Statistics Netherlands

Report

Who needs MRIOs anyway? An alternative assignment of value added of trade

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Remark: The views expressed in this paper are those of the author and do not necessarily reflect the policies of Statistics Netherlands

Abstract

During the last years much progress has been achieved in the field of multi region input-output tables (MRIOs). These are used to show interdependencies between countries in terms of value added and jobs created due to trade. It is commonplace to assign these interdependencies to the country where the goods and services are ultimately consumed. For example, Dutch steel factories sell their products to German car factories that use it to produce cars for China. Then the value added in the Netherlands is counted as due to final consumption in China.

The proposed alternative is to assign the value added as being due to the trading partner at arm's length. In the example above the Netherlands would have value added due to exports to Germany. This measure was already known in the literature on environmental MRIOs. Users, for example ministries or employers' associations, not only find this measure easier to understand, for some purposes they also find it more useful. For several lobby efforts they would like to know in which country exporters directly earn their money and how much. An advantage of the measure is that it does not need an MRIO. A national input-output table and national trade date are sufficient. This enables calculation of more timely and more detailed data. As an application we calculate the value added of direct Dutch exports to the group of countries in the Dutch Good Growth Fund in 2014. This group consists of 68 emerging markets and developing countries.

The paper shows how to assign value added in exports to the direct trading partner. For the ten largest exporters in the world it considers their mutual value added in trade, first assigning it to the direct trading partner, then to the country of final consumption. The conclusion is that the two measures yield different information and that they complement each other.

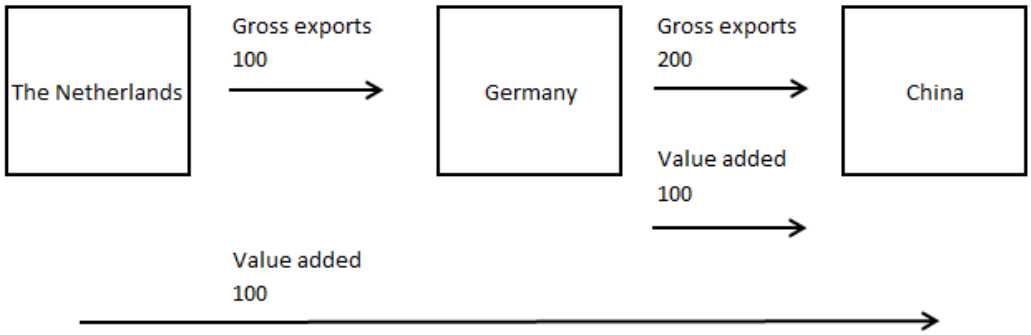
Keywords: *multi-regional input-output analysis, MRIO, ICIO, trade in value added, TiVA, heterogeneity, re-exports, WIOD*

JEL Classification: *D57, F13, F14.*

1. Introduction

In recent years much progress in creating Multi Region Input-Output (MRIO) tables has been achieved by the World Input-Output Database (WIOD, Timmer et al. 2015) project and at OECD/WTO. These tables show trade in intermediates between individual industries in individual countries and the use of their final products. Using these tables yields many new insights. For example, in figure 1.1 below Germany was traditionally seen as the source of imports for China. And there was no relation between the Netherlands and China whatsoever. In reality that relation does exist. Because the Netherlands produce intermediate goods and services (for example steel for the German car industry that uses it to produce cars for China) that are being used by Germany to produce for China. Thus, China is dependent on the Netherlands for supply, the Netherlands are dependent on China for demand. Because there is value added in the Netherlands due to final demand in China.

1.1 Example of a value chain



Source: author's adaptation of OECD (2013).

The new concept of value added due to trade in the whole value chain is very useful. Among others, it answers the question of policy makers: do we optimally use the possibilities that emerging markets provide to us? It shows that a country can benefit from economic growth in emerging markets such as China even if it would not export to those markets itself. Namely, it is sufficient to be in a value chain that ends in China. Also, the new data and concepts allow to determine the role of countries in the value chain: who does what? Los et al. (2014) show that the role of the Netherlands in global value chains is shifting from production to tasks before and after production. E.g. research & development and marketing.

However, for trade policies this is not always the right type of information. For example, Germany and France are important destinations for the products of the Dutch high tech industry. In those countries are the potential customers, the manufacturers that use intermediates supplied by the Dutch high tech industry. Therefore there are activities to promote Dutch products to German and French manufacturers, such as participating at the Hannover Messe or the JEC in Paris. Policy makers would like to monitor of these extra efforts, carried out in programs such as the Dutch Top sector programme (MEA and Panteia/EIM, 2014). They are not that interested in the end users of German and French products that absorbed Dutch inputs somewhere in the production process. As a policy maker once said: "We are not yet lobbying in Australia for German products that contain Dutch parts". And for other policy evaluations, such as the link between bilateral aid and exports (Martínez-Zarzoso et al. 2014; Ministry of Foreign Affairs, 2014), it is also important to know what the value added of exports

at arm's length is. In figure 1.1 there is value added in the Netherlands due to trade at arm's length with Germany, or, using a different concept, due to final demand in China.

1.2 Two assignments to countries of exports of value added

Exports of value added assigned to country of final consumption. In this case, the value added due to trade is assigned to the country where it is ultimately consumed. In the example of 1.1, the Netherlands has exports of value added due to final consumption in China.

Exports of value added assigned to country at arm's length. In this case, the value added due to trade is assigned to the country that receives the direct (gross) exports. In the example of 1.1, the Netherlands has exports of value added due to direct exports to Germany.

The basic idea, assigning indicators related to trade to the country at arm's length instead of to the country of final consumption, is not new. It was already known in the scientific community in environment research. Peters and Hertwich (2008) introduce the idea of emissions embodied in bilateral trade (EEBT). This method determines the emissions in one region (or country) to produce for its exports to another region (or country). See also Peters (2008). However, as far as the author knows, this concept was not yet applied to value added.

Assigning exports of value added to the country at arm's length has several advantages, but it is not meant to substitute the alternative of assigning them to the country of final consumption. As was already briefly mentioned in this introduction, both measures yield valuable, yet different, information.

The structure of this paper is as follows. First it explains the data and methods that were used. Then it quantifies the differences between exports of value added assigned to country at arm's length and assigned to the country of final consumption. It gives an example of timely and detailed results, namely the value added due to direct trade of the Netherlands with 68 emerging markets in 2014. The paper ends with discussion and suggestions for further research.

2. Data

The data for this paper:

- The ICIO (Inter Country Input-Output) table from OECD/WTO for 2011
- The input-output table for the Netherlands for 2014, made by Dutch national accounts
- Dutch trade in goods statistics for 2014
- Dutch trade in services statistics for 2014
- A key to match the goods in the Dutch input-output tables to those in trade in goods statistics
- A key to match the services in the Dutch input-output tables to those in trade in services statistics

The ICIO table from OECD/WTO is publically available at the OECD website. The Dutch data (except for the keys) are available at the website of Statistics Netherlands in aggregated form only. We will now shortly describe the data.

ICIO table of OECD/WTO

This table shows by industry and by country its supply to and use from other industries and also supply for final demand. The table consists of 61 countries (and another group "Rest of World"), 34 industries (69 for China and 50 for Mexico) and 6 final demand categories. The table also contains a row for the total of value added, taxes and subsidies, a row for total production by industry and a column for statistical discrepancies. Everything is denoted in millions of US dollars.

Dutch input-output tables

The main table contains 129 industries, 24 categories of final demand (e.g. exports) and 35 categories of primary inputs (e.g. imports). There are separate figures for exports of domestically produced goods, re-exports, exports of services excluding consumption of foreign visitors in the Netherlands and consumption of foreign visitors in the Netherlands. The numbers are denoted in millions of euros.

Besides the main table, there is also a more detailed table that includes the product level. We only consider that part of the table that contains the four different export categories as described above. It contains the same industries and categories of primary inputs as the main input-output table. However, now data is not on total level, but split up in 188 different groups of goods and services. The numbers are denoted in millions of euros.

Dutch trade in goods statistics

The data has separate numbers for exports of domestically produced goods and re-exports, by country and by product. In 2014 the data contained 240 countries and almost 9000 types of commodity. The numbers are denoted in euros.

Dutch trade in services statistics

The data are split up by 236 countries (and also includes five international organisations such as the European Central Bank) and 77 types of services. The numbers are denoted in thousands of euros.

Key matching goods in national accounts and trade

There is a standard key at Statistics Netherlands that matches all types of commodities in the trade statistics to a unique good in national accounts.

Key matching services in national accounts and trade

Depending on the intended use, there are several keys at Statistics Netherlands that match types of services in trade statistics to services in national accounts. For this paper, that mainly illustrates the idea, a rough key was used to map a service in national accounts to one in Trade Statistics. This matching key can be further improved by map the combination of a service x industry to a service in Trade Statistics. For example, "Juridical, accounting and other administrative services" by the accounting industry could be matched to "accounting services" instead of to the aggregate "Juridical, accounting and other administrative services".

3. Methods

3.1 Assigning exports of value added to countries using the ICIO table of OECD/WTO

The ICIO table can be used to assign exports of value added to the country of final consumption (table 4.1). We want to compare those estimates to exports of value added assigned to the country at arm's length (table 4.2). To do so, it is necessary to make a separate input-output table for each individual country and then apply standard techniques that yield the desired estimates.

3.1.1 Construct input-output tables by country

For each country, the ICIO table of OECD/WTO does not only show exports of goods and services that are used for final demand, but also exports of intermediate goods and services. It is the same for imports. While constructing the new input-output table all exports (and imports) are taken together and considered as final demand. Then figure 3.1.1 reduces to figure 3.1.2.

3.1.1 The ICIO table of OECD/WTO, one country is singled out

		Imports of intermediates by this country								
Exports of intermediates by this country		Intermediates in the country itself		Exports of intermediates by this country		Exports for final demand		Final demand in own country		Exports for final demand
		Imports of intermediates by this country								
		Value added, taxes and subsidies								
		Total								

3.1.2 The new table for an individual country

Intermediates in the country itself		Exports for final demand
Imports		0
Value added, taxes and subsidies		0
Total		

Strictly speaking, the new table is not an input-output table. This is because final demand in the country itself is not correctly included. However, this is no obstacle because that information is not used in the remainder of the process.

3.1.2 Assigning exports of value added to countries using the new country tables

This paragraph shows the exposition by Kranendonk and Verbruggen (2005). Figure 3.1.2 can be seen as a combination of matrices A, P, Z and X:

A X
P
Z

Where

M = n x n matrix of domestically produced intermediary demand
X = n x 61 matrix of domestically produced exports
P = 2 x n matrix of primary inputs used by domestic firms
Z = 1 x n matrix of domestically produced total demand

And n is the number of industries in the country under consideration (usually 34, but 50 for Mexico and 69 for China).

Now define A, the matrix of intermediary input coefficients, as the matrix that results of dividing the column entries of M by the corresponding entry in Z. Define L, the Leontief inverse, as the matrix $(I - A)^{-1}$ where I is the unit matrix of size n x n. Then the element L_{ij} is the amount that industry *i* has to produce for 1 euro of final demand that is produced by industry *j*.

Define PC, the matrix of primary input coefficients, in a similar way: the column entries of P are divided by the corresponding entry in Z. Now set

$$CPS = PC * L * X$$

This matrix shows for exports to every country a decomposition of these exports into primary inputs, namely imports on one hand and value added, taxes and subsidies on the other hand. Thus the CPS matrix eliminates the domestic intermediate part in the input-output table. And CPS_{2j} is the amount of value added (including taxes and subsidies) created in the country due to direct exports to country *j*.

3.2 Assigning exports of value added to countries using Dutch data

Calculations using the Dutch input-output table are slightly more complicated than those using the OECD/WTO table. This is because in the last table primary inputs would be used only by industries, but the Dutch table also contains primary inputs that are used immediately for final demand. And these numbers are not negligible. For example, imports for re-exports amounted to 201 billion euros in 2014. Kranendonk and Verbruggen (2005) also explain how to compute the CPS matrix in this special case.

To estimate value added due to trade with a country (or a group of countries) it is sufficient to replace the matrix of total exports (type of input x type of export) by the matrix of exports to that country. The basic idea in constructing this matrix is that the distribution of exports of a product to countries should be the same in national accounts (NA, where this distribution is unknown) as in Foreign Trade Statistics (FTS, where this distribution is known). The basic idea was used for Dutch exports before (Edens et al., 2015). In more detail:

1. Match each product (or service) in trade statistics to the products (or services) of national accounts using the matching key. Then, for every product in national accounts there are three numbers: total exports according to national accounts, total exports according to trade statistics, and exports to the country according to trade statistics. Do this for the four export categories separately. These categories are domestic exports of goods, re-exports, exports of services (excluding consumption by foreigners in the Netherlands) and consumption by foreigners in the Netherlands.

2. Calculate for every product the share of exports to a country according to national accounts as follows:

$$Share\ by\ country\ (NA) = \frac{exports\ to\ country\ (FTS)}{total\ exports\ (FTS)}$$

   Do this for the four export categories separately. For example, when the share of Germany in re-exports of laptops is 25 per cent in total re-exports of laptops according to Foreign Trade Statistics, the assumption is that it is the same share in national accounts.

3. It is possible that matching is not optimal, and that there are products in national accounts that are not matched to products in trade of goods or services. Then the formula above does not yield exports to a country consistent to national accounts because the denominator at the right hand side is zero. Now use the share of countries in total trade to assign exports of this product to countries. For example, when 15 per cent of total exports of goods is to Germany, the assumption is that the share of Germany for this individual product is 15 per cent as well.

4. The products of national accounts are assigned to different input categories (industries and primary inputs). Calculate the value of exports by an input category of a product to a country as follows:

$$Export\ value\ by\ country = share\ by\ country\ (NA) * value\ total\ exports$$

5. Now sum the value of the products over the input categories to get the estimate of exports to that country by input category. This is done for the four different export categories. It yields four column vectors that together form the export matrix of the country under consideration.

4. Results

This paragraph consists of three parts. First, the two ways to assign exports of value added to a country are compared to see whether they are very similar or not. Then estimates are considered for the bias that arises when assigning to the country at arm's length. This bias is introduced by removing information about imports that have their origin in the importing country itself. The paragraph ends with an example, using Dutch data to make estimates for value added due to exports to a group of countries in 2014.

4.1 Comparing two ways to assign exports of value added to a country

We now compare the two ways to assign exports of value added to a country, to the country of final consumption or to the country at arm's length. This is done for bilateral trade between the countries that, according to the OECD/WTO TiVA database, are the ten largest (gross) exporters in the world.

4.1.1 Exports of value added assigned to country of final consumption, 2011

	Importing country									
Exporting country	China	United States	Germany	Japan	United Kingdom	France	Italy	South Korea	Russia	Canada
	x bln US dollar									
China	X	277	51	131	41	41	30	46	35	37
United States	98	X	75	111	76	50	31	44	21	181
Germany	64	110	X	26	65	82	65	12	31	14
Japan	128	148	23	X	18	14	8	37	15	16
United Kingdom	20	96	51	17	X	36	22	5	12	14
France	20	52	60	14	40	X	40	6	12	8
Italy	16	44	49	11	25	43	X	5	14	7
South Korea	65	59	11	29	6	5	5	X	9	7
Russia	35	49	37	23	16	23	24	8	X	5
Canada	17	228	8	15	10	7	4	6	3	X

Source: OECD/WTO, TiVA database.

For example, table 4.1.1 shows that value added in China due to final consumption in the United States was 277 billion US dollars in 2011. But Chinese value added due to direct exports to the United States amounted to 265 billion US dollars (table 4.1.2). The difference, 12 billion US dollars, is shown in table 4.1.3.

4.1.2 Exports of value added assigned to country at arm's length, 2011

Exporting country	Importing country: China	United States	Germany	Japan	United Kingdom	France	Italy	South Korea	Russia	Canada
	x bln US dollar									
China	X	265	52	136	40	41	30	69	38	35
United States	117	X	76	105	77	48	27	56	18	219
Germany	79	87	X	19	68	90	71	15	32	11
Japan	189	120	22	X	15	10	5	60	14	13
United Kingdom	19	86	59	13	X	37	20	6	11	14
France	23	42	71	12	42	X	45	7	12	7
Italy	18	36	56	9	25	48	X	5	14	6
South Korea	109	43	10	25	4	3	4	X	10	5
Russia	41	37	38	20	12	21	27	12	X	2
Canada	20	261	7	13	10	5	3	8	2	X

Source: author's calculations based on ICIO table of OECD/WTO.

4.1.3 Exports of value added, final consumption minus arm's length, 2011

Exporting country	Importing country: China	United States	Germany	Japan	United Kingdom	France	Italy	South Korea	Russia	Canada
	x bln US dollar									
China	X	12	-1	-5	1	0	0	-23	-3	2
United States	-19	X	-1	6	-1	2	4	-12	3	-38
Germany	-15	23	X	7	-3	-8	-6	-3	-1	3
Japan	-61	28	1	X	3	4	3	-23	1	3
United Kingdom	1	10	-8	4	X	-1	2	-1	1	0
France	-3	10	-11	2	-2	X	-5	-1	0	1
Italy	-2	8	-7	2	0	-5	X	0	0	1
South Korea	-44	16	1	4	2	2	1	X	-1	2
Russia	-6	12	-1	3	4	2	-3	-4	X	3
Canada	-3	-33	1	2	0	2	1	-2	1	X

Source: author's calculations based on ICIO table of OECD/WTO.

Several differences strike out. First, the consistently lower and higher results of China and the United States respectively, in the columns of table 4.1.3. This is not surprising. China is the "supplier of the rest of the world" and thus absorbs many intermediate inputs (and their value added) to supply other countries. In the concept of final consumption, these are assigned to those other countries, in the concept of arm's length, to China itself. For the United States, it is the other way around. Second, trade in value added between Canada and the United States is

lower using the first method than using the second one. This indicates that these countries supply each other with many goods that are used to produce for other countries.

Besides the absolute differences between the results of the two methods shown in table 4.1.3 there are also relative differences, as can be seen in table 4.1.4. For example, value added in Japan due to final consumption in South Korea is 61 per cent of value added in Japan due to direct exports to South Korea. This shows once again that the two methods to assign the value added of exports to a country differ substantially.

4.1.4 Exports of value added, final consumption divided by arm's length, 2011

	Importing country									
Exporting country	China	United States	Germany	Japan	United Kingdom	France	Italy	South Korea	Russia	Canada
	%									
China	X	104	98	96	104	100	99	67	92	107
United States	84	X	98	105	99	104	116	78	116	83
Germany	80	126	X	134	96	91	92	81	97	126
Japan	68	123	106	X	121	137	168	61	106	129
United Kingdom	101	112	87	128	X	98	106	93	106	100
France	89	123	84	121	95	X	89	86	102	115
Italy	87	124	87	129	100	90	X	94	98	122
South Korea	60	136	113	112	166	180	137	X	97	138
Russia	86	133	97	113	128	109	88	65	X	250
Canada	86	87	121	120	95	126	141	77	141	X

Source: author's calculations based on ICIO table of OECD/WTO.

4.2 Estimating bias introduced by omitting information

The method that assigns exports of value added to the country at arm's length introduces a bias when it only uses national input-output tables. Because this will lead to overestimation of the required imports for exports and underestimation of exports of value added. Namely, country A exports to country B using imports that were made with exports from country A. Thus, exports to country B contain direct production in A and indirect production, namely the exports of A embodied in the imports used for exports to country B. But using a national input-output table only direct production is taken into account. The method that assigns exports of value added to the country of final consumption does not have this problem, because it takes the whole value chain into account. This makes it possible to calculate the bias that will be introduced when ignoring the fact that a part of imports for exports will consist of value added created in the own country. In general, this introduced bias is low, as can be seen in table 4.2.1. For example, 1.4 per cent of all domestic value added in Chinese exports consists of value added that was first exported and then imported again. Thus, the errors are relatively small and the method is robust.

4.2.1 Share of re-imported domestic value added in total domestic value added in exports, 2011

Country	Share
	%
China	1.4
United States	0.8
Germany	1.3
Japan	0.4
United Kingdom	0.5
France	0.5
Italy	0.4
South Korea	0.6
Russia	0.3
Canada	0.5

Source: OECD/WTO TiVA database

However, there is evidence that these shares will be higher for neighbouring countries, especially when they are part of the same trade zone and have strongly connected industries. For example, Wilson (2010) gives an example where certain car parts cross the border between Canada, Mexico and the United States six times before the car is fully completed. Table 4.2.2 shows for the manufacturing industries of the NAFTA countries the shares of re-imported domestic value added in total domestic value added in exports. This re-imported domestic value added is the domestic value added that was first exported, then imported to be used for exports again.

4.2.2 Share of re-imported domestic value added in total domestic value added in exports, 2011

	Canada	Mexico	United States
	%		
Total Manufactures	1.0	0.8	1.4
Food products, beverages and tobacco	0.3	0.2	0.7
Textiles, textile products, leather and footwear	0.4	0.4	0.9
Wood and products of wood and cork	0.3	0.3	0.8
Pulp, paper, paper products, printing and publishing	0.3	0.4	0.7
Coke, refined petroleum products and nuclear fuel	0.4	1.0	1.0
Chemicals and chemical products	0.6	0.3	1.1
Rubber and plastics products	0.8	0.5	1.2
Other non-metallic mineral products	0.3	0.3	0.8
Basic metals	1.0	0.3	2.0
Fabricated metal products	0.9	1.1	1.3
Machinery and equipment, nec	0.9	0.7	1.7
Computer, Electronic and optical equipment	0.5	1.0	0.9
Electrical machinery and apparatus, nec	1.3	0.9	1.5
Motor vehicles, trailers and semi-trailers	3.9	1.2	4.1
Other transport equipment	0.9	0.5	1.6
Manufacturing nec; recycling	0.4	0.8	0.9

Source: OECD/WTO TiVA database

Note that OECD does not give such data by partner country. This is because one of the key assumptions in input-output calculations is that all output of a given industry has the same structure of inputs. In reality, output is far more heterogeneous, thus it is very well possible that the correct numbers in table 4.2.2 would be much higher when they would only concern the NAFTA region.

4.3 Example: Dutch exports to DGGF-countries

We now give an example of the possibilities that arise from assigning exports of value added to the country at arm's length. Namely, figures that are both more timely and more detailed. This is possible because only data of one country are needed. The example concerns exports of value added to 68 emerging markets (the DGGF countries) in 2014. The estimates can be made for each country separately whereas most other data sources (e.g. OECD/WTO TiVA, WIOD) only contain a few of these countries.

The Dutch Good Growth Fund (DGGF) stimulates Dutch SMEs to trade with and invest in 68 emerging markets more frequently. These countries are shown in figure 4.3.1. The DGGF framework was announced in October 2013 by the Dutch Minister of Foreign Trade and Development and started in July 2014. The programme blends trade and investment with assistance to the development of low and middle-income countries. It supports access to finance for SMEs so that they can do business in the DGGF countries, thus contributing to economic growth and social inclusion in these countries.

4.3.1 The 68 DGGF-countries

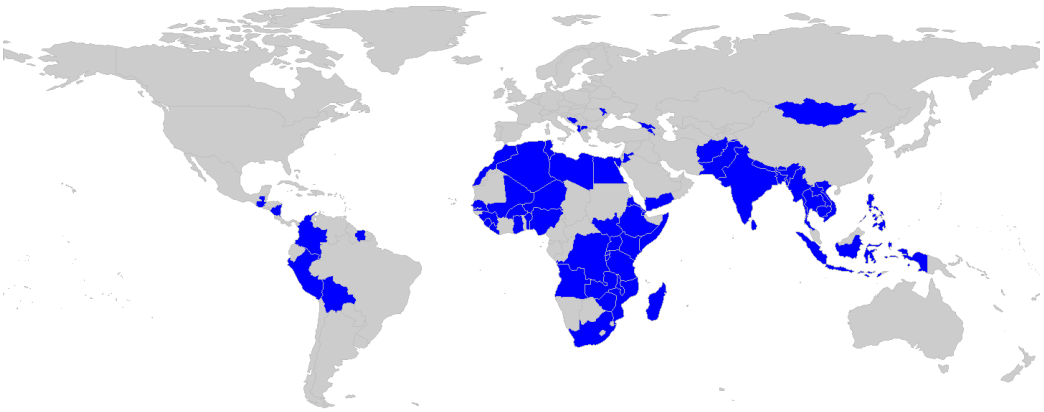


Table 4.3.2 shows the value added of direct exports of the Netherlands to the group of DGGF-countries. It was calculated only using information from the Netherlands. Since that information is already available for the reporting year 2014, the results are more recent than that of other sources such as OECD/WTO and WIOD. They need to collect data for many countries, which takes time. As a consequence, they also need more time to properly integrate the country data than a single country. For such reasons, their data is up to the reporting year 2011.

4.3.2 Dutch exports and exports of value added to DGGF-countries, 2014

	Value	Value after benchmarking against national accounts	Value added
	x mln euro		
Exports of commodities	19527	17277	6253
Exports of services	6791	7513	3990
Total	26318	24790	10243

Total value added in the Netherlands due to direct exports to the DGGF countries is 10 billion euro, which amounts to 1.5 per cent of Dutch GDP.

Note that there is a substantial difference between the value of exports according to the trade statistics and the value after benchmarking against national accounts. This has several reasons. First of all, the distribution of trade among domestic exports of goods and re-exports is different in the two statistics. Trade statistics have less re-exports than national accounts, but more exports of domestically produced goods. At the level of these two export categories, the shares of DGGF countries in total exports are similar for nationals Accounts and trade statistics. Second, as far as the services are concerned, these shares differ much more. This indicates that the assignment of type of services in national accounts to type of services in trade statistics should be further improved.

5. Conclusion and discussion

The two ways to assign exports of value added to a country, to the country of final consumption or to the country at arm's length, yield very different results. Thus they provide different information. This was already known from the ecological literature, that considers emissions embodied in trade (Peters and Hertwich, 2008; Peters, 2008) instead of value added embodied in trade. Using a national input-output table to assign value added due to exports to the country at arm's length introduces a bias. It overestimates the imports embodied in exports and thus underestimates the domestic value added in exports. However, this bias is small. The paper gave an example using this assignment to estimate the value added of direct Dutch exports to a group of 68 emerging markets in 2014. With most MRIOs it would not be possible to make estimates at the desired level and if it would be possible, it would be for older years only.

Assigning to the country at arm's length has several advantages. It is easier to understand, it can be consistent with national accounts, more timely and more detailed, and needs less assumptions. It could even influence some policies, such as the languages taught at school: the language of the direct trading partner, where you earn the money directly, of that of the trading partner where you ultimately earn the money.

However, this does not imply that the indicator that assigns to the country of final consumption should be abolished. Because this indicator (and the concept behind it) has many advantages as well. It shows more interdependencies, it shows where countries ultimately earn their money and it can be used to determine the role of each country in individual value chains (see e.g. Timmer et al. 2014)

The results using a national input-output table to assign value added due to exports to the country at arm's length are automatically consistent with the national data, but those using an MRIO table are not. An MRIO is not consistent with all national data, e.g. due to adapting trade data to remove trade asymmetries making the table consistent. These adaptations can be made in different ways and may lead to very different results. For example, for 2011 the OECD/WTO TiVA database estimates that 29 per cent of Dutch GDP is due to exports. But using WIOD the same number would be 38 per cent. An alternative is to adapt the MRIO in such a way that it is consistent with the national input-output table. This would lead to a single-country national accounts consistent MRIO (a SNAC MRIO, see Edens et al. 2015)

The results using a national input-output table to assign value added due to exports to the country at arm's length need less proportionality assumptions because there are less steps in the value chain. For example, if 5 per cent of inputs of the German automotive industry are from the Dutch metal industry, it is assumed in calculations that use MRIOs that the exports of the German automotive industry to China also consist for 5 per cent of products from the Dutch metal industry. In reality, this could be more (Dutch steel is used mainly for cars and China only imports cars) or less (Dutch steel is used mainly for busses and China only imports German cars and no busses). The way to tackle this problem is to develop data and methods that take this heterogeneity into account. E.g. OECD/WTO MRIO has more detail on industries in China and Mexico. And it created an expert group that studies possibilities how to split up input-output tables and supply and use tables into more detail. For example, multinationals/non-multinationals, traders/non-traders, SMEs/large enterprises. Analysing such tables would yield new insights, such as the role of SMEs in national economies.

A possible extension of the method proposed in this paper is nowcasting to make even more timely estimates, see also Miao and Fortanier (2015). This extension would assume that the technological structure of an economy does not change that quickly. It combines the input-output table of an older year with supply and use information of a more recent year to get estimates for value added of trade at arm's length for the more recent year. Assuming that an input-output table is the same for all four seasons, one could even make quarterly estimates quickly after the end of a quarter. Furthermore, nowcasting based on the input-output table of a single country will be more stable and more accurate than results based on MRIOs. Since these MRIOs already contain some elements of nowcasting in order to make up for the lack of data.

This paper considered exports and showed a method to assign exports of value added to the country at arm's length. Similarly it would be possible to decompose final demand in the Netherlands into primary inputs and further decompose imports by the country at arm's length. This would e.g. show on which countries industries depend for their imports. Then it should be taken into consideration that it is very important to correctly assign imports for domestic final demand and imports for re-exports. The consequences of wrongly assigning imports and a method to improve this assignment were described by Lemmers (2013).

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