 million having active ownership links. Around 70,000 foreign enterprises under Dutch control were found in a first search. FATS is the 'Foreign Affiliates Statistics'. In the Netherlands, like in all European countries, data is collected on foreign companies in the Netherlands ('Inward FATS') and also on Dutch companies abroad ('Outward FATS', or FATSO.

[2] *Rijks breed Programma Circulaire Economie*. See: Rijksoverheid (2016).

the databases to prepare the data and assemble a MRIO database augmented with ownership data in order to facilitate the above mentioned analyses.

This study builds directly upon previous work related to the nexus of environment, economy, globalization and ownership. A study has been conducted by Statistics Netherlands that linked foreign control of enterprises in relation to their materials usage in the Netherlands as monitored by the Material flow Monitor) (CBS, 2016c). Another study by CBS analysed CO_2 emissions in the Netherlands under both foreign and Dutch control as well as for the emissions abroad under control of Dutch enterprises (CBS, 2012; IARIW, 2014). This study analyses the possibility to extend these analyses, both in terms of their topic (via Exiobase) and their scope (to beyond the Netherlands).

In summary, this feasibility study will consist of two parts:

1) Inventory of ownership data:
    a. Ultimate Controlling Institution (UCI), to assess foreign control of enterprises in the Netherlands
    b. Outward FATS, to assess Dutch control abroad, outside of the EU
    c. Inward FATS of all other EU countries from controlling enterprises in the Netherlands
2) Assess the rest of the world. ORBIS contains more detailed property-related information for enterprises across the world. Not only could it be used to assess foreign chains, it may also be useful to strengthen the conclusions found by the study in 1), and to provide additional nuance to these findings. However, as the three datasets under 1 are available for free, the utility of these datasets should be explored before we go into the details of ORBIS, as the latter is not freely available. Hence, one of the questions to be answered is whether investment in ORBIS is worthwhile.

1.1 Structure of the report

Chapter 2 introduces Exiobase and the databases on ownership. In chapter 3, we conduct a basic analysis with the FATS/UCI data to demonstrate the analytical possibilities. We have not obtained data from ORBIS because accessing the data requires a licence. We thus limit our analysis to metadata. Chapter 3 also indicates where the linking to Exiobase will be most successful. In Chapter 4 we first summarize this feasibility study. Then we present conclusions and recommendations regarding the use of databases.

2. Data

2.1 Exiobase

On its website[3] Exiobase is described as "a global, detailed Multi-regional Environmentally Extended (MR EE) Supply-and-Use (SUT) / Input-Output (IOT) database". It was developed by harmonizing and detailing the SUTs for a large number of countries, estimating emissions and resource extractions by industry, linking the country EE SUT via trade to an MR EE SUT, and producing an MR EE IOT from this. The international input-output table can be used for the analysis of the environmental and resource impacts associated with the final consumption of product groups."

In a previous feasibility study by CBS (not published) on the use of Multi-Regional Input Output tables for Circular Economy, Exiobase was assessed as being the best choice for establishing a general methodology to provide footprint indicators and putting the Dutch economy in a global perspective. Therefore, this feasibility study deals with coupling ownership data to Exiobase specifically.

Statistics Netherlands has early access to the not yet publicly available Exiobase version 3.0. The database contains information on 43 countries, 5 RoW[4] (Rest of World) regions, 200 products, 163 industries, 15 land use types, employment per three skill levels, 48 types of raw materials and 172 types of water uses. Exiobase in principle provides a product × product MRIO database as main table, but an industry × industry MRIO database is also available. Descriptions of how such MRIOTs are established and how they can be used for analyses can be found in Tukker *et al.* (2013) and Wood *et al.* (2015). In Annex I we provide a table of the industry sectors that are defined for Exiobase in order to provide an insight into the focus and analytical possibilities of Exiobase.

2.2 Databases on ownership

The study investigates the criterion 'span of control' as a measure for 'ownership'. Thus, if a given business falls under the Dutch span of control then it can be considered a Dutch business. In a globalising world, the controlling countries are not just most likely receive most of the profits, but also decide on the locations of particular resources, materials or emission intensive activities. To that end, we make use of two databases available within CBS (UCI and OFATS), and one database available from Eurostat (IFATS).

2.2.1 UCI

Each enterprise can be part of a larger enterprise group, and such a group can also be established internationally. The Ultimate Controlling Institutional unit (UCI unit) is defined as the company which controls a given Dutch company, which is not under control of another company. Foreign control means that country where the UCI is established is a different country

[3] http://www.exiobase.eu/

[4] A RoW region contains multiple countries. Often in MRIO databases there are many countries and one RoW. Exiobase splits the RoW into a number of RoW regions.

than the Netherlands. This database is used to provide the inward FATS of the Netherlands to Eurostat (see below).

2.2.2 FATS

Statistics on the structure and activity of FATS provide information that can be used to assess the impact of foreign-controlled enterprises on the European economy. These data may also be used to monitor the effectiveness of the internal market and the gradual integration of economies in the context of globalisation.

Outward FATS

Outward FATS are statistics describing the activity of foreign affiliates abroad controlled by UCIs located in the declaring country. So specifically within CBS, it concerns Dutch enterprise groups that exhibit daughter enterprises *outside of the EU*. Viewed from those countries, The Netherlands is the UCI. In total, 13 countries provide these data on a voluntary basis to Eurostat, for some the first reference year dates back to 1995.

Inward FATS

A foreign affiliate as defined in inward FATS statistics is an enterprise resident in a country which is under the control of an institutional unit not resident in the same country. Control is determined according to the concept of the UCI unit. Note that commercial presence in the territory of another country is only one of the modes of delivery of economic activities abroad. Data on inward FATS has been collected on a voluntary basis since reference year 1996 by Eurostat. Currently, some 21 countries participate in this data collection exercise.

Inward FATS data is used to determine the outward FATS of the Netherlands *within the EU*. This means that all countries in the EU are evaluated by the criterion 'UCI in the Netherlands'. Eurostat provides this information aggregated on the NACE Rev.2 level. NACE is a standardized European industrial activity classification (in Dutch, Standaard Bedrijfsindeling, SBI).

2.2.3 Ownership data in ORBIS database

ORBIS is an external database run by a commercial company Bureau van Dijk. It contains detailed company information on over 200 million companies worldwide, including information on ownership. This dataset is exclusively and commercially available. The database includes:

- Shareholdings and subsidiaries
- Share (%) in ownership by country (i.e. NL ownership)
- Direct and indirect ownership
- Ultimate owners - domestic and global
- Independence indicator
- Corporate group - all companies with the same ultimate owner as the subject company
- Company tree diagrams
- Beneficial ownership
- Ability to calculate ownership using either 'bottom up' or 'top down' approaches
- Ability to edit definitions of ownership

The database thus has detailed information on ownership, also with additional detail on distribution of shares of ownership and in type of ownership. Where the enterprises in the

ORBIS database pertain to Dutch enterprises, Statistics Netherlands data can in principle be linked to ORBIS via the Chamber of Commerce number which is also available in the ORBIS database. The success of this link could only be judged once ORBIS data have been obtained and analysed.

3. Analysis

3.1 Technicalities of UCI and FATS

3.1.1 UCI and outward FATS

UCI and outward FATS are available within Statistics Netherlands. The UCI (Ultimate Controlling Institution) is a catalogue established by CBS. This catalogue provides per enterprise (in Dutch, bedrijfseenheid) the enterprise group (in Dutch, ondernemingengroep) it belongs to, the country in which the controlling institution is based, whether or not the enterprise is still active today and the source from which this information is obtained. The most important pieces of information are (1) the enterprise and (2) the country of the controlling institution of the enterprise group. Namely, these two pieces of information provide the key to linking of the controlling country to the NACE[5], which is known for each enterprise. NACE is the variable with which a link can be made to the industry classification in Exiobase.

The outward FATS of CBS provides information for Dutch enterprise groups in which countries **outside of the EU** have daughter enterprises. As opposed to the UCI, this information provides insight into outgoing control, and will be used as a proxy for consumption outside of the EU under Dutch control.

3.1.2 Inward FATS of the EU

Currently, CBS does not maintain a database that contains outward FATS within the EU. One reason for this is that it is not obliged to deliver this information to Eurostat. Another reason is that the inward FATS of other countries within the EU provides the Dutch outward FATS in the EU. When downloading this database from Eurostat, the controlling country needs to be set to the Netherlands. In the future, CBS will likely build and maintain an outward FATS database for daughter enterprises that operate in the EU. The advantage of such a database is that Dutch control in the EU can then be established at the enterprise group level. However, for now, we will deduce Dutch outward FATS within the EU by viewing inward FATS per NACE for the countries in the EU that are under Dutch control. With the UCI and outward FATS, EU inward FATS (obtained from Eurostat) completes the picture for ownership in the Dutch value chain: Dutch enterprises controlled by foreign countries and non-Dutch enterprises that have ultimate control in the Netherlands. First, we will explore some of the results of these three databases for the year 2012.

3.2 Foreign control of Dutch companies and Dutch control of foreign companies by NACE

In this section, we map the span of control on each NACE sector in the Netherlands. This to illustrate the order of magnitude of foreign and domestic control. The data is only available for the NACE sectors in the “business economy”. The industry sectors within the business economy are:

[5] NACE: Nomenclature statistique des Activités économiques dans la Communauté Européenne (Statistical Nomenclature of Economic Activities in the European Community).

- B Mining and quarrying
- C Manufacturing
- D Electricity, gas, steam and air conditioning supply
- E Water supply; sewerage; waste management and remediation activities
- F Construction
- G Wholesale and retail trade; repair of motor vehicles and motorcycles
- H Transporting and storage
- I Accommodation and food service activities
- J Information and communication
- L Real estate activities
- M Professional, scientific and technical activities
- N Administrative and support service activities
- S95 Repair of computers and personal and household goods

The 'business economy' thus excludes agriculture (A) and financial and insurance activities (K). We also map the amount of Dutch control abroad per NACE and relate this to the size of the Dutch economy in terms of persons employed. The idea is to link this information to Exiobase via coupling of NACE to the Exiobase industry sectors. The EU inward FATS and the Dutch outward FATS are available on the 2-digit NACE level[6] (in outward FATS, several 3-digits NACEs are available, but not a lot). UCI is available on the 5-digit NACE level. To make matters consistent and for illustrative purposes, we will present results on the 1-digit NACE level. We believe that this level of detail is sufficient without making the size of the results excessively large. It should be noted that all analyses can be repeated on the 2-digit NACE level without problems.

In this section, we subsequently show UCI of Dutch enterprises, outward FATS of the Netherlands and the inwards FATS in the EU with the Netherlands as the UCI in terms of relative persons employed. We then show a possible quantification of the economic activity of Dutch controlled enterprises abroad.

We show in figure 1 on the 1-digit NACE level the control by country in terms of persons employed of enterprises in the Netherlands in 2012. Note that this information is readily available on the 2-digit NACE level, but is too large to display for illustrative purposes.

[6]In the outward FATS, some categorisations are made at the 3-digit NACE level, but for the majority, only 2-digit classifications are available.

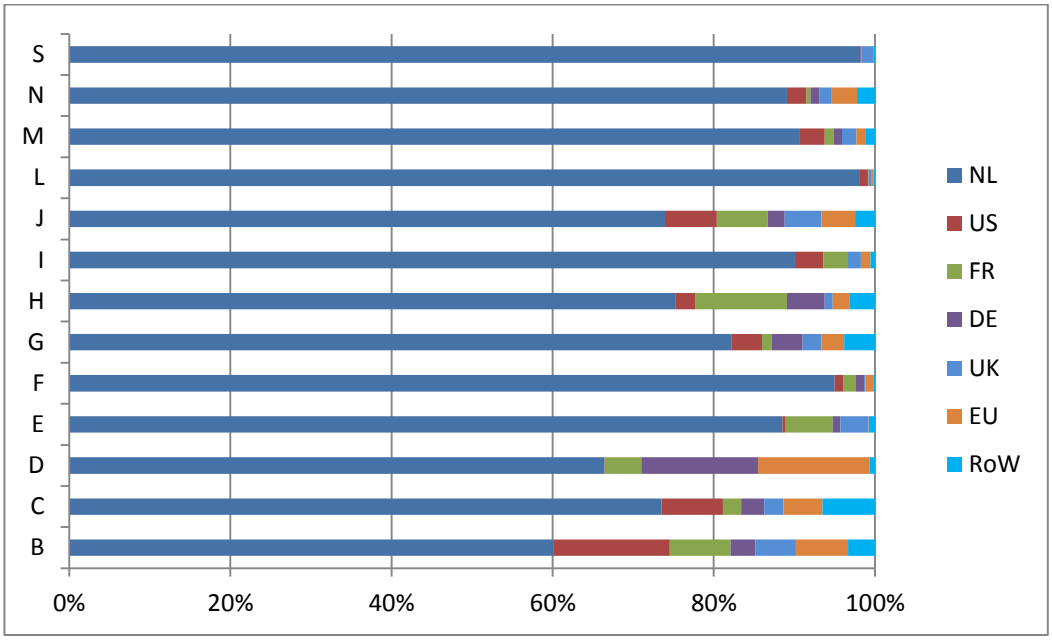

Figure 1 Control span of enterprises in the Netherlands by country in terms of persons employed per NACE (2012). Many countries have been aggregated into the RoW to ease interpretation.

Not surprisingly, the largest portion of control exhibited for enterprises in the Netherlands, is by institutional units (Dutch enterprises) based in the Netherlands itself. Germany, France and the US also have a fair share of control of enterprises in the Netherlands. The total number of persons employed in this analysis is approximately 5.8 million (business economy only).

Figure 2 displays the degree of control in non-EU countries by the Netherlands in terms of persons employed per (1-digit) NACE. Again, we show 1-digit NACE but the 2-digit level is readily available. The total number of persons employed in Dutch daughters is almost 790 thousand, almost 13% of the persons employed by Dutch enterprises in the business economy. Therefore, when using the data in figure 2 as a proxy for Dutch consumption, note that in terms of persons employed the economic activity of foreign, non-EU Dutch controlled is approximately 10% of that in the Netherlands. The Netherlands appears to control large daughter enterprises outside of the EU in Brazil, in the US and in China. A fair share is located in Canada.

We now consider Dutch control in the European Union. The Dutch control of EU enterprises outside the Netherlands in terms of persons employed by daughters of Dutch enterprise groups is highest in Germany and in the UK. It concerns more than 1.5 million persons employed, which is approximately equal to 25% of the total number of persons employed in the Netherlands itself, to show the order of magnitude in relation to the size Dutch economic activity.

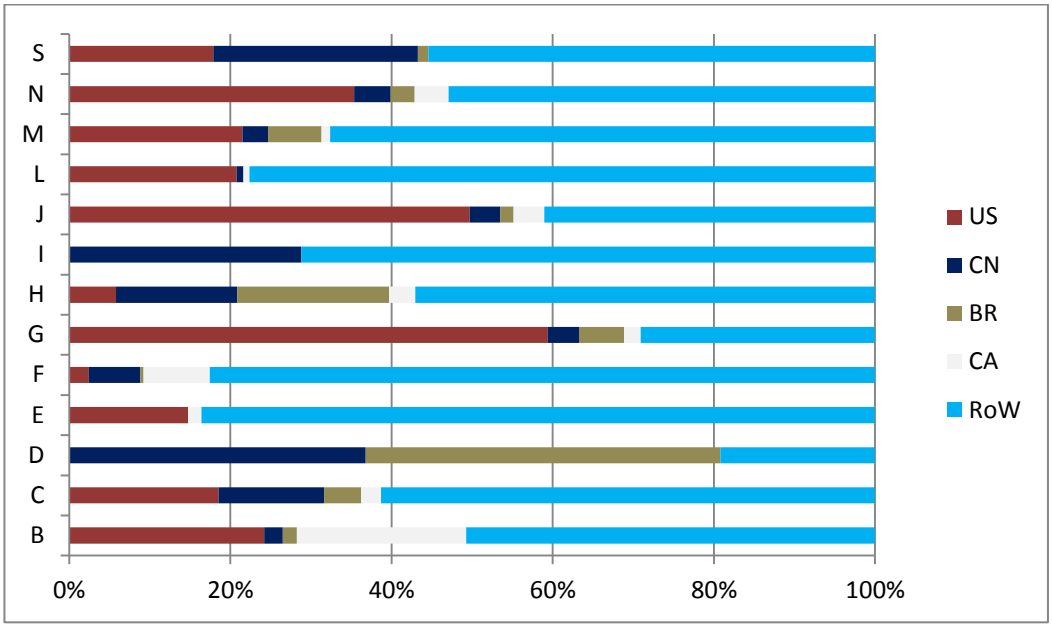

Figure 2 Control span of the Netherlands by country in terms of persons employed for all Dutch daughters outside of the EU per NACE (2012). Many countries have been aggregated into the RoW to ease interpretation.

3.2.1 Consumption in the chain

Now we have established per NACE in terms of number of persons employed as a proxy for economic activity:

1. The amount of foreign control of enterprises in the Netherlands,
2. The amount of Dutch control in the EU,
3. The amount of Dutch control elsewhere in the world outside of the EU.

The first can be used as a proxy for the input in the Netherlands, the second and third as weighting factors for the destinations of the value chain of Dutch activities. However, the second and third cannot be used in their current forms. Additional information is needed per NACE, namely the percentage of persons employed in foreign economies under Dutch control as a percentage once compared to the Dutch economic activity, that is by Dutch residents, i.e.

$$p_{foreign} = \frac{E_{foreign}}{E_{foreign}+E_{Dutch}} \times 100 \qquad \text{(eq. 1)}$$

where $p_{foreign}$ is the percentage of economic activity in a NACE as compared to the Dutch economic activity in that NACE in the Netherlands together with the portion outside the Netherlands which is under Dutch control. Namely, $E_{foreign}$ is the number of persons employed abroad, thus outside the Dutch economy in the NACE (in this chapter, either in the EU or outside of the EU) and E_{Dutch} is the number of domestically employed persons employed in the NACE (regardless of Dutch or foreign control). The denominator is defined as the sum of the persons employed within a NACE domestically and abroad to prevent percentages greater than 100 for activity abroad. One could argue that a suitable alternative would be

$$\frac{E_{foreign}}{E_{Dutch}} \times 100. \qquad \text{(eq. 2)}$$

Table 1 shows the results (percentages) derived using equation 1 for the 1-digit NACE. The results are available for 2-digit NACE.

To help understand how to interpret the results, let us take the example of NACE C (manufacturing) in Germany under Dutch control. Table 1 and figure 3 together imply that in Germany, Dutch daughters account for almost 13% of the persons employed in both the Dutch manufacturing sector and the Dutch controlled manufacturing sector in the EU. This is because manufacturing in the EU under 'Dutch control' comprises 38.4% compared to Dutch manufacturing activity in the Netherlands (table 1) and 33.8% of this control is in Germany (figure 3)[7]. This gives no information on the German manufacturing industry in itself, just on the economic significance of Dutch daughter enterprises in the manufacturing industry in Germany.

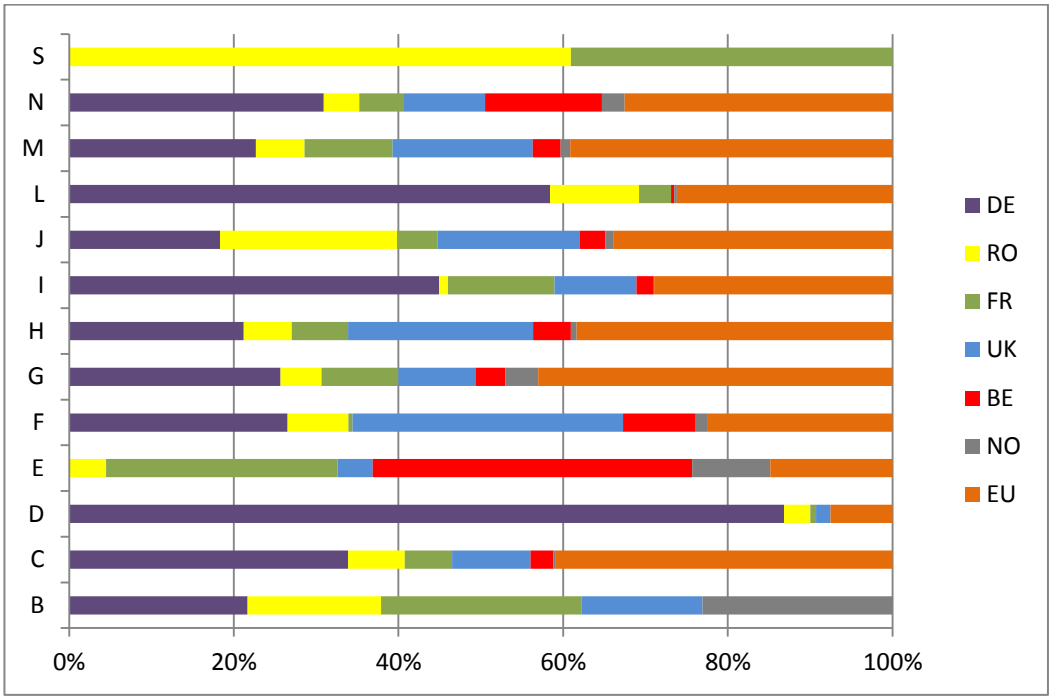

Figure 3 Control span of the Netherlands by country in terms of persons employed for all Dutch daughters inside of the EU per NACE (2012). Many countries have been aggregated into the EU to ease interpretation.

The economic activities of the 2-digit NACEs (10 and beyond, B aggregated (6 and 9)) are available (Annex V).

[7] Calculated as: 0.384 × 0.338 = 0.129 = 13%.

Table 1 Percentage of 'economic activity abroad under Dutch control' as compared to 'the activity in the Dutch economy' in terms of persons employed, by NACE.

NACE	p_{nonEU}	p_{EU}
B Mining and quarrying	76,3	40,2
C Manufacturing	34,4	38,4
D Electricity, gas, steam and air conditioning supply	27,7	28,5
E Water supply; sewerage; waste management and remediation activities	1,4	12,6
F Construction	2,1	7,7
G Wholesale and retail trade; repair of motor vehicles and motorcycles	10,1	19,2
H Transporting and storage	10,5	19,2
I Accommodation and food service activities	0	5,3
J Information and communication	6,6	19,9
L Real estate activities	1,7	11
M Professional, scientific and technical activities	8,2	11,2
N Administrative and support service activities	3,2	25,5
S Other services activities	0,3	0,1

3.3 Linking to Exiobase

The datasets and linkage introduced in the previous section provide the starting point to establish the share and amount of foreign control within Exiobase sectors in the Netherlands, and the amount of Dutch control in foreign countries within Exiobase sectors. The linking of these data to Exiobase requires a linking table which shows the relationship between the NACE sectors and Exiobase sectors. As part of this study, and in order to make a general judgement about the feasibility of such a linking, a preliminary attempt has been made to construct a linking table. This attempt demonstrated that the linking NACE to Exiobase sectors is feasible, but will require more research in order to ensure that the linking table is of the highest possible quality.

More research will be needed to determine the most appropriate way to deal with cases where Exiobase sectors do not share a one-to-one relationship with NACE sectors. Example of these problems are given in Table 2. A good example of where the linking is complicated is industrial activity B (Mining and quarrying). This sector is very thoroughly defined in Exiobase, but less so by the NACE categories.

Table 2 Example of non-unique coupling of NACE to Exiobase sector in sector B (Mining and Quarrying).

NACE	*NACE name*	*Exiobase sector name*
610	Extraction of crude petroleum	Extraction of crude petroleum and services related to crude oil extraction, excluding surveying
610	Extraction of crude petroleum	Extraction, liquefaction, and regasification of other petroleum and gaseous materials
620	Extraction of natural gas	Extraction of natural gas and services related to natural gas extraction, excluding surveying
620	Extraction of natural gas	Extraction, liquefaction, and regasification of other petroleum and gaseous materials
811	Quarrying of ornamental and building stone, limestone, gypsum, chalk and slate	Quarrying of stone
812	Operation of gravel and sand pits; mining of clays and kaolin	Quarrying of sand and clay
812	Operation of gravel and sand pits; mining of clays and kaolin	Quarrying of sand and clay
893	Extraction of salt	Mining of chemical and fertilizer minerals, production of salt, other mining and quarrying n.e.c.
899	Other mining and quarrying n.e.c.	Mining of copper ores and concentrates
899	Other mining and quarrying n.e.c.	Mining of lead, zinc and tin ores and concentrates
899	Other mining and quarrying n.e.c.	Mining of other non-ferrous metal ores and concentrates
899	Other mining and quarrying n.e.c.	Mining of aluminium ores and concentrates
899	Other mining and quarrying n.e.c.	Mining of precious metal ores and concentrates
899	Other mining and quarrying n.e.c.	Mining of uranium and thorium ores
899	Other mining and quarrying n.e.c.	Mining of iron ores
899	Other mining and quarrying n.e.c.	Mining of nickel ores and concentrates
910	Support activities for petroleum and natural gas extraction	Extraction of crude petroleum and services related to crude oil extraction, excluding surveying
910	Support activities for petroleum and natural gas extraction	Extraction of natural gas and services related to natural gas extraction, excluding surveying
910	Support activities for petroleum and natural gas extraction	Extraction, liquefaction, and regasification of other petroleum and gaseous materials

In table 2, NACE 0899 is present and corresponds to 8 Exiobase sectors. It is therefore necessary to divide the NACE according by an appropriate division key in order to allocate the correct part of the NACE sector to a relevant Exiobase sectors. The first step in executing the linking

between Exiobase and the ownership data is to improve the linking table. This can be achieved by gaining more information on how the Exiobase categories are determined and by searching for additional information which can provide division keys. In general, making a linking table which performs satisfactorily appears feasible. However, truly judging the performance of a linking table requires testing the plausibility of the results produced by its application.

4. Conclusions and recommendations

With this study a first assessment is made whether the proposed connection between the three main databases with information on 'ownership' (CBS's UCI and outward foreign affiliates (FATS) and Eurostat's European inward FATS coming from the Netherlands) and Exiobase can be executed. The outcome of this feasibility study is generally positive. With the type of micro data internally available within CBS, the attempted coupling to Exiobase can be performed.

For some parts of the foreseen coupling (Dutch controlled enterprises abroad) the external data on 'control' is required and should be obtained and accessed. Similarly positive is the prospect to access the external database ORBIS. ORBIS has data on a substantial number of Dutch controlled enterprises abroad, bringing nuance to the findings that can be obtained from our own databases. For example, ORBIS contains information on the share in ownership by country (in %) and on direct and indirect ownership. These companies are often big with substantial number of employees for example. Although the exact coverage of foreign companies under Dutch control of this database is unclear, we can expect sufficient coverage to facilitate meaningful analysis. Moreover, ORBIS contains useful information on control regarding NACE A (agriculture), which is hard to establish within CBS due to the sources that are used to construct UCI and FATS.

Because the ORBIS database is not freely available, its use by Statistics Netherlands needs to be carefully evaluated. An indication can be provided on the range of the costs of using particular (parts of) ORBIS on request. This issue will need to be carefully addressed in the earliest stages of any future research on this topic. In any case, openly or internally available data provides a satisfactory basis for analysis of enterprise ownership. There is the possibility that ORBIS can be used internally within Statistics for other purposes than that described in this study. It is therefore important to consider carefully the most cost-efficient way to obtain ORBIS data.

Thus, the results of this feasibility study are a first, but promising step towards linking data on the 'span of control' to Exiobase for assessing global value chains with several possible environment extensions such as resource and material use, water use or carbon emissions. The required linkage of the necessary data appears feasible, thus enabling the construction of a database that describes the global economy and its environmental effects with information on which nation's businesses are engaging in given activities and to what extent. A database that enables a long list of opportunities for analysing globalisation, related resources usage, environmental impact and even the relevant income flows in connection to National Income, not just GDP. The linked databases and connected data allows us to derive useful new information to support practice, research and multiple policy topics.

The successor of this study will provide the opportunity to compare different approaches for quantifying emissions and attributing them to controlling countries. It should be noted that different approaches and aggregations for assessment of CO_2 emissions yield considerable different and interesting results in terms of emissions of Dutch controlled companies in the Netherlands and abroad. Therefore, this study can also be a first towards a standard methodology for such assessments, eliminating any significant discrepancies in results.

Because the linkage of the relevant databases on company control to Exiobase seems feasible, we make seven recommendations regarding the study in which this would take place.

1. Time series

The possibility to analyse more than a single year, possibly 2010 next to 2014 in future research, and maybe even an extended time series, would be valuable to analyse trends in global value chains and resource and emission efficiencies, or put differently in circular economy aspects. Such data in time series might help in answering questions on 'carbon leakage' or 'resource leakage'.

2. Agriculture

Primary agricultural production sector and financial industries may require particular attention in the next research to check and compare on sufficiency and consistency of the data on 'company control' in these industries. One may well expect that shares of 'foreign control' are pretty low in agriculture though.

3. Geopolitics and rare materials

For future research we recommend to focus on certain monetary and physical flows, (rare) materials, regions and on particular combinations to study geopolitical aspects and risks. The focus will be determined by policy priorities which can be feasible studied given the industry and product classifications in Exiobase.

4. Availability and coverage of databases

The continuous availability, completeness and coverage of the databases mentioned herein, need to be tested and confirmed upon starting any follow-up project.

5. Perspective for action

The potential continuation of the study should also sufficiently pay attention to what can be learned from the linked statistics and databases and the value chains it describes. Insight will be provided into resource and emission efficiencies, both territorial and with respect to ownership. For example, if we find that Dutch controlled companies abroad show particularly high resources inefficiencies and/or emission inefficiencies, or the other way around, this can pave the way for action in terms of domestic policy.

6. Span of control emissions

Calculating what the CO_2 emissions of the Netherlands are, requires first addressing definitional questions such as whether to include activities of residents living abroad. Linking ownerships data to Exiobase facilitates calculating the carbon footprint of companies within Dutch span of control. Emission intensities can also be calculated.

7. Complexity analysis and prospect for cooperation

Within CBS, several projects in the field of complexity are being proposed that may need ORBIS information as well. It is worthwhile to investigate the need for this database within CBS and to propose internal collaborations, as mentioned above, and to carefully consider which parts of ORBIS are essential for our research to minimize the costs. Then the purchase of an expensive external source can be arranged centrally, i.e. for CBS as a whole. Such a situation can further promote CBS's research output and collaborations.

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Annex I Industrial Activity Definitions of Exiobase

Exiobase contains 163 industrial activity definitions, listed below.

Agriculture	Cultivation of paddy rice
	Cultivation of wheat
	Cultivation of cereal grains nec
	Cultivation of vegetables, fruit, nuts
	Cultivation of oil seeds
	Cultivation of sugar cane, sugar beet
	Cultivation of plant-based fibres
	Cultivation of crops nec
Farming	Cattle farming
	Pigs farming
	Poultry farming
	Meat animals nec
	Animal products nec
	Raw milk
	Wool, silk-worm cocoons
	Manure treatment (conventional), storage and land application
	Manure treatment (biogas), storage and land application
Forestry and fishing	Forestry, logging and related service activities
	Fishing, operating of fish hatcheries and fish farms; service activities incidental to fishing
Mining and quarrying	Mining of coal and lignite; extraction of peat
	Extraction of crude petroleum and services related to crude oil extraction, excluding surveying
	Extraction of natural gas and services related to natural gas extraction, excluding surveying
	Extraction, liquefaction, and regasification of other petroleum and gaseous materials
	Mining of uranium and thorium ores
	Mining of iron ores
	Mining of copper ores and concentrates
	Mining of nickel ores and concentrates
	Mining of aluminium ores and concentrates
	Mining of precious metal ores and concentrates
	Mining of lead, zinc and tin ores and concentrates
	Mining of other non-ferrous metal ores and concentrates
	Quarrying of stone
	Quarrying of sand and clay
	Mining of chemical and fertilizer minerals, production of salt, other mining and quarrying n.e.c.

Food processing	Processing of meat cattle
	Processing of meat pigs
	Processing of meat poultry
	Production of meat products nec
	Processing vegetable oils and fats
	Processing of dairy products
	Processed rice
	Sugar refining
	Processing of Food products nec
Manufacturing	Manufacture of beverages
	Manufacture of fish products
	Manufacture of tobacco products
	Manufacture of textiles
	Manufacture of wearing apparel; dressing and dyeing of fur
	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
	Re-processing of secondary wood material into new wood material
	Pulp
	Re-processing of secondary paper into new pulp
	Paper
	Publishing, printing and reproduction of recorded media
	Manufacture of coke oven products
	Petroleum Refinery
	Processing of nuclear fuel
	Plastics, basic
	Re-processing of secondary plastic into new plastic
	N-fertiliser
	P- and other fertiliser
	Chemicals nec
	Manufacture of rubber and plastic products
	Manufacture of glass and glass products
	Re-processing of secondary glass into new glass
	Manufacture of ceramic goods
	Manufacture of bricks, tiles and construction products, in baked clay
	Manufacture of cement, lime and plaster
	Re-processing of ash into clinker
	Manufacture of other non-metallic mineral products n.e.c.
	Manufacture of basic iron and steel and of ferro-alloys and first products thereof
	Manufacture of gas; distribution of gaseous fuels through mains

	Re-processing of secondary steel into new steel
	Precious metals production
	Re-processing of secondary preciuos metals into new preciuos metals
	Aluminium production
	Re-processing of secondary aluminium into new aluminium
	Lead, zinc and tin production
	Re-processing of secondary lead into new lead
	Copper production
	Re-processing of secondary copper into new copper
	Other non-ferrous metal production
	Re-processing of secondary other non-ferrous metals into new other non-ferrous metals
	Casting of metals
	Manufacture of fabricated metal products, except machinery and equipment
	Manufacture of machinery and equipment n.e.c.
	Manufacture of office machinery and computers
	Manufacture of electrical machinery and apparatus n.e.c.
	Manufacture of radio, television and communication equipment and apparatus
	Manufacture of medical, precision and optical instruments, watches and clocks
	Manufacture of motor vehicles, trailers and semi-trailers
	Manufacture of other transport equipment
	Manufacture of furniture; manufacturing n.e.c.
	Recycling of waste and scrap
	Recycling of bottles by direct reuse
Electricity and water	Production of electricity by coal
	Production of electricity by gas
	Production of electricity by nuclear
	Production of electricity by hydro
	Production of electricity by wind
	Production of electricity by petroleum and other oil derivatives
	Production of electricity by biomass and waste
	Production of electricity by solar photovoltaic
	Production of electricity by solar thermal
	Production of electricity by tide, wave, ocean
	Production of electricity by Geothermal
	Production of electricity nec
	Transmission of electricity
	Distribution and trade of electricity
	Steam and hot water supply
	Collection, purification and distribution of water

Construction	Construction
	Re-processing of secondary construction material into aggregates
Trade, motor vehicles and transport	Sale, maintenance, repair of motor vehicles, motor vehicles parts, motorcycles, motor cycles parts and accessories
	Retail sale of automotive fuel
	Wholesale trade and commission trade, except of motor vehicles and motorcycles
	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods
	Hotels and restaurants
	Transport via railways
	Other land transport
	Transport via pipelines
	Sea and coastal water transport
	Inland water transport
	Air transport
	Supporting and auxiliary transport activities; activities of travel agencies
	Post and telecommunications
Financial institutions and insurance agencies	Financial intermediation, except insurance and pension funding
	Insurance and pension funding, except compulsory social security
	Activities auxiliary to financial intermediation
	Real estate activities
	Renting of machinery and equipment without operator and of personal and household goods
	Computer and related activities
Other business	Research and development
	Other business activities
Government	Public administration and defence; compulsory social security
Education	Education
Health and social work	Health and social work
Waste treatment	Incineration of waste: Food
	Incineration of waste: Paper
	Incineration of waste: Plastic
	Incineration of waste: Metals and Inert materials
	Incineration of waste: Textiles
	Incineration of waste: Wood
	Incineration of waste: Oil/Hazardous waste

	Biogasification of food waste, incl. land application
	Biogasification of paper, incl. land application
	Biogasification of sewage slugde, incl. land application
	Composting of food waste, incl. land application
	Composting of paper and wood, incl. land application
	Waste water treatment, food
	Waste water treatment, other
	Landfill of waste: Food
	Landfill of waste: Paper
	Landfill of waste: Plastic
	Landfill of waste: Inert/metal/hazardous
	Landfill of waste: Textiles
	Landfill of waste: Wood
Industrial activities nec	Activities of membership organisation n.e.c.
	Recreational, cultural and sporting activities
	Other service activities
	Private households with employed persons
	Extra-territorial organizations and bodies

Annex II Part of the UCI in the Netherlands per country and 2-digit NACE (%)

Each 2-digit NACE level (column) sums up to 100%.

Country/NACE	10	11	12	13	14	15	16 ….
AE	0,0	0,0	0,0	0,0	0,0	0,0	0,0
AF	0,0	0,0	0,0	0,0	0,0	0,0	0,0
AR	0,0	0,0	0,0	0,0	0,0	0,0	0,0
AT	0,0	0,0	0,0	0,0	0,0	0,0	0,0
AU	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BE	1,2	8,4	0,0	1,2	1,1	0,0	0,0
BH	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BM	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BN	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BR	0,2	0,0	0,0	0,0	0,0	0,0	0,0
BY	0,0	0,0	0,0	0,0	0,0	0,0	0,0
CA	0,7	0,0	0,0	0,2	0,0	0,0	0,0
CH	1,0	0,0	0,0	0,4	0,0	5,8	0,1
CL	0,0	0,0	0,0	0,0	0,0	0,0	0,0
CN	0,2	0,0	0,0	0,0	0,0	0,1	0,0
CO	0,0	0,0	0,0	0,0	0,0	0,0	0,0
CR	0,0	0,0	0,0	0,0	0,0	0,0	0,0
CY	0,0	0,0	0,0	0,0	0,0	0,0	0,0
CZ	0,0	0,0	0,0	0,0	0,0	0,0	0,0
DE	1,4	0,1	0,0	1,2	0,2	0,0	0,4
DK	0,3	0,0	9,6	0,0	0,0	6,3	0,0
DO	0,0	0,0	0,0	0,0	0,0	0,0	0,0
DZ	0,0	0,0	0,0	0,0	0,0	0,0	0,0
EE	0,0	0,0	0,0	0,0	0,0	0,0	0,0
…	…	…	…	…	…	…	…

Annex III Part of the outward FATS of the Netherlands per country and 2-digit NACE (%)

Each 2-digit NACE level (column) sums up to 100%.

Country/NACE	10	11	12	13	14	15	16 ….
AE	0,0	0,0	0,0	0,8	0,0	0,0	0,0
AF	0,0	0,0	0,0	0,0	0,0	0,0	0,0
AI	0,0	0,0	0,0	0,0	0,0	0,0	0,0
AL	0,0	0,0	0,0	0,0	0,0	0,0	0,0
AM	0,0	0,0	0,0	0,0	0,0	0,0	0,0
AO	0,0	0,0	0,0	0,0	0,0	0,0	0,0
AR	0,8	0,0	0,0	2,1	0,0	0,0	0,0
AT	0,0	0,0	0,0	0,0	0,0	0,0	0,0
AU	0,2	0,0	0,0	4,9	0,0	0,0	0,0
AW	0,0	0,0	0,0	0,0	0,0	0,0	0,0
AZ	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BA	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BB	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BD	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BE	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BF	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BG	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BH	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BI	0,0	1,3	0,0	0,0	0,0	0,0	0,0
BM	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BN	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BO	0,0	0,0	0,0	0,0	0,0	0,0	67,4
BQ	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BR	3,1	3,5	0,0	0,8	0,0	0,0	0,0
BS	0,0	0,7	0,0	0,0	0,0	0,0	0,0
BW	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BY	0,4	1,6	0,0	0,0	0,0	0,0	0,0
CA	4,7	0,0	0,0	2,7	0,0	0,0	4,2
…	…	…	…	…	…	…	…

Annex IV Part of the inward FATS of the EU per country and 2-digit NACE (%)

Each 2-digit NACE level (column) sums up to 100%. In these statistics, Eurostat introduces confidentiality in terms of persons employed, hence we cannot calculate percentages. For instance, NACE 12 (in C), Manufacture of tobacco products, is kept confidential by Eurostat and percentages are unavailable.

Country/NACE	10	11	12	13	14	15	16….
AT	1,1	0,0	.	0,0	0,0	0,0	0,0
BA	0,0	0,0	.	0,0	0,0	0,0	0,0
BE	5,2	7,5	.	0,0	0,0	0,0	0,0
BG	0,0	14,4	.	0,0	30,8	0,0	0,0
CY	0,0	0,0	.	0,0	0,0	0,0	0,0
CZ	1,0	0,0	.	6,4	0,0	0,0	14,9
DE	26,6	0,0	.	30,2	0,0	0,0	10,9
DK	0,6	0,0	.	0,0	0,0	0,0	0,0
EE	0,0	0,0	.	0,0	0,0	0,0	0,0
EL	1,9	0,0	.	0,0	0,0	0,0	0,0
ES	9,3	30,1	.	5,8	0,0	0,0	0,0
FI	0,0	0,0	.	0,0	0,0	0,0	0,0
FR	4,0	23,5	.	4,6	0,0	0,0	8,0
HR	0,0	0,0	.	0,0	0,0	0,0	0,0
HU	2,9	0,0	.	0,0	0,0	4,8	6,2
IE	0,0	0,0	.	0,0	0,0	0,0	0,0
IT	1,6	14,0	.	0,0	0,0	0,0	0,0
LT	0,5	0,0	.	0,0	0,0	0,0	10,9
LU	0,0	0,0	.	0,0	0,0	0,0	0,0
LV	0,0	0,0	.	0,0	0,0	0,0	6,9
MT	0,0	0,0	.	0,0	0,0	0,0	0,0
NL	0,0	0,0	.	0,0	0,0	0,0	0,0
NO	0,6	0,0	.	2,6	0,0	0,0	0,4
PL	10,8	0,0	.	35,8	18,6	0,0	30,3
PT	1,4	0,0	.	0,0	0,0	0,0	0,0
RO	4,7	10,5	.	7,9	50,6	95,2	11,5
SE	5,5	0,0	.	0,0	0,0	0,0	0,0
SI	0,0	0,0	.	3,9	0,0	0,0	0,0
SK	1,5	0,0	.	0,0	0,0	0,0	0,0
UK	20,6	0,0	.	2,8	0,0	0,0	0,0

Annex V Economic activities of Dutch controlled enterprises abroad (% of Dutch economic activity in terms of persons employed)

NACE 2-digit	*Relative economic activity outside the EU*	*Relative economic activity in the EU*
10	32,8	32,6
11	89,3	58,3
12	38,3	.
13	21,9	29,3
14	4,9	53,9
15	1,3	61,0
16	1,3	14,7
17	14,0	21,5
18	0,5	10,1
19	88,7	30,1
20	62,7	43,4
21	16,8	22,9
22	16,6	55,4
23	0,3	19,7
24	0,1	59,0
25	5,2	20,1