

Identifying true trade patterns: correcting bilateral trade flows for re-exports

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Abstract

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1. Introduction

A substantial and increasing part of the trade in goods are re-exports. Re-exported goods are treated in the National Accounts as being imported in and exported from a 'transit country'. This country only has short-term ownership of the goods, that are traded between two other countries. Data on bilateral trade flows used to estimate models of international trade are not usually corrected for re-exports. This implies that a re-exporting country is mistakenly taken as the origin of the trade flow (on the export side). Similarly, the re-exporting country is also treated as a final destination of a trade flow (on the import side). Re-exports in trade statistics may produce the following three main consequences: (1) the distance decay of trade is wrongly estimated, (2) a country's main trading partners are wrongly identified, and (3) the volume of total world trade is overestimated. Most studies of international trade are based on the gravity model (see, e.g., Deardorff, 1998, and Anderson and van Wincoop, 2003). The gravity model postulates that bilateral trade depends on the economic size of the trade partners, which reflects market size and purchasing power, and a variety of measures of distance (or proximity) between the countries to reflect trade costs. A wrongly estimated distance decay of trade may affect the main conclusions from these studies. The misidentification of main trading partners may lead to wrongly targeted export promotion policies. The overestimation of the volume of trade may put too much (policy) emphasis on trade as an important factor in economic development. The recent literature on global value chains will also be affected, since not only the total value-added incorporated in export flows is of importance when identifying a country's important trading partners, but also the actual destination of exports.

This paper estimates bilateral trade flows that are cleaned from re-exports. The World Input-Output Database (WIOD) provides information on bilateral trade.¹ The data are consistent with countries' National Accounts. The trade flows between origin and destination are not corrected for re-exports. However, WIOD includes estimates of the size of re-exports. Hence, it is possible to correctly estimate the volume of world trade. Using a constrained non-linear optimization procedure we estimate the complete re-export matrices. Assuming that trade patterns of re-exports are the same as the average trade patterns, we adjust the WIOD trade tables by changing the origin of the re-exported imports and cleaning these re-exports from the import flows of the 'transit country'. In doing so, this paper thus addresses consequences 1) and 2) above.

¹ See Timmer (2012) for an overview of the contents, sources and methods used in compiling WIOD.

The remainder of this paper is organized as follows. Section 2 presents our methodology for estimating trade flows cleaned from re-exports. Section 3 illustrates the effects from the correction of trade flows. Section 4 concludes.

2. Estimating trade flows cleaned from re-exports

2.1. Determining the re-exports matrices

WIOD provides information on bilateral trade between 40 countries for 59 product categories, including services, according to the European Statistical Classification of Products by Activity (CPA) 2002.² The WIOD tables include the following variables:

- 1) $RE_{i,p}$ Re-exports RE per country i and product p excluding trade margins.
- 2) $T_{i,j,p}$ Imports of product p by country j coming from country i excluding trade margins.³
- 3) $IM_{j,p}$ Imports by country j excluding trade margins.
- 4) $Ex_{i,p}$ Exports from country i excluding trade margins.

We want to determine the re-exports table $RET_{i,q,j,p}$ describing the re-export of product p coming from country i , re-exported by country q , and with final destination country j .

Under the assumption of the same import patterns of imports and re-exports we have the following probabilities of the origin of imports $PI_{i,j,p}$ and destination of exports $PE_{i,j,p}$:

- 5) $PI_{i,j,p} = \frac{T_{i,j,p}}{\sum_{i'} T_{i',j,p}}$ probabilities of the origin of imports
- 6) $PE_{i,j,p} = \frac{T_{i,j,p}}{\sum_{j'} T_{i,j',p}}$ probabilities of the destination of exports

² The supply and use tables also distinguish 35 industries. In this paper we focus on total trade by product category.

³ The supply and use tables in WIOD list international trade margins separately. These trade margins also have to be corrected for re-exports. See the appendix for information on the methodology for correcting the trade margins.

To determine the re-exports table we want to minimize Z

$$Z = \sum_{i,q,p} (\hat{e}_{i,q,p})^2 + \sum_{q,j,p} (\hat{e}'_{q,j,p})^2 \quad (0.1)$$

with errors $\hat{e}_{i,q,p}$ and $\hat{e}'_{q,j,p}$, that are determined by the following equations:

$$REO_{i,q,p} = PI_{i,q,p} RE_{q,p} + \hat{e}_{i,q,p} \quad (0.2)$$

$$RED_{q,j,p} = PE_{q,j,p} RE_{q,p} + \hat{e}'_{q,j,p} \quad (0.3)$$

These two equations describe the origin $REO_{i,q,p}$ and the destination $RED_{q,j,p}$ of the re-exports. Moreover, the system will be solved under the conditions that re-export destinations and origins can never exceed total exports and import of a country, respectively. That is,

$$\sum_q REO_{i,q,p} \leq Ex_{i,p} \quad (0.4)$$

$$\sum_q RED_{q,j,p} \leq IM_{j,p} \quad (0.5)$$

In addition we add the following two constraints, which state that re-exports add up to the predetermined amount:

$$RE_{q,p} = \sum_i REO_{i,q,p} \quad (0.6)$$

$$RE_{q,p} = \sum_j RED_{q,j,p} \quad (0.7)$$

The quadratic minimization (0.1) under the constraints (0.2), (0.3), (0.4), (0.5), (0.6), and (0.7) will give us the re-export matrices $RET_{i,q,j,p}$, where

$$RET_{i,q,j,p} = \frac{REO_{i,q,p}}{RE_{q,p}} RED_{q,j,p} \quad (0.8)$$

We can use these matrices to determine trade matrices $TRE_{i,j,p}$ that are cleaned from re-exports. The starting point are the trade matrices given in the WIOD where re-exports have already been

taken out of the total imports. The only thing we have to do is adjust the WIOD trade tables by changing the origin of the re-exported imports. Thus, first we subtract the re-exported imports from the original trade tables at their final destination and subsequently we add all the 'true' origins of these re-exports. This is explained by the following equation:

$$TRE_{i,j,p} = T_{i,j,p} - RED_{i,j,p} + \sum_q RET_{i,q,j,p} \quad (0.9)$$

2.2. Closing the system: Exports equal imports

We know that total imports coming from a certain origin cannot exceed the exports of that origin. Therefore, the following condition should be satisfied:

$$Ex_{i,p} \leq \sum_j TRE_{i,j,p} \quad (0.10)$$

This gives the following condition that has to be added to the estimation of the re-exports that can be obtained by substituting (0.6), (0.9), and (0.8) into (0.10).

$$Ex_{i,p} \leq \sum_j \left(T_{i,j,p} - RED_{i,j,p} + \sum_q \frac{REO_{i,q,p}}{RE_{q,p}} RED_{q,j,p} \right) \quad (0.11)$$

Please note that this constraint is non-linear and including this constraint will change the problem from a quadratic (or conic) minimization problem into a non-linear minimization problem.

The degree that exports of a country are larger than the sum of the imports coming from that country to all the other distinguished countries is due to missing exports to the rest of the world. These can be booked as such.

2.3. The consistent minimization problem

The minimization problem needed to determine the re-export tables consists therefore of the minimization of Z in equation (0.1) under the constraints (0.2), (0.3), (0.4), (0.5), (0.6), (0.7), and (0.11). This will result in the complete re-export matrices.

3. Results

We have calculated trade matrices corrected for re-exports for the period 2000–2010. This section illustrates the effects from the correction on (i) the average trade distance of countries and (ii) the relative importance of countries in trade with other countries.

Table 1 shows the effect from the correction of trade flows on the average distance of countries in trade with all other countries for the period 2000–2010. Results are based on total trade. The numbers represent the (absolute) change in the average trade distance of countries as a percentage of the average distance in the original (WIOD) trade flows in the period 2000–2010. Table 1 gives the results for exports, Table 2 gives the corresponding results for imports.

Table 1. Change in average trade distance^a exports, total trade

AUS	0.66	IRL	3.63
AUT	1.83	ITA	3.46
BEL	7.55	JPN	1.00
BGR	4.13	KOR	1.51
BRA	1.72	LTU	15.16
CAN	7.00	LUX	16.07
CHN	0.69	LVA	9.23
CYP	7.01	MEX	7.33
CZE	2.60	MLT	26.78
DEU	5.73	NLD	2.79
DNK	6.34	POL	1.36
ESP	1.21	PRT	5.27
EST	18.67	ROU	4.16
FIN	1.28	RUS	3.80
FRA	4.53	SVK	4.42
GBR	2.62	SVN	3.67
GRC	10.60	SWE	0.70
HUN	3.43	TUR	2.87
IDN	3.32	TWN	4.33
IND	1.14	USA	2.36

^a In percentage of the average distance in the original trade flows

Table 2. Change in average trade distance^a imports, total trade

AUS	1.12	IRL	5.38
AUT	4.85	ITA	5.53
BEL	12.18	JPN	2.82
BGR	2.17	KOR	1.80
BRA	0.41	LTU	7.77
CAN	5.06	LUX	33.71
CHN	3.30	LVA	15.56
CYP	3.78	MEX	3.53
CZE	5.45	MLT	1.33
DEU	10.65	NLD	8.73
DNK	3.49	POL	6.20
ESP	1.08	PRT	2.29
EST	6.52	ROU	1.65
FIN	4.79	RUS	9.67
FRA	4.97	SVK	6.03
GBR	8.13	SVN	5.96
GRC	3.06	SWE	8.17
HUN	7.27	TUR	1.73
IDN	1.87	TWN	0.87
IND	3.75	USA	6.40

^a In percentage of the average distance in the original trade flows

The change in the average trade distance due to the correction for re-exports is over 5 per cent on average. This holds for exports and imports (5.3 and 5.7, respectively). In other words, when trade patterns are not cleaned from re-exports the average distance in world trade is off the mark by some 5-6 per cent. The tables illustrate that the effects can be much larger for individual countries.

Table 3 shows to what extent the importance of countries in trade with other countries changes due to the correction for re-exports. We look at the importance of countries as an export destination. Countries' importance is measured by their rank in the list of largest export destinations for other countries. We find that, without correction for re-exports, a typical re-exporting country like The Netherlands is ranked on average 1.5 higher as an export destination than with correction. It follows that the importance of The Netherlands as a destination in trade is overestimated when re-exports are not properly taken into account. On the other hand, Luxembourg is ranked up to a factor 2 lower than its actual importance. Hence, in reality Luxembourg is a more important destination for trade than the (uncorrected) trade data would suggest. However, part of its imports arrive via a 'transit country'.

Table 3. Change in ranking as an export destination, total trade

NLD	1.54	TUR	0.13
SVN	1.15	BRA	0.03
EST	0.87	IDN	0.03
LVA	0.77	SVK	-0.03
JPN	0.69	GRC	-0.08
TWN	0.51	POL	-0.08
BEL	0.49	DEU	-0.10
HUN	0.44	ROU	-0.13
MEX	0.41	GBR	-0.15
CHN	0.38	FRA	-0.33
PRT	0.28	ITA	-0.38
AUS	0.26	ESP	-0.41
IND	0.26	RUS	-0.44
CAN	0.23	BGR	-0.49
FIN	0.23	SWE	-0.49
MLT	0.21	IRL	-0.64
CYP	0.18	AUT	-0.72
LTU	0.18	DNK	-1.13
USA	0.18	KOR	-1.82
CZE	0.15	LUX	-2.15

The results above may not seem impressive, but it should be noted that they are based on total trade. Below, we present results at the level of product groups. Re-exports are merely a feature of goods trade, and not so much of services trade. We therefore focus on the results from the correction of trade flows for goods trade. Due to lack of space, we present results for a few (random) categories of goods trade only.⁴

The analysis at the level of product groups reveals much stronger effects from correcting trade flows for re-exports on the average distance in trade (exports). This is illustrated in Tables 4–7. The change due to the correction for re-exports can amount to over 700 per cent (e.g., Slovakia in ‘other transport equipment’). The largest overall change in average trade distance is found in ‘other transport equipment’ (130 per cent on average for all countries).

⁴ Results for all goods trade are available upon request.

Table 4. Change in average trade distance^a exports, Crude petroleum and natural gas; services

AUS	0.89	IRL	
AUT	2.90	ITA	16.97
BEL	54.44	JPN	0.54
BGR	24.33	KOR	14.06
BRA	1.92	LTU	107.64
CAN	0.42	LUX	
CHN	1.48	LVA	
CYP	81.99	MEX	0.44
CZE	8.15	MLT	3.11
DEU	31.62	NLD	12.35
DNK	3.54	POL	4.08
ESP	8.25	PRT	
EST	2.51	ROU	6.73
FIN	76.11	RUS	2.18
FRA	3.29	SVK	5.20
GBR	3.40	SVN	62.95
GRC	59.64	SWE	50.13
HUN	12.90	TUR	30.36
IDN	0.09	TWN	0.45
IND	2.50	USA	1.06

^a In percentage of the average distance in the original trade flows

Table 5. Change in average trade distance^a exports, Printed matter and recorded media

AUS	39.77	IRL	4.95
AUT	12.13	ITA	7.54
BEL	14.58	JPN	46.92
BGR	160.01	KOR	45.12
BRA	37.56	LTU	231.09
CAN	68.97	LUX	768.43
CHN	8.00	LVA	174.19
CYP	124.48	MEX	144.51
CZE	49.71	MLT	50.71
DEU	15.06	NLD	14.08
DNK	59.17	POL	296.07
ESP	15.35	PRT	57.20
EST	382.75	ROU	69.47
FIN	32.27	RUS	63.86
FRA	3.11	SVK	358.13
GBR	3.41	SVN	337.74
GRC	77.94	SWE	54.99
HUN	150.96	TUR	69.50
IDN	42.20	TWN	21.58
IND	65.39	USA	8.24

^a In percentage of the average distance in the original trade flows

Table 6. Change in average trade distance^a exports, Radio, television & communication equipment app.

AUS	3.09	IRL	11.46
AUT	6.81	ITA	6.29
BEL	19.10	JPN	3.27
BGR	9.40	KOR	4.85
BRA	5.03	LTU	19.93
CAN	14.12	LUX	84.85
CHN	2.85	LVA	28.72
CYP	63.86	MEX	3.22
CZE	5.19	MLT	5.00
DEU	8.71	NLD	36.39
DNK	13.38	POL	10.73
ESP	10.63	PRT	5.01
EST	27.76	ROU	16.40
FIN	6.90	RUS	5.70
FRA	7.68	SVK	15.20
GBR	8.07	SVN	9.44
GRC	26.38	SWE	3.29
HUN	5.83	TUR	7.10
IDN	4.48	TWN	3.58
IND	3.49	USA	1.35

^a In percentage of the average distance in the original trade flows

Table 7. Change in average trade distance^a exports, Other transport equipment

AUS	11.95	IRL	136.81
AUT	86.07	ITA	4.00
BEL	247.10	JPN	1.61
BGR	256.68	KOR	1.18
BRA	21.08	LTU	282.69
CAN	17.73	LUX	319.41
CHN	3.88	LVA	145.78
CYP	69.81	MEX	123.40
CZE	204.92	MLT	143.08
DEU	9.18	NLD	27.48
DNK	92.42	POL	214.82
ESP	41.32	PRT	290.93
EST	523.26	ROU	148.27
FIN	137.18	RUS	46.95
FRA	4.87	SVK	732.68
GBR	1.37	SVN	236.52
GRC	61.85	SWE	72.32
HUN	335.77	TUR	51.43
IDN	13.05	TWN	56.51
IND	29.67	USA	3.73

^a In percentage of the average distance in the original trade flows

The effects on countries' importance in trade with other countries are also much stronger at the level of product groups (Tables 8–11). In the product category 'Radio, television and communication equipment and apparatus', The Netherlands is ranked on average 14 higher as an export destination

when re-exports are not taken into account. This is the largest case of over- or underestimation of a country's relative importance in goods trade.

Table 8. Change in ranking as an export destination, Crude petroleum and natural gas; services

SVK	2.08	PRT	-2.21
AUT	1.88	LUX	-2.29
LTU	1.75	BRA	-2.58
FRA	1.57	TWN	-2.70
DEU	0.57	GRC	-3.00
CYP	0.12	SWE	-3.06
TUR	0.00	RUS	-3.09
BEL	-0.16	CHN	-3.35
CZE	-0.31	GBR	-3.53
BGR	-0.57	FIN	-4.00
JPN	-0.60	CAN	-4.10
POL	-1.11	IND	-4.11
HUN	-1.27	AUS	-5.00
SVN	-1.27	DNK	-5.20
ITA	-1.29	IDN	-5.92
ESP	-1.68	ROU	-6.11
NLD	-1.69	EST	-7.83
KOR	-1.70	MLT	-13.80
LVA	-1.88	IRL	
USA	-2.11	MEX	

Table 9. Change in ranking as an export destination, Printed matter and recorded media

EST	8.50	PRT	4.28
IDN	8.00	FIN	4.19
CYP	7.61	ROU	4.13
LVA	7.58	TWN	3.71
LTU	7.25	KOR	3.16
BRA	7.19	ITA	3.04
MLT	7.17	AUS	2.63
MEX	6.03	CAN	2.61
IRL	6.03	BEL	2.15
IND	6.00	GRC	2.15
JPN	6.00	AUT	2.04
SVN	5.91	DNK	1.85
SVK	5.29	NLD	1.65
BGR	4.94	FRA	1.39
CZE	4.90	USA	0.00
LUX	4.83	GBR	-0.20
TUR	4.74	ESP	-0.22
CHN	4.61	RUS	-0.24
HUN	4.52	DEU	-0.45
SWE	4.50	POL	-2.10

Table 10. Change in ranking as an export destination, Radio, television & communication equipment app.

NLD	14.03	AUS	-0.49
IRL	3.79	FRA	-0.59
CAN	2.54	POL	-0.59
BEL	2.51	ITA	-0.74
DNK	2.26	AUT	-0.82
TWN	1.56	ESP	-0.95
MEX	1.44	LVA	-1.00
LUX	1.28	GRC	-1.08
HUN	0.79	KOR	-1.28
CYP	0.77	LTU	-1.49
SWE	0.62	CZE	-1.79
GBR	0.54	RUS	-1.90
DEU	0.37	IND	-2.08
USA	0.36	MLT	-2.26
SVK	0.33	FIN	-2.28
EST	0.18	SVN	-2.33
PRT	0.15	BRA	-2.54
ROU	-0.18	IDN	-2.59
CHN	-0.28	TUR	-2.64
JPN	-0.28	BGR	-3.15

Table 11. Change in ranking as an export destination, Other transport equipment

LVA	12.20	HUN	5.73
MLT	11.16	DNK	5.67
CHN	11.11	KOR	5.04
PRT	10.21	CZE	4.95
TWN	9.92	IRL	4.78
LTU	9.56	CAN	4.75
EST	9.50	TUR	4.43
SVK	9.46	BEL	4.42
LUX	9.16	FIN	4.39
SVN	9.13	BGR	3.78
MEX	8.41	USA	3.56
CYP	7.68	GRC	3.52
ROU	7.62	FRA	3.47
JPN	6.57	ESP	3.16
IDN	6.55	SWE	3.06
AUS	6.52	POL	2.24
RUS	6.29	ITA	1.80
IND	6.14	NLD	0.47
BRA	6.00	GBR	0.14
AUT	5.83	DEU	-0.25

4. Conclusion

This paper estimates bilateral trade flows that are cleaned from re-exports. We adjust the WIOD trade tables by changing the origin of the re-exported imports. The paper shows that the effects from the correction on the average trade distance of countries and the relative importance of countries in trade with other countries are substantial, in particular in goods trade.

The results presented in this paper are relevant from a scientific as well as a policy point of view. The results warrant an inspection of the main conclusions regarding distance decay derived in gravity models based on trade data that are not cleaned from re-exports. Not taking into account re-exports when estimating a gravity model may bias the results, since the 'true' trade flows and distances are over- or underestimated. Moreover, the characteristics of re-exporting countries are erroneously used to explain trade flows. Trade data that are not cleaned from re-exports may also lead to the wrong identification of main trading partners based on the product value or its incorporated value-added (global value-chain approach). This has consequences for export promotion policies such as trade missions of local governments to increase the trade with their main trading partners.

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Appendix. International trade margins

WIOD lists international trade margins separately. These trade margins also have to be corrected for re-exports. Again, we have no specific information on the re-exports. It seems however appropriate to assume that the international trade and transport margins from the 'true' origin to the re-exporting country have been included in the price of the exported good leaving the trade and transport margins from the re-exporting country to the receiving country. We therefore only have to reallocate the transport margins for the final destination country leaving totals exactly the same.

The international trade margins $ITMRE_{i,q,j,p}$ cleaned from re-exports can therefore be determined as follows.

$$ITMRE_{i,j,p} = ITM_{i,j,p} - \frac{ITM_{i,j,p}}{T_{i,j,p}} RED_{i,j,p} + \sum_q \frac{ITM_{q,j,p}}{T_{q,j,p}} RET_{i,q,j,p} \quad (0.12)$$