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Whither Panama? Constructing a consistent and balanced world SUT system including international trade and transport margins

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Abstract

This paper aims to complement work done within the WIOD project (the 'World Input Output Database' project financed by the EU's Seventh Framework Programme), which compiled supply and use tables for 40 countries, covering about 85% of the world economy. The paper describes the derivation of international trade and transport margins (TIR services) together with a consistent and balanced system of supply and use tables at the world level. As a by-product, this also yields supply and use tables including valuation matrices for the Rest of the World, the approximately 15% of the world economy not covered by the 40 countries included in the WIOD database. The procedure assures a 'balanced world economy' with respect to trade in all goods and services.

Keywords: transport margins, supply and use tables, world modelling

JEL codes: C67, C82, F15

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1 Introduction[1]

Various attempts have been ongoing recently to construct international input-output tables; examples are the OECD-WTO initiative (OECD-WTO, 2012), EXIOPOL (EXIOPOL, 2011), EORA (Kanemoto et al., 2011; Geschke et al., 2011), and region specific tables such as the Asian IDE-JETRO tables (IDE-JETRO, 2006; Hiratsuka, 2010) and the WIOD project (see Timmer et al., 2012, for an overview).[2] Amongst them, the WIOD project is the only one where the world input-output tables (WIOTs) are derived from a system of international supply and use tables (SUTs). In the WIOD project SUTs for 40 countries, covering about 85% of world economic output, are collected. These SUTs are first collected at the national level and transformed into an 'international' version with the national SUTs connected via trade linkages. Except in the 'analytical' version of the WIOD database, however, the 'Rest of the World' (RoW) is not explicitly included, i.e., no attempt has been made to construct a SUT for RoW.[3] Likewise, although international trade and transport margins are included (constituting the link between exports valued at fob and import valued at cif), these margins are not linked back to the global economy. At a national level, domestic trade and transport margins are however linked back to the economy when transforming tables from use in purchaser prices to use in basic prices by re-distributing trade and transport margins to trade and services sectors.

This paper aims to address these two shortcomings where it should be noted that these two issues are not independent of each other. 'Linking back' international trade and transport margins to the relevant sectors of the economy necessitates a SUT for the Rest of the World so that at the world level, the supply and use of all commodities, goods as well as services – including transport services – will be balanced. It will also avoid the need to resort to any kind of 'Panama assumption' in modelling the supply of transport services (see below). This then provides a consistent supply and use system for the world which is balanced in terms of all flows. This paper discusses how this can be achieved and points to the severe data constraints faced and the – therefore – partly far-reaching assumptions that have to be made. Thus, the resulting SUT for RoW and the world SUT system can only serve as a first step in this construction process. Further research will then have to be focused on how to improve on these assumptions and to eliminate existing data constraints.

Apart from (numerically) balancing world input and output, the derivation of a SUT for RoW has also other aspects to recommend it: as it is, the WIOD project will give world-wide input-output linkages

[1] The authors wish to thank Erwin Kolleritsch from Statistik Austria for his advice and valuable discussions.

[2] For websites of relevant initiatives and similar data: EXIOPOL (http://www.feem-project.net/exiopol/); GTAP (https://www.gtap.agecon.purdue.edu/); IDE-JETRO (http://www.ide.go.jp/English/); OECD-WTO initiative (www.oecd.org/trade/valueadded); WIOD (http://www.wiod.org/); WTO ‚Made in World' (http://www.wto.org/english/res_e/statis_e/miwi_e/miwi_e.htm)

[3] The RoW in the analytical WIOTs has been estimated in the framework of the IO tables rather than the supply and use framework; see Timmer et al. (2012) for a detailed documentation.

in the form of (quadratic) IO tables only. There are, however, some aspects in favour of using SUTs instead of IOTs: for one, the derivation of IOTs (which are derived from SUTs) requires 'technology assumptions' to be made, which essentially are rules on how to deal with atypical production. Product-by-product tables are, for example, derived under the 'industry technology assumption' implying that atypical products are produced with the same technology as the typical product, whereas under the 'commodity technology assumption', atypical commodities are produced with the technology of the sector of which the commodity is the typical product. In the WIOD project industry-by-industry tables are derived using the 'fixed product sales structure assumption', i.e. model D (see Eurostat, 2008, Chapter 11, for details). The two assumptions have different pros and cons and will yield different IOTs. However, when SUTs are available, IOTs can be constructed at this basis, but not vice versa. The move from SUTs to IOTs, therefore, results in a loss of information. Also, in modelling, SUTs are arguably more versatile: it is quite easy to combine SUTs with econometrically derived equations in so-called 'econometric IO models' (for Austrian examples, see Kratena and Wüger, 2006 and Fritz et al., 2005) whereas IOTs tend to be less flexible in this respect. The derivation of a consistent SUT for RoW will allow constructing such an econometric IO model at the world level.

2 Outline of strategy and data requirements

2.1 The Panama assumption revisited

Although specific information seems hard to come by, other world models (the most prominent of which is certainly GTAP) seem to skip over the issue of international transport costs by making a sort of 'Panama assumption': international transport services are assumed to be provided by the Rest of the World via 'flags of convenience' (the rather common practice among shipping companies to register their vessels in ports with lax regulatory regimes), the archetypical provider of such flags being Panama[4]. However, data from the United Nations' Statistical Division UNSD[5] do not really bear out this assumption: although relative to total GDP, Panama's transport sector is above average, the sector 'Transport, Storage and Communications' accounts for 16% of Panama's total value added; the (unweighted) world average is about 9% (the average of the WIOD countries is 8.6%, of the non-WIOD countries it is 9.1%). However, the important business of the Panama Canal probably makes up a substantial part of this sector. But even if Panama's entire transport sector were devoted to international transport margins, this would contribute USD 2.5 billion to international trade.

[4] According to the CIA World Fact Book (https://www.cia.gov/library/publications/the-world-factbook/geos/pm.html), Panama's merchant fleet, with 6,379 vessels, is the world's largest. 5,244 of those vessels are foreign owned, almost half of which are Japanese.

[5] UN Statistics Division: http://unstats.un.org/unsd/economic_main.htm

Compared to the transport costs estimated at 5-10% of the world trade volume of some USD 12,000 billion in 2011[6], this would be only like a drop in the ocean. Of course, the Rest of the World is more than Panama; but even the combined 'Transport, Storage and Communication' sectors of all non-WIOD countries seem to be too small: according to the UNSD, combined value added in this sector amounts to about USD 400 billion, which corresponds to an estimated USD 800 billion of output. Assuming that international transport margins are produced in RoW only would imply that something in the range of 50 to 100% of RoW's transport output would have to be devoted to international trade.

Clearly, international transport services have to be provided on a much broader basis. As we will argue, this broader basis are 'normal' (net) exports of trade and transport services as recorded in national SUTs.

2.2 Construction strategy

The strategy of constructing such a consistent and balanced system consists of a number of sequential steps:

Step 1: Estimation of total supply of international trade and transport margins (TIR) services[7]

Step 2: Derivation of an initial matrix of cif-fob corrections

Step 3: Determination of the matrix of cif-fob corrections such that, based on this initial matrix, the sum over all bilateral cif-fob corrections equals the sum of all TIR services supplied, i.e.

$$\sum_{world}(\text{cif-fob corrections}) = \sum_{world}(\text{TIR-services}),$$

Step 4: Distribution of total cif-fob margins to the TIR services trade, surface-, sea- and air-transport

Step 5: Derivation of a trade matrix for the TIR services

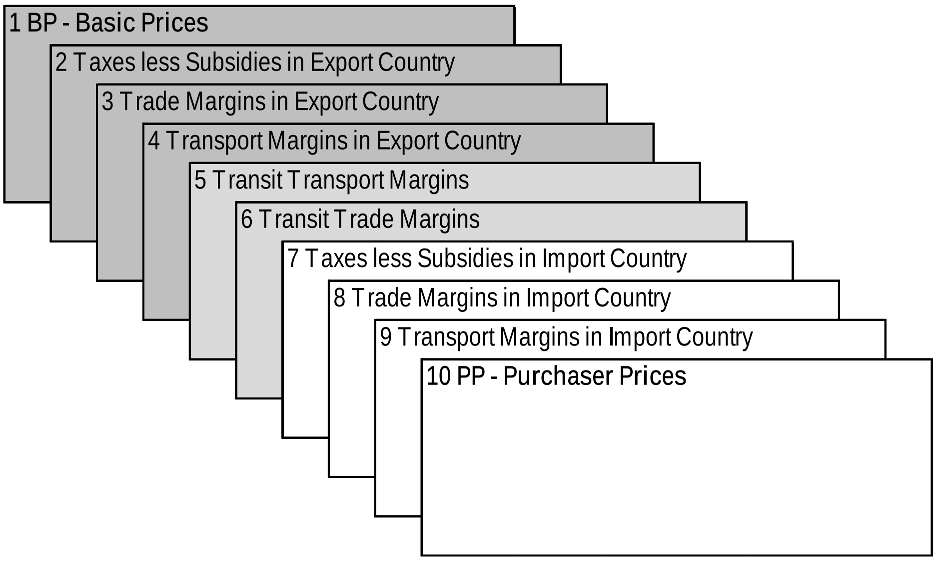
The aim of the exercise is therefore to derive an international margins matrix which – in analogy to the margins matrices of the national SUTs – re-distributes international margins which are imported as part of the cif price to the respective TIR services. In analogy to margins matrices in national SUTs, the fob-price of exports would be a 'basic price', the cif-price of imports would be a 'purchaser price', and the difference cif-fob would be the international trade and transport margins. The total chain

[6] http://www.wto.org/english/news_e/pres11_e/pr628_e.htm

[7] We propose to call the services which make up international trade and transport margins TIR services (referring to the 'TIR'-signs affixed to lorries employed in international transit). TIR services consist of CPA codes 51 (wholesale trade), 60 (land transport: road, rail, pipeline), 61 (shipping), 62 (air transport), and 63 (auxiliary transport services). The motivation for defining these 5 services as 'TIR services' will be discussed below.

from the producer (located in some country) to the consumer (located in some other country) of some good might therefore be described as a series of ten matrices:

Figure 1 – From basic to purchaser prices in global SUTs



Starting from the basic price (BP) at the producer's door in table 1, we add taxes less subsidies (TlS) and domestic trade and transport margins in the exporter's country (tables 1-4) to arrive at exports in fob terms, X_{fob}. Further, adding international trade and transport margins (TIR) result in the import price, M_{cif}, at the importer's border (tables 5 and 6). Tables 7-10 illustrate price transmission within the importing country: TlS (possibly including import duties) as well as (national) trade and transport margins are slapped on the border price, resulting in the purchaser price (PP) finally billed to the consumer (table 10).

In the SUT system, tables 1-4 as well as 7-10 are parts of the national SUTs – of the exporting and importing country, respectively. Tables 5 and 6, however, are not part of any national SUT – in a sense, they are 'missing' from our system of national SUTs (except in the case of neighbouring countries, where the absence of transit costs results in X_{fob} prices being equal to the M_{cif} price). This will allow us to determine the 'world supply' of TIR services, which, as we will argue, should be the world-wide net export of the respective services.

2.2 Data requirements

Though schematically it seems to be a rather straightforward undertaking, the actual implementation is hampered by a number of hurdles. In this section we therefore report such an empirical exercise which was carried out for the year 2005.

The supply and use tables (in USD) for the 40 WIOD countries are taken from the final version of the WIOD project's database. Information for the 'Rest of the World' (RoW) is taken from the United Nations' Statistical Division UNSD[8]. For a set of 210 countries (which we take to represent 'the whole world') it provides value added data for 7 sectors (plus country totals for private and public consumption, investment, inventories, and imports and exports); for a smaller set of 165 countries, data are available for value added, intermediate consumption and output for 13 sectors (see below on how these data sources are combined).

Information on trade flows of goods (CPA codes 1-37) is taken from the UN COMTRADE database. We collected total imports and exports of all countries and subtracted bilateral flows of WIOD countries. These bilateral data have then been adjusted according to the same procedure as the other WIOD bilateral trade data.[9] Information on trade in services is taken as well from the WIOD data for trade in services, which include bilateral flows for all countries in the world. These data for trade in services are combined from various sources (Balance of Payment data from IMF, OECD, Eurostat); see Timmer et al. (2012) for details.

Additionally, we use information on trade by mode of transport (air, road, rail, sea, post, unknown) as compiled by Eurostat to gain some idea about the different modes used in the transportation of different goods.

3 Estimation of supply and requirements of TIR services

As outlined above, the first step is to determine the overall magnitude of the supply of TIR services and to figure out from where these international trade and transport margins (TIR) are delivered. As these services have to be produced somewhere, these are recorded in the tables of domestic supply. Moreover, as these are not consumed in the producing country, they enter (probably after the imposition of domestic TlS) the export vector X_{fob} (fob = free on board; this is the price at the border of the *exporting* country). These TIR exports are, however, not explicitly imported in any country – instead, they enter the importing country as part of the 'composite good' (= manufactured good plus international trade and transport margins) valued as M_{cif} (cif = cost, insurance, freight) which is the price at the border of the *importing* country. Therefore, the export surplus at the world level of TIR services should give an indication of the total difference of M_{cif} and X_{fob} – in other words, total TIR costs. A look at the total net exports by goods and services of the 40 WIOD countries confirms these deliberations:

[8] UN Statistics Division: http://unstats.un.org/unsd/economic_main.htm

[9] We thank Johannes Pöschl (wiiw) for data work.

Table 1 – Net exports of the 40 WIOD countries

Goods:

CPA		WIOD-Net exports
1	Products of agriculture, hunting and related services	-38,059
2	Products of forestry, logging and related services	-9,852
5	Fish and other fishing products	-14,252
10	Coal and lignite, peat	-12,255
11	Crude petroleum and natural gas, services	-567,275
12	Uranium and thorium ores	**53**
13	Metal ores	-30,922
14	Other mining and quarrying products	**1,941**
15	Food products and beverages	-37,100
16	Tobacco products	-6,789
17	Textiles	**56,078**
18	Wearing apparel, furs	-97,797
19	Leather and leather products	-27,091
20	Wood and products of wood and cork	-10,229
21	Pulp, paper and paper products	**1,010**
22	Printed matter and recorded media	**15,067**
23	Coke, refined petroleum products and nuclear fuel	-61,560
24	Chemicals, chemical products and man-made fibres	-93,843
25	Rubber and plastic products	**20,510**
26	Other non metallic mineral products	-34
27	Basic metals	-51,683
28	Fabricated metal products, except machinery	**31,864**
29	Machinery and equipment n.e.c.	**21,205**
30	Office machinery and computers	-56,234
31	Electrical machinery and apparatus n.e.c.	**36,370**
32	Radio, television and communication equipment	-48,824
33	Medical, precision and optical instruments	-32,822
34	Motor vehicles, trailers and semi-trailers	**41,046**
35	Other transport equipment	**85,678**
36	Furniture, other manufactured goods n.e.c.	-85,099
37	Secondary raw materials	**6,442**

Services:

CPA		WIOD-Net exports
40	Electrical energy, gas, steam and hot water	-2,577
41	Collected and purified water, distribution services of water	**443**
45	Construction work	-2,171
50	Trade, maintenance and repair services of motor vehicles	**4,549**
51	Wholesale trade and commission trade services	**252,012**
52	Retail trade services, repair services	**29,656**
55	Hotel and restaurant services	-2,810
60	Land transport and transport via pipeline services	**67,682**
61	Water transport services	**145,075**
62	Air transport services	**15,892**
63	Supporting and auxiliary transport services	**23,497**
64	Post and telecommunication services	**441**
65	Financial intermediation services, except insurance	**122,412**
66	Insurance and pension funding services	-27,094
67	Services auxiliary to financial intermediation	**7,728**
70	Real estate services	-16,900
71	Renting services of machinery and equipment	**5,237**
72	Computer and related services	**55,855**
73	Research and development services	**768**
74	Other business services	-85,170
75	Public administration and defence services	**2,108**
80	Education services	**763**
85	Health and social work services	-3,473
90	Sewage and refuse disposal services	-768
91	Membership organization services n.e.c.	-1,871
92	Recreational, cultural and sporting services	-6,535
93	Other services	**1,772**
95	Services of households as employers of domestic staff	**136**

Source: WIOD; own calculations.

The largest trade deficit of the WIOD countries is for good 11 (crude petroleum). This is no surprise since – with the exception of Russia (and, to a smaller extent, Brazil and Mexico) – the WIOD area does not cover any major oil exporters. The largest trade surplus is for services 51 (wholesale trade), 61 (shipping) and 65 (financial services) – two sectors among which are providers of margins. What is even more striking, as Table 1 shows, is that *all* services which are credited with providing trade and transport margins (50-52, 60-63) in the national SUTs exhibit positive net exports from the WIOD countries. However, in our list of TIR services we included only 51 (wholesale trade) plus the four transport services 60-63. Retail trade services (52) is omitted since – according to the 'territorial principle' – retail services should be consumed at the place of production, i.e., at the place of the retailer. CPA 50 is more contentious as it covers trade in vehicles (both wholesale and retail), gas stations, as well as repair of vehicles. Thus, the wholesale part of CPA 50 should be included in our list of TIR services – which, however, is impossible to disentangle from the other components of 50. We chose not to include 50.[10] The resulting value of CPA 51 and 60-63 was taken as the contribution of the WIOD countries regarding total supply of TIR services. In the year under consideration, 2005, this amounts to roughly USD 500 billion.

However, this amount does not include the Rest of the World which still accounts for about 15% of world GDP and might be an important provider of such services. Lacking SUTs for RoW, we start constructing them: on the basis of the UNSD data, we utilize the average commodity structure of the SUTs for the WIOD countries which might come closest to the 'Rest of the World' – we chose Brazil (BRA), Indonesia (IDN), and India (IND) – denoted as BII. Applying this commodity structure to total output and intermediate use by the seven sectors as well as the categories of final demand as included in the UNSD database, we derived a 'proxy' SUT for the RoW. At this stage the RoW-SUT is only indicative and serves the sole purpose of deriving net exports in TIR services. At a later stage, we will derive a consistent SUT for RoW, where the M_{cif} and X_{fob} vectors are the results of a commodity balancing at the world level. The reason for this sequential approach is that the balancing at the world level does not work for the TIR services: if our above reasoning is correct, the world needs to run a (statistical) surplus in TIR services as these are not properly reported in the national SUTs of either the exporting or the importing countries (see discussion above), with this surplus constituting the cif-fob difference in the trade of manufactured goods.

This 'proxy' SUT for RoW, however, shows a surprising result (see table 2): the surplus of net exports in TIR services is almost non-existent – it is estimated at USD 1 billion only (as compared with the USD 500 billion surplus of the WIOD countries). At first sight, this seems puzzling as – after all – the RoW includes Panama and Liberia, two important providers of 'flags of convenience'. A second look

[10] This aspect is one point of potential refinements requiring more detailed information.

reveals, however, that for example the ten largest shipping lines are all located in WIOD countries; the same is true for the largest 'general purpose' logistic enterprises such as FEDEX, DHL and UPS. As for the 'flags of convenience', the UNSD database credits neither Panama nor Liberia with an excessively large transport sector (the flag of convenience most probably involves nothing more than the payment of a registration fee). In this light, the result that RoW does not contribute to the world supply of TIR services seems not so far off, probably.

A word of caution has to be raised with respect to this estimated amount of net exports of TIR services from RoW: the number hinges crucially on the structural assumptions; using different assumptions yields appreciably different TIR totals. We think that our result of zero net exports from RoW (being based on the average structure of BRA, IND, IDN) represents the lower bound of the reasonable range; the upper bound would probably correspond to RoW's share in world value added in transport services, which is 13%, and which might imply that RoW's share in world TIR exports could amount to some USD 60-80 billion.

Table 2 – World-wide net exports (=X_{fob}-M_{cif}) of TIR services

	WIOD	RoW	Total
51 - Wholesale trade and commission trade services	252,012	965	252,977
- Land transport and transport via pipeline services	67,682	9,420	77,102
61 - Water transport services	145,075	- 6,338	138,737
62 - Air transport services	15,892	- 7,920	7,972
63 - Supporting and auxiliary transport services	23,497	5,133	28,630
Total	504,158	1,260	505,418

Source: WIOD; UNSD; own calculations.

Summing up, the total world supply of TIR services is estimated at around USD 500 billion with the RoW providing only little of it. As in the case of national trade and transport margins we assume that TIR services are used for transport of agricultural, mining, and manufactured goods only (CPA codes 1-37).

4 Construction of a consistent trade matrix

4.1 Derivation of an initial matrix of cif-fob corrections

Having thus derived the overall supply of TIRs in a first step, the second step is to derive initial estimates for the cif-fob corrections in the bilateral relations. This is based on detailed COMTRADE data using panel estimation methods and explained in Streicher (2012) in detail. There, cif markups on fob prices are modelled as a function of distance, landlockedness, and whether two trading partners are located on the same continent, plus commodity fixed effects.

This results, first, in a bilateral matrix of cif-fob ratios for each product of CPA codes 1-37. Applying these estimated ratios to the bilateral product-specific import levels results in a matrix of cif-fob corrections in levels. This matrix is then reconciled with the total supply of TIR services as presented in Section 3.1. It should be noted here that these adjustments only affect the level of cif-fob corrections in value terms, but not the relative structures.

Having derived such a matrix of bilateral cif-fob mark-ups, the third step is then the derivation of a consistent trade matrix for all commodities. The construction of such a trade matrix consists of four parts which are discussed in turn.

1. A trade matrix for TIR-carrying commodities 1-37, including cif-fob corrections (Section 4.2)
2. A trade matrix for services other than TIR services which do not involve a cif-fob correction (Section 4.3)
3. A trade matrix for TIR services 51, 60-63. Part of trade in these services is brought about by the cif-fob correction of step 1 (importers of commodities import TIR services as part of the cif price) (Section 4.4).

These steps lead to a trade matrix of dimension importer x exporter x commodity. At this stage, no distinction is made between different trade structures for different *uses* of a commodity. This will constitute a further step:

4. Disaggregation of the trade matrix derived in steps 1-3 to allow for different trade structures by different uses (intermediates, consumption and final demand).

4.2 Trade matrix for goods

For the TIR-carrying commodities, CPA 1-37, the problem to be solved may be illustrated as follows:

Figure 2 – Trade evaluated in cif and fob terms

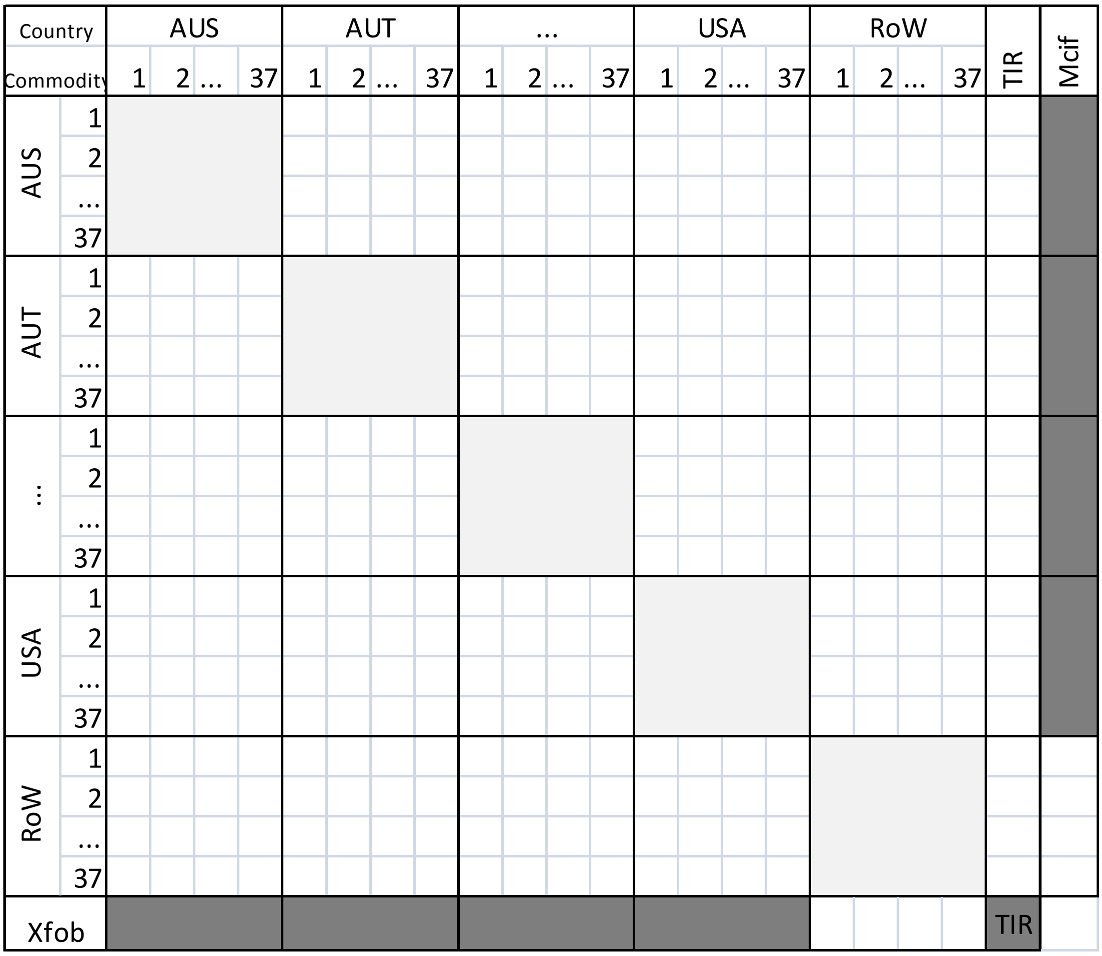


Figure 2 illustrates the trade flows between all countries and commodities 1-37. Due to cif-fob margins this constitutes a very 'incomplete' boundary value problem: First, we know the M_{cif}-vector for the WIOD countries from the SUTs made available, but not for RoW; likewise, we know the X_{fob}-vector only for the WIOD countries, but again not for RoW.[11] Second, from the TIR vector, which represents the wedge between X_{fob} and M_{cif}, we only know the sum – it was estimated in Step 1 above at about USD 500 billion.

To tackle this incomplete boundary value problem by RAS, we actually disaggregate the above matrix into 3 matrices which have to satisfy that:

Trade matrix in fob + TIR matrix = Trade matrix in cif

Initial values for the trade matrix in cif are derived from the COMTRADE database; derivation of initial values for the TIR matrix was done in step 2 – they are scaled to total TIR as derived in step 1.

[11] Even if we had information on the export and import vectors of RoW, a balancing algorithm would still be necessary in all likelihood, to ensure equality of global exports and imports conditional on the TIRs.

The third matrix, the trade matrix in fob prices, is the difference between the fob and the TIR matrices.

Being very incomplete, this boundary value problem cannot be solved in the usual way. Instead, we iterate over the (unknown) boundary values for RoW: iteratively and for each commodity, X_{fob} and M_{cif} of RoW are adapted such that the total X_{fob} and M_{cif}, respectively, of the WIOD group become feasible: in case there are 'too little' exports from RoW to satisfy the WIOD area's import needs, X_{fob}(RoW) is raised; similarly for M_{cif} (RoW). The TIR matrix is adapted in each step, keeping total TIR at the predefined level. To prevent this algorithm from settling on the 'RoW only' solution (i.e. that *all* exports from the WIOD area go to RoW and that *all* imports into the WIOD area originate in RoW), an additional constraint has to be introduced: the sum of total RoW exports over all commodities 1-37 is set at a fixed share of total world exports. This fixed share is derived from the COMTRADE data base and amounts to 12%. In essence, this implies that *total* exports from RoW are fixed at 12% of total world exports; the commodity structure, however, is determined in the RAS.

This algorithm balances X_{fob} and M_{cif} for commodities 1-37 at the world level, while at the same time yielding TIR flows between countries. However, these are *total* TIR flows, without distinction between the individual TIR services 51, 60-63. For this disaggregation, we use information from the Eurostat data on trade by transport mode, which record extra-EU flows for the member states by HS2 commodities and a number of modes of transport: air, sea, road, rail (plus post and 'unknown'). Although this database provides a very 'Eurocentric' view, it seems to be the only source for this kind of information. For trade between partners sharing a continent (like the continental EU member states), an ad-hoc correction to the transport structure of flows was introduced, by substantially reducing the air and sea shares and raising the land transport share.

For the disaggregation, this provides some information on the mode of transport, i.e. TIR services 60-63. Still missing is the share of wholesale trade, CPA 51, for which we have no information whatsoever. The solution was a pragmatic one: as an initial guess, the wholesale share was assumed to be a uniform 50% for all flows (this is the share of 51 in total TIR). This is certainly pragmatic, but probably not overly so. At least, it seems to involve not much more pragmatism than already used in the derivation of the national SUTs: comparing all WIOD countries, the share of wholesale in trade and transport margins is surprisingly similar for all commodities, at around 45%. Boundary values for this RAS (shaded in gray in Figure 3) are then given by world totals of the TIR services as indicated in Table 2 on the one hand and cif-fob difference for each flow on the other.

Figure 3 – Disaggregation of TIR flows

			TIR services					
Exporter	Importer	Good	51	60	61	62	63	Total
AUS	AUT	1						0.09
		2						0.00
		5						0.00
		10						0.00
		....						.....
		37						0.15
AUS	BEL	1						0.69
		2						
		5						0.00
		10						51.59
		....						.....
		37						0.14
....	....	....						.....
ROW	USA	1						688.36
		2						37.13
		5						295.25
		10						92.11
		....						.....
		37						1.67
Total			252,977	77,102	138,737	7,972	28,630	505,418

4.3 Trade matrix for other services

The trade matrix for services other than TIR services is simpler: as we assume that these do not carry TIR margins, we do not need to introduce a cif-fob correction. Therefore, the net export vector for RoW is known: it is simply the mirror to the net exports from the WIOD area. However, it is only *net* exports which are known – to derive exports and imports separately, we have to follow a similar procedure as in the case of commodities 1-37, namely fixing RoW's share of world exports for services. Like the starting values for the trade matrix, this share should be derived from the Balance of Payments database. However, the RoW share according to the BoP, at around 13%, proved 'too low to balance the world'; we had to use a share of 21% instead.

4.4 Trade matrix for TIR services

The last part concerns the trade submatrix of TIR services: clearly, 'recorded' imports and exports of these services cannot balance at the world level, as part of the exports enters importing countries only via cif-fob corrections (i.e. international trade and transport margins). Therefore, one first has to add these corrections to imports of TIR services; i.e.:

for all TIR services 51, 60-63:

total import of a trade&transport service (in BP) of Importer =

direct import of T&T service (in cif) of Importer

+ $\sum_{(Exporter,Good)}$ TIR service(Importer, Exporter,Good).

After that, the balancing algorithm is the same as in the case of other services. Again, we have to fix an export share for RoW, which in this case is close to the BoP share of 14%.

4.4 Trade matrix – differentiation by user

In the previous three steps we derived a trade matrix of dimension importer x exporter x commodity. However, the WIOD project provides some more detail: in the international SUTs there is a distinction between intermediate consumption, final consumption (by households, by non-profit organisations serving households (NPISH) and government) and investment demand (the basis for the different trade structures are highly disaggregated trade data). Using RAS and taking trade structures by user from the WIOD international SUTs as starting values[12], we adapt them to the boundary values presented by the trade matrix from step 3.

One of two crucial differences between our trade matrix by user and WIOD's international SUTs is in the treatment of re-exports (i.e., exports of previously imported goods which did not undergo any processing or transformation). Following WIOD, we take re-exports as a 'residual', i.e. re-exports occur when imports of a commodity are higher than domestic use[13]. In WIOD, however, re-exports are recorded as a separate *user*; also, re-exports originate from the home country only – they are not explicitly and specifically imported. Following SUTs from European countries (see, e.g., Statistik Austria, 2011), we re-define re-exports as imports of user 'export'. Assuming the same initial trade

[12] For the SUT for RoW – which will be derived in the next chapter – we assume that all users in RoW exhibit identical trade structures.

[13] This is not accurate, however: for example, in Austria's official SUT, imports of exports are recorded for a much higher number of commodities than is the case in WIOD's international SUT (compare Statistik Austria, 2011).

structure as for imports of intermediates, re-exports thus are included in the same RAS procedure as are imports by any other user.

The other difference is that we define an additional user: in our table, TIR is the additional user which uses the international trade and transport margins derived above. Demand of user TIR consists of demand for commodities 51, 60-63 and is satisfied by imports only. By this setup, we ensure that the ‘official’ M_{cif} numbers for TIR services are satisfied (these are the sum of TIR services imports for all users excluding TIR – remember: we derived world demand for TIR services as the world-wide net exports of TIR services. TIR, therefore, ‘eats up’ this excess demand for TIR services in a consistent way, without interfering with the rest of the SUTs).

5 Construction of a SUT for RoW

As a result of the derivation of a consistent trade matrix as described above, we also have at our disposal vectors X_{fob} and M_{cif} for the Rest of the World. These we will use to construct a SUT for RoW. As already emphasized in the introduction, some caution is required: the resulting RoW-SUT should not be considered as *the* SUT for RoW, but rather as *a* SUT which is consistent, in the sense that it will lead to full commodity balance at the world level. Nevertheless, it will be constructed in such a way that much available information on the RoW economy is incorporated.

Information on the RoW is taken from the United Nations’ Statistical Division UNSD[14] providing economic indicators for about 210 countries. Besides country totals (such as GDP, imports, exports, etc.), this source also provides some (modest) disaggregation; on the supply side, it includes data on value added for eight sectors:

- Agriculture, hunting, forestry, fishing (ISIC A-B)
- Mining, Manufacturing, Utilities (ISIC C-E)
- Manufacturing (ISIC D)
- Construction (ISIC F)
- Wholesale, retail trade, restaurants and hotels (ISIC G-H)
- Transport, storage and communication (ISIC I)
- Other Activities (ISIC J-P)
- (Imports of goods and services)

For final demand, the following categories are covered (valued at purchaser prices):

[14] UN Statistics Division: http://unstats.un.org/unsd/economic_main.htm

- Household consumption expenditure (including Non-profit institutions serving households)
- General government final consumption expenditure
- Gross capital formation
- Gross fixed capital formation (including Acquisitions less disposals of valuables)
- Changes in inventories
- (Exports of goods and services)

The Rest of the World is derived as the sum over the approximately 170 non-WIOD countries. The sum of exports and imports cannot be used directly, as it also includes inter-RoW trade; however, appropriate vectors X_{fob} and M_{cif} for RoW are already available as a by-product of the derivation of a consistent trade matrix as discussed above.

A different segment of the UNSD database provides more detailed information, albeit for a smaller set of 165 countries (also, it has data in national currency only). In addition to value added, this database provides output and intermediate consumption; moreover, it includes 13 instead of 7 sectors of production. We combine the two data sets by aggregating the 13 sectors of the second data set to the 7 sectors of the first; then, after summing over the non-WIOD countries, we take the VA/Q ratios and apply them to the VA data from the first data set, thereby generating an estimate for the RoW's Q and S. The results are presented in Table 3. Using the numbers on output and intermediate use (in PP) for the seven sectors and the four categories of final demand as included in the UNSD database, an initial guess for the commodity structure of supply and demand by sector and category, respectively, is taken from the WIOD SUTs as the average of the three countries Brazil, Indonesia and India (BII). We also aim at a 'clean' transformation of supply in basic prices to use in purchaser prices; therefore, we also use average TnS (Taxes net of Subsidies on commodities) and TTM-structures (trade and transport margins) again as derived from the three countries mentioned above.

The balance which has to be achieved is given by supply (RoW) = demand (RoW):

$$M_{cif} + domSup^{BP} = domUse^{PP} + X_{fob} - TlS(domUse^{PP} + X_{fob}) - TTM(domUse^{PP} + X_{fob})$$

M_{cif} and X_{fob} are given; starting from BII structures, the other terms are adapted to achieve this identity. This adaptation is not implemented as a full RAS; rather, it is done in a sequential way: the column sums of domestic supply in basic prices ($DomSup^{BP}$) were held at the levels derived from UNSD, only allowing for a different commodity structure (as the most extreme example, the share of CPA 11, oil and gas, in the output of the *mining* sector had to be substantially increased with respect to BII in order to satisfy world demand for this commodity); to facilitate this we assumed that RoW sectors exhibit primary production only. The balancing was brought about mainly through modifications on the demand side. But even here, the deviation of the column sums from the UNSD totals was moderate, with a range of ± 5%. The balancing totals for final demand are given in Table 4.

In total, RoW accounts for 11% of world production, 14% of world imports in cif, and 18% of world exports in fob (excluding codes 10-13, oil, coal, and iron ore, where RoW's share in world exports is more than 60%, this share drops to 14%).

Table 3 – The Rest of the World in numbers

	[mio US$]		
	VA	**S**	**Q**
GrossDomesticProduct(GDP)	**5,282,191**		
Supply:			
Agriculture,hunting,forestry,fishing(ISICA-B)	411,489	201,935	613,424
Mining,Utilities	941,056	322,293	1,263,348
Manufacturing(ISICD)	780,298	1,675,372	2,455,671
Construction(ISICF)	247,156	335,700	582,856
Wholesale,retailtrade,restaurantsandhotels(ISICG-H)	692,456	432,624	1,125,080
Transport,storageandcommunication(ISICI)	403,505	394,057	797,562
OtherActivities(ISICJ-P)	1,576,275	759,532	2,335,808
Importsofgoodsandservices	1,752,166		
TaxeslessSubsidies=GDP-Σ(VA)	229,956		
FinalDemand:			
Householdconsumptionexpenditure(includingNPISH)	2,948,535		
Generalgovernmentfinalconsumptionexpenditure	745,774		
Grossfixedcapitalformation	1,067,606		
Changesininventories	71,293		
Exportsofgoodsandservices	2,069,772		

Note: Imports and Exports of Goods and Services are results from the trade balancing algorithm.
Source: UNSD; own calculations.

The structure of RoW by commodity is presented in Table 5. Apart from mining products, RoW's competitive edge can be found in agriculture, forestry and fisheries (codes 1-5), textiles and leather (codes 18 and 19) and refined petroleum products (23). Trade in services is more contentious: here, numbers on RoW's share in world totals (which may seem quite high – see e.g. codes 70, 85 and 91) are certainly plagued by rather low trade volumes where, typically, exports make up only a very small share of domestic production. On the other hand, a few of the services with a high RoW share are especially conducive to offshoring (66 – insurance; 74 – business services). Also, reports on booming medical tourism in some RoW countries may justify the high share in world exports of code 85 (medical services).

Table 4 – Final demand for Rest of the World after balancing

		Supply	Use in PP	Use of margins	Taxes minus subsidies	Use in BP
AtB	Agriculture, Hunting, Forestry and Fishing	613,424	201,935	24,798	3,881	198,054
C	Mining and Quarrying	859,061	172,828	11,585	3,629	169,199
15t16	Food, Beverages and Tobacco	558,036	403,184	54,836	5,970	397,213
17t18	Textiles and Textile Products	169,741	106,528	13,857	1,953	104,575
19	Leather, Leather and Footwear	40,617	26,062	3,233	613	25,450
20	Wood and Products of Wood and Cork	37,185	19,846	2,430	417	19,429
21t22	Pulp, Paper, Paper , Printing and Publishing	87,358	54,926	5,712	1,692	53,234
23	Coke, Refined Petroleum and Nuclear Fuel	256,218	173,464	9,006	3,867	169,597
24	Chemicals and Chemical Products	343,803	236,426	22,243	5,674	230,752
25	Rubber and Plastics	68,310	47,186	5,494	1,256	45,930
26	Other Non-Metallic Mineral	61,371	35,999	3,524	666	35,333
27t28	Basic Metals and Fabricated Metal	214,890	145,206	12,983	2,681	142,525
29	Machinery, Nec	102,901	71,046	7,992	2,582	68,464
30t33	Electrical and Optical Equipment	221,937	158,736	17,051	4,940	153,797
34t35	Transport Equipment	187,341	130,799	11,682	4,491	126,309
36t37	Manufacturing, Nec; Recycling	105,962	65,964	9,093	1,726	64,238
E	Electricity, Gas and Water Supply	404,287	149,465	8,396	1,987	147,478
F	Construction	582,856	335,700	44,250	9,742	325,958
50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	44,037	7,623	330	150	7,472
51	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	411,192	128,825	5,971	2,402	126,423
52	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	441,887	146,626	6,771	2,731	143,895
H	Hotels and Restaurants	227,964	149,550	17,402	2,522	147,028
60	Inland Transport	412,662	241,875	18,771	6,518	235,357
61	Water Transport	50,745	17,315	1,191	402	16,914
62	Air Transport	26,003	13,272	872	301	12,971
63	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	70,868	26,712	1,113	499	26,212
64	Post and Telecommunications	237,285	94,883	4,790	2,283	92,601
J	Financial Intermediation	376,556	107,334	2,349	1,801	105,533
70	Real Estate Activities	404,604	81,573	2,110	1,284	80,289
71t74	Renting of M&Eq and Other Business Activities	306,538	128,477	4,396	2,825	125,652
L	Public Admin and Defence; Compulsory Social Security	476,469	141,275	7,483	2,722	138,553
M	Education	249,908	83,522	5,133	1,549	81,973
N	Health and Social Work	172,096	80,943	6,590	1,717	79,226
O	Other Community, Social and Personal Services	330,837	134,642	10,306	3,542	131,100
P	Private Households with Employed Persons	18,798	1,766	169	33	1,732
Imp_cif	Imports (valued at cif)	1,752,166				
Final Demand:						
Cons_h	Household consumption expenditure (including NPISH)		3,065,465	224,275	56,682	3,008,784
Cons_g	General government final consumption expenditure		792,366	1,383	1,863	790,503
GFCF	Gross fixed capital formation		1,035,263	67,334	26,680	1,008,583
Inven	Changes in inventories		71,220	14,097	2,359	68,861
Exports	Exports of goods and services		2,069,870	198,472	51,324	2,018,546
Total	**Total**	**10,925,915**	**11,155,698**	**869,472**	**229,956**	**10,925,915**

Source: Own calculations.

Table 5 – RoW production, imports and exports by commodity

	RoW totals [Mio. US$]			RoW as % of world total		
CPA	Make	Imports cif	Exports fob	Make	Imports cif	Exports fob
1	527,840	26,439	53,502	24%	13%	28%
2	66,835	602	8,102	30%	3%	43%
5	18,750	96	12,182	15%	0%	43%
10	77,151	3,178	9,433	31%	6%	20%
11	637,678	41,558	553,057	44%	5%	66%
12	-	57	-	0%	98%	0%
13	88,650	2,819	26,183	38%	3%	31%
14	55,583	18,302	9,323	21%	21%	11%
15	511,472	62,725	78,241	15%	13%	17%
16	46,564	404	5,535	23%	2%	23%
17	72,148	79,157	14,146	11%	34%	6%
18	97,593	13,030	85,910	21%	5%	35%
19	40,617	6,004	25,623	20%	5%	24%
20	37,185	10,201	14,538	8%	10%	16%
21	56,678	18,996	12,263	9%	12%	8%
22	30,680	22,340	2,505	5%	31%	4%
23	256,218	63,371	96,464	14%	16%	26%
24	343,803	112,272	167,332	13%	11%	17%
25	68,310	44,041	12,498	7%	18%	5%
26	61,371	16,053	9,272	7%	14%	9%
27	157,045	88,460	115,136	8%	15%	20%
28	57,845	48,837	10,965	4%	19%	4%
29	102,901	141,927	58,226	5%	17%	7%
30	43,371	52,281	78,350	10%	12%	20%
31	72,557	78,542	19,700	8%	21%	6%
32	79,977	164,548	151,477	7%	18%	18%
33	26,032	30,948	44,844	5%	11%	16%
34	187,152	120,101	19,642	8%	12%	2%
35	189	106,810	7,934	0%	33%	3%
36	105,862	21,046	85,542	16%	6%	27%
37	100	7,560	23	0%	32%	0%
40	388,227	3,816	6,199	18%	9%	15%
41	16,060	446	2	7%	75%	0%
45	582,856	1,334	3,421	10%	7%	18%
50	44,037	1,562	1	5%	53%	0%
51	411,192	22,353	23,318	10%	32%	8%
52	441,887	17,948	22	12%	66%	0%
55	227,964	10,086	12,795	10%	12%	15%
60	412,662	1,788	11,208	19%	3%	8%
61	50,745	13,410	7,072	13%	22%	4%
62	26,003	9,771	1,851	6%	8%	1%
63	70,868	1,517	6,651	7%	2%	6%
64	237,285	6,744	6,137	13%	12%	11%
65	326,422	123,392	977	10%	60%	0%
66	50,135	5,447	32,468	4%	7%	45%
67	-	8,556	829	0%	24%	2%
70	404,604	48	16,948	7%	0%	68%
71	67,764	7,212	1,920	11%	22%	6%
72	35,578	56,933	1,028	3%	48%	1%
73	111,319	4,641	3,865	19%	9%	7%
74	91,876	40,406	125,339	2%	9%	27%
75	476,469	2,245	134	10%	24%	1%
80	249,908	2,188	1,424	13%	20%	13%
85	172,096	71	3,542	4%	1%	58%
90	225,042	202	960	42%	6%	27%
91	32,749	307	2,178	8%	8%	53%
92	38,242	3,987	10,494	3%	7%	18%
93	34,804	2,877	1,102	3%	11%	4%
95	18,798	177	41	7%	57%	13%
Total	9,173,749	1,752,166	2,069,870	11%	15%	18%

Source: Own calculations.

6 Concluding remarks

The paper described a strategy for constructing a trade matrix together with supply and use tables for the Rest of the World resulting in a consistent world SUT system in the sense that at the world level, supply and use of all commodities is balanced. In doing so we (i) show that it is possible to derive consistent trade and transport margins (TIR) to account for the wedge between fob and cif prices; 'consistency' meaning that also for TIR services, equality of demand and supply is provided for at the world level; (ii) reveal the data needs and/or assumptions required to bring this consistency about; and (iii) based on these TIR flows, we show that it is possible to construct a SUT for the Rest of the World which ensures a 'balanced world' with respect to all goods and services. In the construction we further rely on and stick to official data on world output and demand (as published by the UN) to quite a large extent (as far as this is possible).

Of course, as this is very much research in progress, a number of open questions and the need for further research and efforts remain. These include (but are not limited to) the following items: (i) The estimation for total TIR margins is split in two: total TIR margins provided by WIOD countries on the one hand and RoW on the other hand. The estimate for the RoW part is quite ad-hoc. Although some ad-hocery in this respect is indispensable (after all, we do not have SUTs for RoW when we start this exercise; rather, a SUT for RoW can only be derived *post festum*), the derivation might be placed on a sounder footing. (ii) Room for improvement is certainly given when distributing TIR margins to the five TIR services; the initial values for the RAS which ensures consistency in this respect are based on Eurostat data and include information on extra-EU trade only, thus introducing a strong Eurocentric bias. (iii) As for the SUT for RoW, this is certainly not *the* SUT, but only *a* SUT which ensures that the commodity balance at the world level is ensured. However, it is not taken from thin air, but based on boundary values for output and intermediate and final consumption taken from the UNSD data base; to a large degree, these boundary values can be met. Nevertheless, more effort could and should be invested to further improve this congruence, even if improvement can most probably not be achieved via better data, but only 'statistically' via better algorithms. (iv) The exercise presented here was limited to the derivation of a trade matrix and RoW-SUT for 2005; a valid question concerns the feasibility (and sensibility) of applying this procedure to other years as well, thus providing a time series of trade matrices and SUTs for RoW. This is certainly possible; however, the main concern arising here is inter-temporal comparability: by repeating this exercise for, say, 1995-2009, the period for which SUTs for the WIOD countries are available, would we be able to learn something about the time development of TIR margins (and about the development of RoW)? Without having done this exercise (yet), it is hard to tell how 'meaningful' these time series would *look*; however, given the assumptions and 'manual interventions' necessary for the year 2005, it is a fair bet that such a time series would have a serious range of uncertainty. At the very least, the ad-hoc elements used for 2005 (mainly involving the RoW-part of total TIR margins and then the derivation of the RoW-SUT) would have to be much more formalized in order to allow for repeatability (and comparability) over time.

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