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Karam Shaar

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Further enquiries to:

The Administrator
School of Economics and Finance
Victoria University of Wellington
P O Box 600
Wellington 6140
New Zealand

Phone: +64 4 463 5353
Email: alice.fong@vuw.ac.nz

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Karam Shaar [a]

Abstract

When two countries report different values about trading with each other, the globally endemic phenomenon of trade data discrepancy arises. Substantial discrepancy in claims raises serious concerns about the quality of international trade data, which has profound implications on policymakers and researchers alike. In this paper, we construct an index which measures the level of consistency between each country's reports on bilateral trade data and the corresponding data reported by the rest of the world. The index takes into account the relative significance of each trade partner and the level of data availability. The paper investigates 1,517,085 bilateral trade flows from 1962 to 2013 and concludes that: (a) malpractice is the main reason why some countries have lower data quality than others, (b) for most countries, trade data quality is in fact improving over time, (c) countries are generally more aware of the origin of their imports than they are aware of the destination of their exports. Our original findings have impacts on any study which utilizes trade data.

JEL Classification: F1, C02, C18

Keywords:

Bilateral trade data

Trade data quality

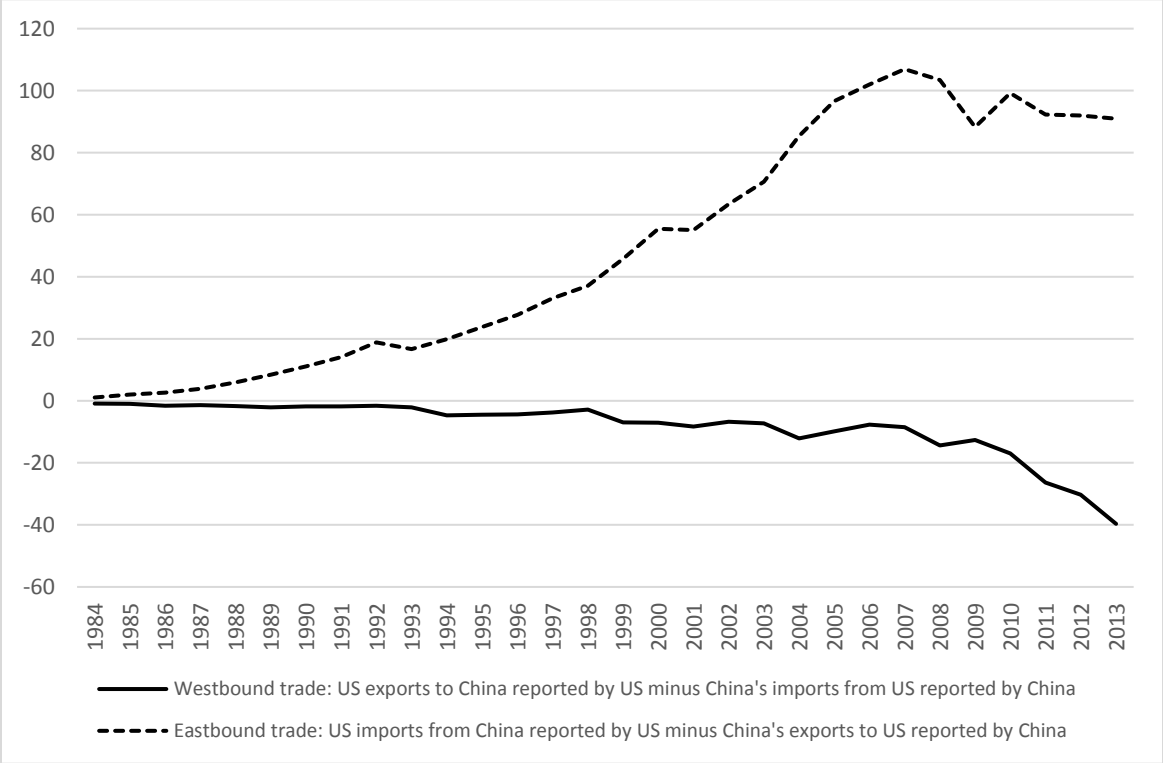
Data discrepancy

[a]: Victoria University of Wellington, Wellington 6140, New Zealand, email: karam-sh88@hotmail.com

1. Introduction

Trade data discrepancy is a phenomenon where two countries report different values of trade with each other while the values should be theoretically identical as they represent the same goods over the same period of time. US-China discrepancy is the most studied relation in the literature.

Figure 1: US-China trade data discrepancy in $ billions



Raw data is retrieved from the Standard International Trade Classification, COMTRADE

In 2013, US-reported trade deficit with China was $346.3 billion, while the figure stood at $215.7 billion according to China's reports, which accumulates merely 62% of the former's claim. Although trade data discrepancy is endemic globally (Ferrantino, Liu and Wang 2012), the topic is widely under researched in relations other than the US-China-Hong Kong trilateral trade. As shall be seen later in this paper, the quality of trade data in other countries is much worse. Trade data reported by some countries is somehow meaningless.

Substantial discrepancy leads a study which utilizes the trade data reported by a certain partner to reach different conclusions if it used the data reported by the other. For example,

Bahmani-Oskooee, Hegerty and Harvey (2013) report "drastically different results" for the impact of exchange rate on trade between the US and South Korea depending on which of the two countries reported the data. Such results raise serious questions about the quality of trade data of both sources. As well stated by the celebrated econometrician Damodar Gujarati (2004), "the researcher should always keep in mind that the results of research are only as good as the quality of the data".

The best way to account for discrepancy is to reconcile the data reported by both partners and therefore produce one, more reliable, set of data. However, reconciling bilateral trade data is extremely problematic. This is why, to the best of our knowledge, no attempt has been made to reconcile global trade data. Assuming the causes of discrepancy between two countries are correctly detected, there are no data on most of them.

Table 1: potential causes of discrepancy

type	Cause	Explanation
lack of uniformity in data compilation methodology between the partners	what constitutes exports and imports	the treatment of re-exports, goods in transit, inward and outward processing, and re-imports.
	partner attribution	attributing exports to the final known destination or the country of consignment, attributing imports to the country of origin or the country of consignment
	geographical definition of a trade partner	Example: whether the Virgin Islands are a part of the United States or a separate entity/country.
	conversion to foreign currency	what method is used to express the value of trade in terms of foreign currency
uniformity in data compilation methodology	the valuation method of exports and imports	where imports are reported on Cost Insurance Freight (CIF) basis, exports are reported on Free on Board (FOB)
	timing effect	Shipments are registered at different points of time by both countries since they are registered as they happen
malpractice	mis-invoicing	over-invoicing the value of a shipment to take advantage of certain export support schemes or under invoicing for duty evasion
	Smuggling	not registering a shipment for duty avoidance or due to the illegality of the traded goods by either one of the partners or both
	partner mis-attribution	attributing trade to another partner (against the stated methodology), whether due to lack of information, negligence, or in order to benefit from lower duties

* Source: Authors' summary

Because reconciling trade data is in most cases unachievable due to data unavailability, the issue of discrepancy has been widely ignored in the literature and its implications on economic research have been even more disregarded. This is reflected in the fact that most studies which utilize trade data do not even cite the reporting partner but rather the data compiler, i.e. the United Nations (UN), International Monetary Fund (IMF), and World Trade Organization (WTO).

Since reconciling corresponding bilateral trade data is very problematic, we believe that our second best effort is to rank world countries in terms of their data quality. In this study, a country which generally produces numbers more similar to its partners is deemed to be a high quality reporter. Trade Data Quality Index (henceforth, TDQI) is constructed through comparing the claims of a certain country on bilateral trade with the claims of all of its partners in a certain year. Through this comparison, we produce a measure of similarity

between a country's data and the data reported by the rest of the world. The measure later takes into account the relative significance of trade partners and punishes a country for not reporting any bilateral data at all. This study investigates 1,517,085 bilateral trade flows from 1962 to 2013 using R Programming Language and produces a simple index which ranges from 0 to 100. The higher the TDQI the better the quality of a country's data.

Previous studies aware of the problem of trade data discrepancy tried to develop some methodologies to reduce its impact on their research. For example, in a widely cited paper, Calderon, Chong and Stein (2007) state to "have always relied on the data reported by the country with higher income in the country-pair". With TDQI, making the decision of data reporter selection is much more convenient as it depends on the quality of the data itself and not a proxy of it.

Identifying the more reliable partner in any bilateral trade relation has applications in almost any study which utilizes trade data. We recommend any future research utilizing bilateral trade data to use our index and retrieve the data from the reporter with higher average data quality, which increases the likelihood of selecting the more reliable of the available two data sources in that particular pair. Users of total trade data (a country's trade with the whole world) can benefit from TDQI through excluding the countries with poor data quality from their research or to alternatively take the sum of all corresponding trade flows reported by reliable partners to generate a more genuine proxy for aggregate trade.

Trade data quality index measures data quality on bilateral level to draw conclusions on total, bilateral, and commodity levels. Although our index measures data quality on bilateral total level, it still can be used on commodity level. This is because the exact same nine causes of discrepancy (Table 1) affecting the quality of trade data at the bilateral total level do also affect the quality at bilateral commodity level, in addition to commodity misclassification. Therefore, assuming that countries with lower quality at total bilateral level are proportionately more likely to misclassify their commodity trade, TDQI remains valid as a good measure of data quality at commodity level.

TDQI has profound impacts on constructing international trade indices. Additionally, the findings reported in this paper can be used to generate more accurate international trade data through improving the methodology followed in IMF's Direction of Trade data set.

The database reports bilateral total trade data and estimates the value of exports and imports of a country when it does not report data by looking at the data reported by its partner. In case neither partner reported any data, DOT estimates the value of trade based on extrapolations from other time periods and in line with developments in trade patterns with other partners. Therefore, TDQI can be used to improve the methodology used in DOT through systemizing the process in which the data reported by one country is used as a proxy for the other. The same methodology can be later extended to bilateral commodity trade data as well. Finally, the mathematical measures used in this paper can greatly help policymakers and researchers to trace and investigate the key reasons behind a certain TDQI score for a certain country.

Findings in this paper confirm the widely accepted, yet untested, assumption that countries are more aware of the value and origin of their imports than they are aware of the value and destination of their exports. In accordance with the substantial growth in global trade, the number of countries reporting their bilateral data has also increased over the past five decades. Moreover, although global trade has never been this complex, the quality of trade data for exports and imports is in fact relatively improving in most countries. Most importantly for this paper, we find a strong evidence that global discrepancy is largely due to malpractice in the customs of certain countries.

The rest of the paper is organized as follows. Section 2 explains the research methodology and the data used in this paper. Section 3 presents the findings. The paper is concluded in section 4.

2. Research methods and data specifications

2.1 Data specifications

Customs in different countries follow different national classification systems to track their external commodity merchandise for purposes of duty imposition and economic analysis. Most countries also report their trade statistics to international institutions such as the UN and World Customs Organization (WCO). In their turn, these institutions aim to achieve unanimous scales and definitions for international trade data. Among the most used international trade classification systems are the Standard International Trade

Classification (SITC) of the UN and the Harmonized Commodity Description and Coding System, commonly known as the Harmonized System (HS), of the WCO (West 2010).

HS is a multipurpose international commodity nomenclature. It was adopted in 1983 and entered into force in 1988. HS is revised every 5-7 years. In its latest revision in 2012, it comprises nearly 5,000 commodity groups, which theoretically cover almost 16,000 final commodities. Each group is numbered by a six-digit code, where an increase in digits reflects an increase in data disaggregation. In Harmonized System (2014), the groups are arranged in a legal and logical structure depending on the nature of the commodity.

On the other hand, the UN Statistical Division, Commodity Trade Statistics Database (COMTRADE), maintains the Standard International Trade Classification (SITC). As opposed to HS, SITC structure is based on the economic functions of commodities at different stages of development. SITC is the oldest international commodity classification system. The first version was released in 1950 and revision 4 in 2008. Similar to HS, the number of commodities in the latest revisions have expanded substantially.

Both classifications publish bilateral total trade as well as bilateral commodity trade data. Based on our analysis, we observe no differences between bilateral total trade data reported in HS or SITC even in different revisions. The differences are largely on commodity level. Therefore, for the sake of maximizing the time period, we retrieve the data reported by SITC Revision 1. Our investigated data is annual, extends from 1962 to 2013, and covers all available bilateral total trade data, which comes to 1,517,085 observations. Although we were able to obtain data for 2014, we exclude it from the analysis since it is still subject to multiple revisions by reporting countries. The data compiled by HS and SITC is publicly available on many online portals. This paper downloads the data from the World Integrated Trade Solutions (WITS), administered by the world bank.

Although the IMF reports bilateral total trade data in its Directions of Trade (DOT) database, we use SITC because, unlike DOT, no estimates and predictions are made for any observation. This allows for testing the quality of the data as reported by countries. As far as we are concerned, WTO does not report bilateral data and the number of reporting countries for total trade is smaller than in COMTRADE and HS and extends over shorter spans. The World Bank retrieves its trade data from WTO, IMF, and the UN.

SITC distinguishes between two types of bilateral trade. First, bilateral total trade. Second, bilateral gross trade.

Gross exports= total exports+ re-exports

Gross imports= total imports+ re-imports

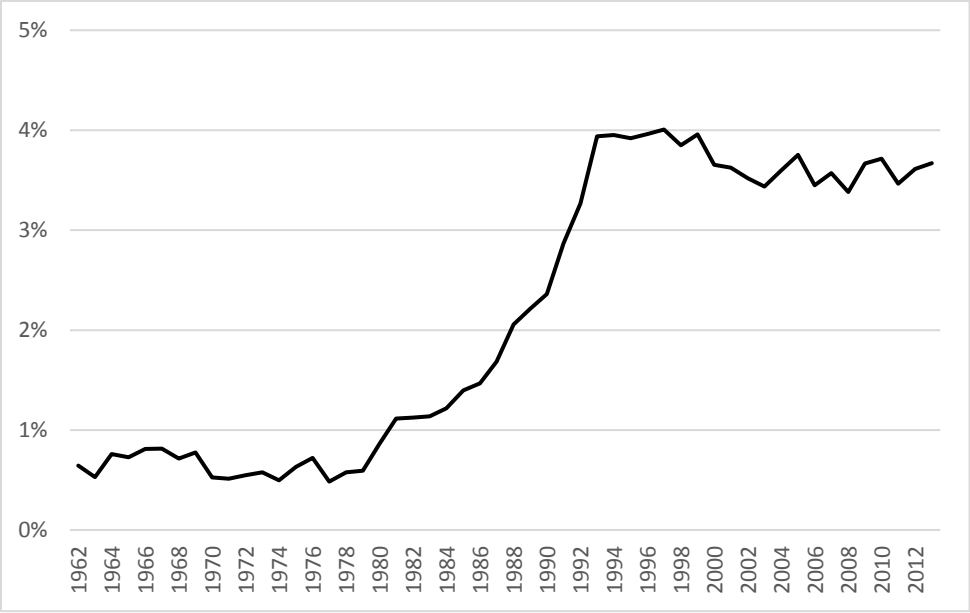
As defined by the UN Statistical Office (2011), re-imports are imports of domestic goods which were previously recorded as exports (returned), while re-exports are exports of foreign goods which were previously recorded as imports and later re-exported without substantial changes. Assuming no bilateral re-exports and re-imports are taking place, total and gross bilateral trade data would be identical. Additionally, bilateral trade data reported by a certain country would be comparable with the corresponding claim of its partner.

For all countries along the period 1962-2013, reported re-imports as a percentage of gross imports was barely 0.5%. To ensure comparability between corresponding bilateral trade data, we assume no re-imports took place along the period of the study. Alternatively, we assume that all countries are equally engaged in re-importing activities, which allows TDQI to remain comparatively correct although very slightly downward biased for both exports and imports.

Globally, re-exports as a percentage of gross exports along 1962-2013 was almost 3.2%. In 2013, as much as 92.5% of recorded world re-exports was conducted through Hong Kong and the US only, with 63.5% and 29% respectively. According to SITC recommendations, a country is supposed to attribute its exports to the final known destination and its imports to the country of origin. Hence, we use bilateral total data rather than bilateral gross data to enhance comparability between corresponding trade flows. Assuming all global re-exports happen in Hong Kong and the US only, TDQI of imports of only these two countries would be downward biased. TDQI for their exports remains unaffected since re-exports are not included in bilateral total exports but are in fact included in total and aggregate imports when they enter a country. Therefore, TDQI results for the imports of the two countries is deemed to be less reliable for the recent

three decades in which re-exports as a percentage of global gross exports started to exceed 1%.

Figure 2: Global share of re-exports in gross exports for 1962-2013



The final issue to be addressed about the data is the fact that countries, according to SITC rules, should report their exports based on FOB and their imports based on CIF. This recommendation deters us from directly comparing corresponding bilateral trade data since the importer includes the costs of insurance and freight in the value of imports and the exporter does not include them in the value of exports. However, the same logic applied to the treatment of re-imports in TDQI applies here. That is, assuming all countries are equally susceptible to this comparability problem, TDQI remains correct if understood comparatively, i.e. for ranking purposes, and this is exactly what the index aims to achieve. CIF/FOB margin is generally a function of distance between partners. Therefore, our assumption is plausible since countries conduct their trade based on economic interests rather than distance. That is to say, all countries are somehow equally likely to trade with the same combination of far and near partners.

2.2 Research methods

For a specific year and direction of trade flow, let *N* denote the number of all trade partners involved in the calculation of TDQI for country *i*. For partner $j = 1, \dots, N$, we define:

I_{ij}: import value of *i* from partner *j*, reported by *i*

E_{ij}: export value of *i* to *j*, reported by *i*

I_{ji}: import value of *j* from *i*, reported by *j*

E_{ji}: export value of *j* to *i*, reported by *j*

$E_{i.}$: sum of export values of *i* to all partners, reported by *i*

$I_{i.}$: sum of import values of *i* from all partners, reported by *i*

Exports size ratio:

$$SR_{ij}^{E} = \frac{E_{ij}}{I_{ji}} \qquad [1]$$

Imports size ratio:

$$SR_{ij}^{I} = \frac{I_{ij}}{E_{ji}} \qquad [2]$$

The size ratios explain the relative difference between the bilateral trade flow of country *i* and the corresponding value reported by its partner *j*. The size ratio measure is unit free, thus, it is comparable across time and space. Size ratios could vary from greater than 0, since the numerator and denominator are greater than 0, to infinity depending on which partner reports a higher value. For the sake of uniformity, we take the reciprocal of a size ratio that exceeds unity:

If $SR_{ij}^{E} > 1 \rightarrow SR_{ij}^{E^*} = 1/SR_{ij}^{E}$; If $SR_{ij}^{E} < 1 \rightarrow SR_{ij}^{E^*} = SR_{ij}^{E}$

If $SR_{ij}^{I} > 1 \rightarrow SR_{ij}^{I^*} = 1/SR_{ij}^{I}$; If $SR_{ij}^{I} < 1 \rightarrow SR_{ij}^{I^*} = SR_{ij}^{I}$

The modified measure of size ratio is also unit-free. However, it range from greater than 0 to 1. Thus, this measure could be understood as the percentage similarity between a

bilateral trade flow and its corresponding value reported by the partner, regardless which partner reports a higher value. We calculate the similarities for country *i* and all of its trade partners from *j* to *N* for the case of exports and imports separately.

Later we calculate the relative significance of each similarity measure between country *i* and each of its trade partners as reflected by trade shares. Trade shares are unit-free, range from greater than 0 to 1, and add up to unity. Exports trade share of country *j* in the total exports of *i* as reported by *i* is calculated as follows:

$$Sh_{ij}^{E} = \frac{E_{ij}}{E_i} \qquad [3]$$

Imports share of country *j* in the total imports of *i* as reported by *i:*

$$Sh_{ij}^{I} = \frac{I_{ij}}{I_i} \qquad [4]$$

For country *i*, TDQI is the weighted average of the percentage similarities between *i*'s reports on trade and the corresponding values reported by all of its partners. That is, the values *i* reports as exports to (imports from) its partners *j* to *N* and the values *j* to *N* report as imports from (exports to) *i*. Imports and exports TDQI are calculated as follows:

$$TDQI_i^I \; for\; reported\; data = \frac{\sum_{j=1}^{N} Sh_{ij}^{I} * SR_{ij}^{I^*}}{\sum_{j=1}^{N} Sh_{ij}^{I}} = \frac{\sum_{j=1}^{N} Sh_{ij}^{I} * SR_{ij}^{I^*}}{1} = \sum_{j=1}^{N} Sh_{ij}^{I} * SR_{ij}^{I^*} \qquad [5]$$

$$TDQI_i^E for\; reported\; data = \frac{\sum_{j=1}^{N} Sh_{ij}^{E} * SR_{ij}^{E^*}}{\sum_{j=1}^{N} Sh_{ij}^{E}} = \frac{\sum_{j=1}^{N} Sh_{ij}^{E} * SR_{ij}^{E^*}}{1} = \sum_{j=1}^{N} Sh_{ij}^{E} * SR_{ij}^{E^*} \qquad [6]$$

TDQI is again a measure that ranges from greater than 0 to 1. The higher the TDQI, the higher the similarity between country *i*'s data and the data reported by its partners. The weights involved in the calculation of TDQI are the trade shares associated with similarity measures to reflect their relative significance in the overall reported trade. The rationale behind TDQI is straightforward. A country which generally reports trade values that are inconsistent with what is claimed by its trade partners is assumed to have low data quality.

Each similarity measure between two trade values is included in the calculation of two TDQIs. The TDQI of imports of one country and the TDQI of exports of the other.

Therefore, although a country with higher data quality gets its TDQI lowered due to trading with a country with lower quality, as *j* grows to *N* (i.e. TDQI includes all similarities into calculation) TDQI ultimately reflects to what extent each country's data is similar to the data reported by its partners. Merchants conduct their external trade based on economic incentives and regardless the quality of trade data their countries report. Thus, as *j* grows to its maximum *N* in Equations 5 and 6, all countries are assumed to be equally likely to trade with the same combination of countries with good and bad data quality. Therefore, although downward biased by itself as a measure of quality, TDQI remains correct if understood in a comparative context, i.e. compared from a year to another, trade flow to another, and a country to another. This is exactly what TDQI aspires to achieve.

The main concern about the accuracy of TDQI arises when a country does not report all of its bilateral trade data. This would cause the measure of TDQI to be biased due to the biasness of the trade shares used as a weighting vector for the average of bilateral trade data similarities. Therefore, a country with low data availability might have an artificially high or low TDQI. To account for the impact of trade data availability on TDQI, we first develop a Trade Data Availability Index (henceforth, TDAI). To this end, for country *i* in a specific year, let:

m_i^I: number of countries which reported exports to country *i* while *i* did not report any imports from them

n_i^I: number of all countries which reported exports to country *i*

m_i^E: number of countries which reported imports from country *i* while *i* did not report any exports to them

n_i^E: number of all countries which reported imports from country *i*

Imports TDAI for country *i* is given as follows:

$$TDAI_i^I = \frac{1-(\frac{m_i^I}{n_i^I})}{100} \qquad [7]$$

Exports TDAI for *i*:

$$TDAI_i^E = \frac{1-(\frac{m_i^E}{n_i^E})}{100} \qquad [8]$$

TDAI is a unit-free measure that ranges from above 0 (since we exclude any country which does not report any data at all from our analysis) to 1. The higher the TDAI, the more available the bilateral trade data of a country. However, not reporting bilateral trade with a certain partner or partners might be the right practice from the home country *i* because such a trade did not actually happen. Assuming that all countries are equally susceptible to this scenario, TDAI, as TDQI, remains comparatively correct although downward biased by itself.

Since not reporting any bilateral data, while the partner does, indicates a similarity of 0, the overall trade data quality of a country equals:

$$TDQI_i^E = TDQI_i^E * TDAI_i^E \quad [9]$$

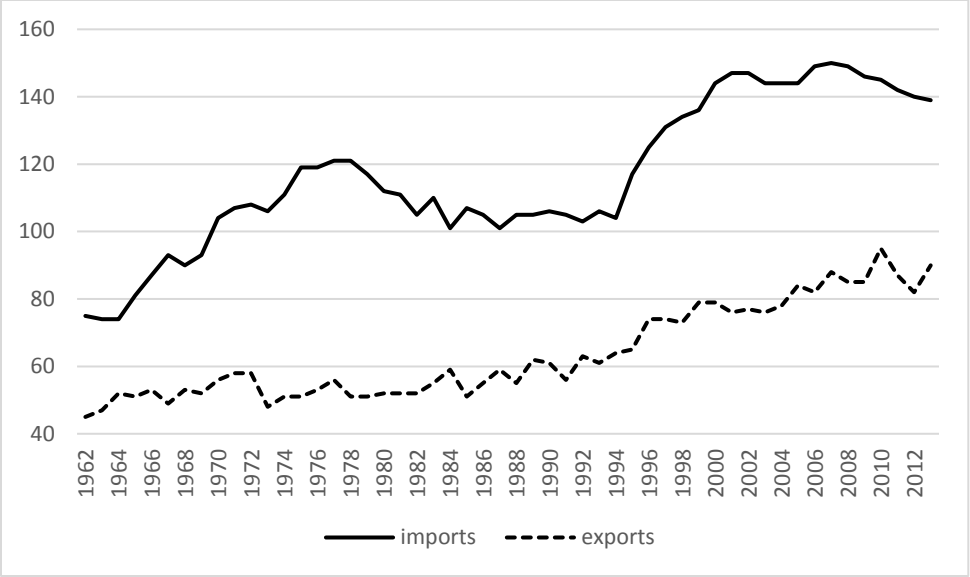
$$TDQI_i^I = TDQI_i^I * TDAI_i^I \qquad [10]$$

As TDAI and TDQI range from above 0 to 1, the product of the two also ranges from above 0 to1. TDQI is the measure of overall quality of a country's trade data. Additionally, since TDAI and TDQI are both downward biased, yet comparatively correct, overall TDQI should also be understood only comparatively. The measure is a function of not only the quality of available data, but also the level of data availability. The higher the index, the higher the overall quality of trade data.

3. Results and discussions

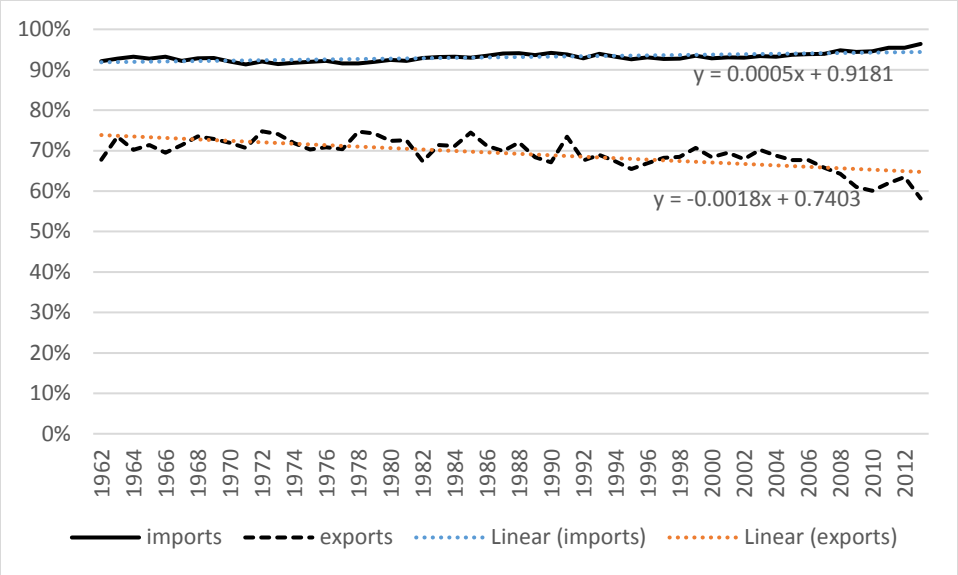
The number of countries reporting their bilateral trade has substantially increased over time. Where merely 81 countries reported bilateral exports to at least one partner in 1962, the number rose to 148 in 2013. For imports, on the other hand, this number rose from 82 to 148 over the same period. This reflects the exponential growth in global trade in the recent five decades.

Figure 3: Number of countries reporting any bilateral trade to SITC



The number of countries with TDAI above 80% for exports has risen over time from 45 countries in 1962 to 90 in 2013. On the other hand, the number of countries with TDAI above 80% for imports has risen from 75 countries in 1962 to 139 in 2013. TDAI for imports has been higher than for exports for the whole time period of this study. Therefore, in line with Figure 3 as well, it is safe to say that countries are generally more aware of the origin of their imports than they are aware of the destination of their exports. This is because it is easier to identify the origin of imports than to identify the destination of exports due to re-exporting activities. The same fact is reflected in the following.

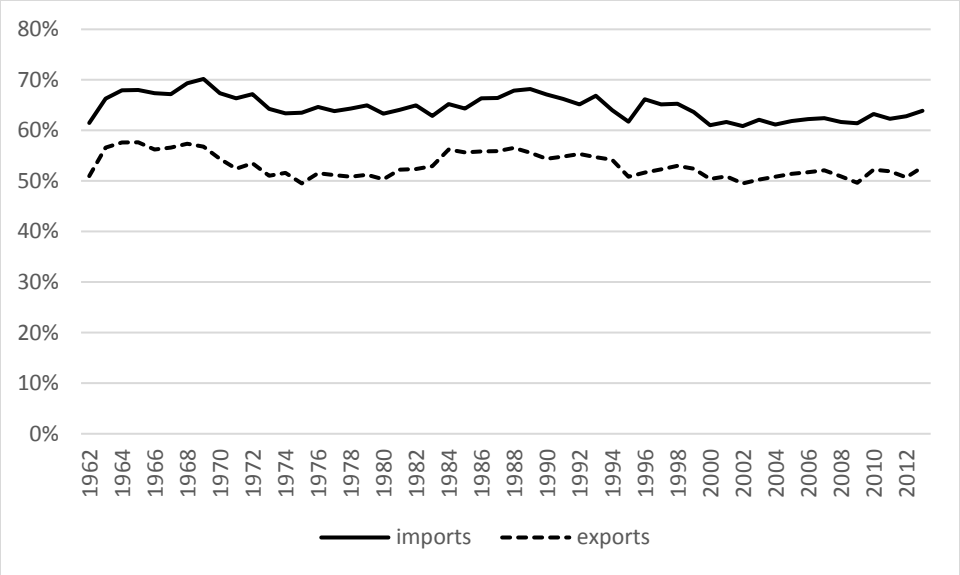
Figure 4: Annual average of TDAI for all countries



OLS linear trends suggest that countries, on average, are becoming slightly more aware of the origin of their imports. However, the same does not apply to exports. This can be understood in accordance with Figure 2, which shows the relative increase in global re-exports over time. Re-exporting activities make it much harder for exporting countries to identify the countries of final destination. This is strongly supported by the fact that the correlation coefficient between world re-exports as a percentage of gross exports and annual average of TDAI for exports of all countries is as strong as -67.5% for the period 1962-2013.

After calculating TDAI and trade shares for all countries, we were left with 1,324,658 bilateral trade observations for which there is corresponding data reported by the partner to calculate the size ratios in Equations 1 and 2. Similar to Figure 4, Figure 5 graphs the average of TDQI for all countries in a certain year to get a sense of the dynamic changes in global trade data quality.

Figure 5: annual average of TDQI for all countries



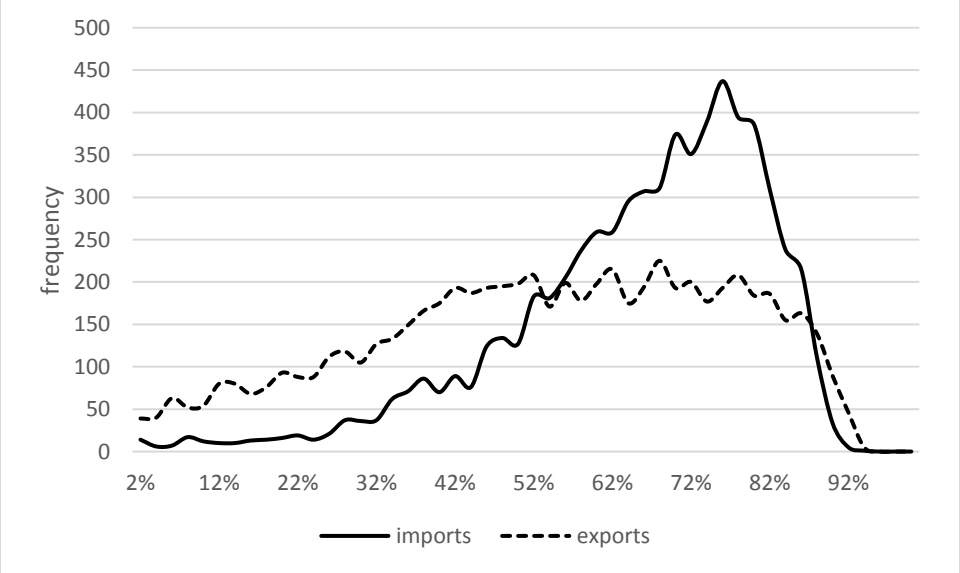
Two main conclusions can be drawn from Figure 5. First, as stated earlier, countries are generally more aware, or may be also more interested, in tracking their imports than their exports. Second, no changes in global data quality can be actually observed over time. However, the latter fact is a little misleading, because, in general, new reporters to SITC are the countries who generally report lower quality data. They later tend to improve over time.

To capture this fact, for each country, we calculate the difference between TDQI in the last year it reported data to SITC and the first year. For the case of exports, 114 countries had a positive difference while 95 had a negative difference. Therefore, we conclude that the quality of exports of more countries has improved rather than worsened over time. A stronger improvement happened at the side of imports where the number of countries with quality improvement stood at 122 compared with 89 with negative differences. On top of this, it should be noted that countries who recently started to report their trade data to SITC have smaller shares in global trade. That is, the average of trade data quality weighted by global trade shares for all countries over time would suggest even a greater improvement in global trade data quality.

Expectedly, the findings also indicate that countries with higher data availability tend to have higher data quality as well. The correlation between TDQI and TDAI for all countries in 2013 stood at 68% for imports and 83% for exports. Additionally, correlation between TDQI imports and TDQI exports in the same year was as high as 70%. That is, countries with high quality data tend to have high TDQI for both exports and imports, and vice versa.

The distribution of TDQI for all countries and years is left skewed. This applies to both exports and imports. The fact that TDQI for exports is less skewed and has a lower kurtosis suggest that world countries are more homogenous in terms of their exports data quality as compared to imports quality.

Figure 6: distribution of TDQI for all countries and all years



To get a sense of who are the countries with extreme data quality, we sort them based on their TDQI irrespective to the year. Table 2 lists the 10 most frequently appearing countries among the 100 countries with the highest (and lowest) TDQI for exports and imports. The countries are sorted by the frequency of appearance from highest to lowest.

Table 2: countries with the highest and lowest trade data quality

Countries with highest imports data quality		Countries with highest exports data quality		Countries with lowest imports data quality		Countries with lowest exports data quality	
Country	Freq.	Country	Freq.	Country	Freq.	Country	Freq.
Australia	10	Canada	25	Botswana	10	Montserrat	11
Denmark	10	Germany	20	Macao	10	Kiribati	9
Sweden	10	Spain	12	Namibia	10	Mali	7
Denmark	10	Belgium-Luxembourg	8	Swaziland	8	Swaziland	6
Switzerland	9	Italy	8	Lesotho	7	Virgin Islands (U.S.)	6
United States	7	France	6	Turks and Caicos Islands	6	Turks and Caicos Islands	5
Italy	5	Denmark	5	Antigua and Barbuda	5	Bhutan	4
Canada	4	Mexico	3	Afghanistan	4	Niger	4
Ireland	4	Portugal	3	Bhutan	4	Rwanda	4
United Kingdom	4	Czech Republic	2	Comoros	4	Tuvalu	4

As can be immediately observed, the countries with highest data quality are, as of 2013, all economically developed. These countries tend to have stricter rule of law, which strongly suggests that the main cause of international trade data discrepancy is in fact malpractice in the customs of certain countries. We define malpractice as smuggling, partner misattribution, and mis-invoicing (please refer to Table 1 for the details). On the other hand, countries with low data quality are, in general, the ones where corruption is endemic and border controls are largely non-existent. This applies particularly to almost all African countries on the list of countries with lowest TDQI. These results provides more evidence to the findings of Yeats (1990) in his paper: "*On the accuracy of economic observations: Do sub-Saharan trade statistics mean anything?*".

Finally, it can be also observed that some countries with very low TDQI are in fact tiny islands such as Turks and Caicos Islands, Antigua and Barbuda, Comoros, Tuvalu, Kiribati, and the Virgin Islands, which are either not recognized by some countries as sovereign states, or not considered as countries by their partners in the first place. Although, as mentioned earlier, TDQI for the imports of Hong Kong and the US is less reliable due to their engagement in re-exporting activities, we notice the US still appeared as a top quality reporter for its imports. This in fact is because, although substantial in

global terms, US re-exports as a share of total imports ranged from as low as 1% to at most 10% along the period of this study. Therefore, re-exports did not have a strong bias in measuring TDQI for US imports.

4. Conclusion

The issue of trade data discrepancy has long been ignored, which had profound impacts on the accuracy of economic analysis. This study aimed at constructing an international index that measures the quality of trade data using a multi-mirror technique in which a country's bilateral data is compared with the data reported by all of its trade to check for similarity. Our results are available for public access using the following link.

Given that no attempts have been made to reconcile trade data globally, we recommend any future study utilizing aggregate or bilateral trade data, on total or commodity level, to first consult our findings. If a researcher aims to use total trade data, TDQI helps to decide whether to include the total trade data of a country with low TDQI in economic analysis. We highly recommend avoiding the use of data reported by any country with low TDQI. This is because the values of trade and the changes from a year to another do not mean much in such a country. Alternatively, for the countries with low TDQI, say less than 60%, we recommend summing up the corresponding bilateral trade data reported by all partners to arrive at a more accurate value of total trade. In this case, CIF/FOB margins between corresponding trade flows need to be taken into account. Second, if a researcher aims to use bilateral trade data, we recommend to retrieve the data from whichever trade partner with higher TDQI. This practice increases the likelihood of picking the more accurate data source.

For policymakers, TDQI and TDAI provide an initial, yet strong, indication on whether malpractices are taking place in a country's customs. We additionally publish the results on size ratios as described in Equations 1 and 2, which are very helpful in tracing the causes of data discrepancy in any country in a given year.

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