Constructing a consistent and balanced world SUT system including international trade- and transport margins -Wither Panama

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Preliminary and unfinished version – Comments welcome

Abstract

This 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. This assures a "balanced world economy" with respect to trade in all goods and services.

1 Introduction

In the WIOD project supply and use tables (SUTs) for 40 countries, covering about 85% of world economic output, are collected. These SUTs are available as national SUTs and in 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.[1] 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 economy in the way national TTMs are linked back to the economy when transforming tables from use in purchaser prices to use in basic prices, TTMs are re-distributed to the TTM services.

This paper aims to address these shortcomings. "Linking back" international trade and transport margins to the relevant sectors of the economy further provides a SUT for the Rest-of-the-World such that at the world level, the supply and use of all commodities, goods as well as services, will be balanced. Though this is – given the partly far-reaching assumptions to be made and the data constraints faced – only an approximation for a SUT of ROW, it will, however, yield a "consistent" supply and use system for the world, i.e. it is balanced in terms of all flows. It will also avoid the need to resort to any kind of "Panama Assumption" (see below).

Apart from (numerically) balancing world input and output, this derivation of a SUT for ROW has other aspects to recommend it: as it is, the WIOD project will give world-wide Input Output linkages in the form of (quadratic) IO tables only. There are, however, a few things to be said in favour of using SUTs instead of IOTs: for one, the derivation of IOTs (which are derived from SUTs) requires a "technology assumption" to be made, which essentially are rules on how to deal with atypical production (under the "industry technology assumption", atypical products are produced with the same technology as the typical product. Under the "commodity technology assumption", atypcial commodities are produced with the technology of the sector of which the commodity is the typical product). 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 econometric results in so-called "econometric IO models"; IOTs, on the other hand, are much less flexible in this respect.

The Panama Assumption revisited

Although concrete information seems to be 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 the "Panama assumption": international transport costs are somehow assumed to be provided by "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

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[1] 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.

being Panama[2]. However, data from the United Nations' Statistical Division UNSD[3] do not really bear out this assumption: although relative to total GDP, Panama's transport sector is above average, the important business of the Panama Canal probably makes up a substantial part of this sector: 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%). But even if all of Panama's transport sector were devoted to international transport margins, this would contribute only 2.5 bn US$ to international trade - With transport costs estimated at 5-10% of a world trade volume of some 12.000 bn US$ in 2011[4], this would be only a drop in the ocean. 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 Outline of strategy

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

1. Estimation of total supply of TIR services[5]
2. Derivation of an initial matrix of cif-fob-corrections
3. Determination of the matrix of cif-fob corrections such that the sum over all bilateral cif-fob corrections equals the sum of all TIR services supplied, i.e. $\sum_{world}$(cif-fob corrections) = $\sum_{world}$(TIR-services), based on this initial matrix,
4. Distribute total cif-fob margins to the TIR services trade, surface-, sea- and air-transport

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 this 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 (now international) trade- and transport margins. The total chain from the producer (located in some country) to the consumer (located in some other country) of some good might be described as a series of ten matrices:
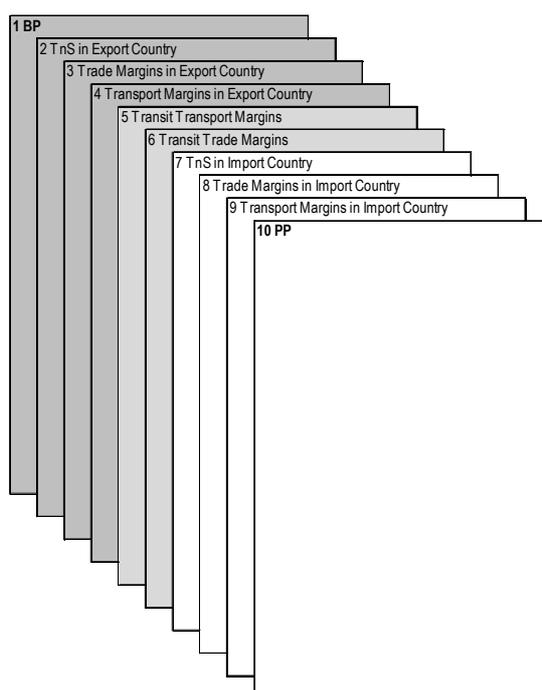
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[2] According to the CIA World Fact Book (https://www.cia.gov/library/publications/the-world-factbook/geos/pm.html), Panama's merchant fleet, with 6,379 vessels, is the world's largest. 5,244 of those vessels are foreign owned, almost half of which are Japanese.

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

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

[5] We propose to call the services which make up international trade and transport margins TIR services (after the "TIR"-signs[5] 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 presented below.

Figure 1 – System of matrices

Starting from table 1's basic price (BP) at the producer's door, we add taxes net subsidies (Tns), trade and transport margins in the exporter's country (tables 1-4) to arrive at the exports in fob terms, X_{fob}. Further, including international trade and transport margins 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: TnS (possibly including import duties) as well as (national) trade and transport margins are slapped on the border price, resulting in table final purchaser's price (PP) finally billed to the consumer.

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 presently argue, should be the world-wide net export of the respective services.

3 Data needs

This exercise was carried out for the year 2005. The supply and use tables (in US$) for the 40 WIOD countries are taken from the last version of the WIOD project's database.

Data on the "Rest-of-the-World" ROW are taken from the United Nations' Statistical Division UNSD[6]. Here, one can find economic indicators for about 210 countries. Besides countries (like GDP, imports, exports, etc), the data also provide some (modest) disaggregation; on the supply side, it includes data on output, intermediate consumption (in purchaser prices) and 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):

- 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 170 non-WIOD-Countries.

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 ben adjusted according to the same procedure as the other WIOD bilateral trade data.[7] Information for trade in services is taken as well from the WIOD data for trade in services which include bilateral flows for all countries.

Additionally, we utilize 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.

4 Estimation of total supply of TIR services

Where would international trade and transport margins come from? As these 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 TnS) the export vector X_{fob}. These 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&transport margins) valued at M_{cif} (cif = Cost, Insurance, Freight). Therefore, the export surplus at the world level of TIR services (sectors listed above) should give an indication for the total

difference of M_{cif} and X_{fob} – in other words, as total TIR costs. A look at the total net exports by goods and services of the 40 WIOD countries confirms these deliberations:

Table 1 – WIOD net exports

Goods:			Services:	
CPA	WIOD-NetX		CPA	WIOD-NetX
1	-38,059		40	-2,577
2	-9,852		41	**443**
5	-14,252		45	-2,171
10	-12,255		50	**4,549**
11	-567,275		51	**252,012**
12	**53**		52	**29,656**
13	-30,922		55	-2,810
14	**1,941**		60	**67,682**
15	-37,100		61	**145,075**
16	-6,789		62	**15,892**
17	**56,078**		63	**23,497**
18	-97,797		64	**441**
19	-27,091		65	**122,412**
20	-10,229		66	-27,094
21	**1,010**		67	**7,728**
22	**15,067**		70	-16,900
23	-61,560		71	**5,237**
24	-93,843		72	**55,855**
25	**20,510**		73	**768**
26	-34		74	-85,170
27	-51,683		75	**2,108**
28	**31,864**		80	**763**
29	**21,205**		85	-3,473
30	-56,234		90	-768
31	**36,370**		91	-1,871
32	-48,824		92	-6,535
33	-32,822		93	**1,772**
34	**41,046**		95	**136**
35	**85,678**			
36	-85,099			
37	**6,442**			

The largest trade deficit of the WIOD countries is for good 11 (crude oil) – not surprisingly, since – with the exception of Russia (and Brasil) – 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 margin providers among them. What is more, as the diagram shows, <u>all</u> services which in the SUTs are credited with providing trade and transport margins (50-52, 60-63) 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: we omitted 52, since according to the "territorial principle", retail services should be consumed at the place of production – i.e., at the locality of the retailer. CPA 50 is more contentious – it covers trade in vehicles (both wholesale and retail), gas stations, as well as repair of vehicles. Thus, the wholesale part of 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.

This value was taken as the contribution of the WIOD countries towards total supply of TIR services; it amounts to roughly 500 billion US-$ in 2005. What about the rest of the world? Lacking SUTs for ROW, we start making 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 BRA, IDN, IND and MEX. 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 "synthetic" SUT for the ROW. This SUT is very preliminary, and it is treated as such – except for net exports in TIR services, which we take at face value (later, 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). This balancing, however, does not work for the TIR services – if our above reasoning is correct, the world needs to run a surplus in the TIR services, with this surplus constituting the cif-fob-difference in the trade of manufactured goods.

This preliminary SUT for ROW however shows a surprising result: the surplus of net exports in TIR services is non-existent – in fact, there is even a slight deficit of about 7 billion US-$ (as compared with the 500 billion US-$ surplus of the WIOD countries). Though at first, this seems puzzling as, after all, the ROW includes Panama and Liberia, two providers of "flags of convenience". A second look reveals, however, that for example the 10 largest shipping lines all located in WIOD countries; the same is true for the largest "general purpose" logistic enterprises, like FEDEX, DHL, UPS. As for the "flag of convenience", the UNSD database credits neither Panama nor Liberia with an above-average 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.

Summing up, the total world supply of TIR services is estimated at around 500 billion US-$; as is the case for national trade and transport margins, we assume that TIR services are used for agricultural, mining, and manufactured goods only (CPA-codes 1-37).

5 Derivation of an initial matrix of cif-fob-corrections

The derivation of initial estimates for the cif-fob-correction, based on COMTRADE data using panel estimation methods, is explained in a different paper (Streicher, 2012). There, cif markups on fob prices are modelled as a function of distance, landlockedness, and whether two trading partners are on the same continent, plus commodity fixed effects.

6 Construction of a consistent trade matrix

The next step is then the derivation of a consistent trade matrix for all commodities which is split into three parts:

1. A trade matrix for TIR-carrying commodities 1-37, involving cif-fob corrections;
2. A trade matrix for services other than TIR services (they do not involve a cif-fob correction);
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).

6.1 Trade Matrix for Goods

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

Country	AUS				AUT				...				USA				ROW				TIR	Mcif
Commodity	1	2	5 ...	37	1	2	5 ...	37	1	2	5 ...	37	1	2	5 ...	37	1	2	5 ...	37		
AUS 1 2 5 ... 37																						
AUT 1 2 5 ... 37																						
⋮ 1 2 5 ... 37																						
USA 1 2 5 ... 37																						
ROW 1 2 5 ... 37																						
Xfob																				TIR		

The illustration shows the trade flows between all countries and commodities 1-37. This is a very "incomplete" boundary value problem: one knows the M_{cif}-vector for the WIOD countries, but not for ROW; likewise, we know the X_{fob}-vector only for the WIOD countries. Of 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 500 billion US-$.

To tackle this incomplete boundary value problem by RAS, we actually disaggregate the above matrix into 3 matrices: trade matrix in fob + TIR matrix = trade matrix in cif. Initial values for the trade matrix in fob 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. The third matrix, the trade matrix in cif prices, is the sum of the fob and the TIR matrix.

Being very incomplete, this boundary value problem cannot be solved in the usual way. Instead, one has to iterate over the (unknown) boundary values for ROW: iteratively, 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 that 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%.

This algorithm balances Xfob and Mcif 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, information from the Eurostat data on trade by transport mode, which records 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 data base provides a very "Euro-centric" view only, 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), and 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 TIR services this provides some information on the mode of transport. 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 uniformly 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 what was used in the derivation of the national SUTs: averaging over all WIOD countries, wholesale's share in trade and transport margins is surprisingly similar for all commodities, at around 45%). Boundary values for this RAS are then given by world totals of the TIR services on the one hand and cif-fob difference for each flow on the other.

6.2 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 data base. 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.

6.3 Trade Matrix for TIR services

The last step concerns the trade submatrix of TIR services: clearly, "recorded" im- 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 transprt margins). Therefore, one first has to add these corrections to imports of TIR services. 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%.

7 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 mentioned in the introduction, this will not be *the* SUT for ROW, but *a* SUT which is consistent in the sense that it will lead to a full commodity balance at the world level. Nevertheless, it will be constructed such that much available information on the ROW economy is incorporated.

This information on the "Rest-of-the-World" ROW is taken from the United Nations' Statistical Division UNSD[8]. Here, one can find economic indicators for about 210 countries. Besides country totals (like GDP, imports, exports, etc), the data also provide some (modest) disaggregation; on the supply side, it includes data on output, intermediate consumption (in purchaser prices) and 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):

- 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 over 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 a by-product of the consistent trade matrix as described above.

Using the numbers on output and intermediate ise (in PP) for the seven sectors and the four categories of final demand as included in the UNSD data base an initial guess for the commodity structure of supply and demand by sector and category, respectively, is taken from the WIOD SUTs as

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

the average of the four countries BRA, IDN, IND and MEX (BIIM). 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) as derived from BIIM.

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

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

M_{cif} and X_{fob} are given; starting from BIIM-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 domSup^{BP} were held more or less constant (to ± 1% of the values given by 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 BIIM in order to satisfy world demand for this commodity). The adaptation 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%.

8 Discussion

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 system in the sense that at the world level, supply and use of all commodities is balanced.

In so doing, we showed 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 the services which make up the TIR services, equality of demand and supply is provided;
- we also showed the data needs and (some of the) assumptions needed to bring this consistency about;
- based on these TIR flows, it is possible to construct a SUT for the Rest-of-the-World, which brings about a "balanced world" with respect to all goods and services; in so doing, we were also able to stick to official data on world ouptut and demand to quite a large extent.

Of course, open questions and need for "further research" remain; they include (but are not limited to):

- The estimation for total TIR margins is split in two: total TIR margins provided by WIOD countries on the one hand and ROW at 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.
- 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.

- 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 most probably, improvement cannot be achieved via better data, but only "statistically" via better algorithms.
- The exercise presented here was limited to the derivation of 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. Of course, 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 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 say 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 random component. 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 formalised in order to allow for repeatability (and comparability).

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