# *Reconciling Bilateral Trade Data*

# *for Use in GTAP*

**by Mark J. GEHLHAR**

**GTAP Technical Paper No.10**

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## *Abstract*

Bilateral trade flows are reported by importer and exporter. Large discrepancies in reported import/export trade flows can be found. The GTAP database requires consistency between the export flow and its corresponding import flow for all partner pairs. Bilateral trade data in its reported form cannot, therefore, be directly used for GTAP. Various methods can be used to produce a consistent set of bilateral trade flows. However, achieving consistency alone does not necessarily provide credible trade flows. Matrix balancing using trade totals published by international agencies are not appropriate since these totals are not reconciled but are simply totals from country-reported flows.

A method is proposed with the aim of extracting the most reliable trade flows from reported import and export flows. Specific examples are used to illustrate how discrepancies can result from reporting errors and transport margins. Evidence is shown indicating that discrepancies often arise from erroneous reporting by one of the partners. Systematic reporting errors associated with a reporter can be measured by the share of consistent transactions with partners. The most reliable reported flows are selected based on credibility of reporters.

The source of international bilateral trade for GTAP is United Nations COMTRADE database. It contains the complete set of countries in the world and the set of commodities covering total merchandise trade. Since errors in reporting are country-commodity specific, data is processed at the individual country and SITC 4-digit level before aggregating to the 30-region 31-sector level used in the GTAP data base (revision 3).

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# *Reconciling Bilateral Trade Data for Use in GTAP*

## *1. Introduction*

Development of merchandise trade data poses a somewhat different challenge than for other data components in the GTAP database. The problem is less a matter of finding scarce data and more a matter of resolving inconsistent data. This is because one country's exports are also another country's imports and imports and exports are reported by both partners. This reporting arrangement produces two trade records representing the same trade flows. Large discrepancies can be found when comparing a country's export flows with its corresponding partner's import flows. Discrepancies in bilateral trade statistics pose a problem for use in the GTAP database.

The GTAP model/database links countries through bilateral trade. An accounting identity exist where the value of imports at *cif* prices minus the value of transportation services equals the value of exports of exports at *fob* prices. For a given bilateral transaction, the reported import value can be substantially less than, or several times greater than the reported export value. Thus, reported trade statistics in their "raw" form are not suitable for the GTAP database. Various methods can be employed to make the import and export values consistent with each other. But satisfying this consistency condition alone does not solve the important problem of establishing reliable bilateral trade flows.

The reliability of trade data affects the credibility of model results. The direction and composition of trade, often referred to as the *structure of trade,* has direct bearing on the final results of any simulation exercise. Trade structure determines how impacts of a given policy shock are distributed across different economies in the world. But the fact that large discrepancies exist in reported trade statistics would suggest there is some degree of uncertainty attached to the trade structure. This is troubling because results of liberalization in those sectors having high levels of protection can be particularly sensitive to alternative trade shares. Furthermore, unlike behavioral parameters, which can be readily modified, uncertainty associated with any component of the initial base data becomes a permanent *fixture* in the GTAP model. There is only one solution to the problem and that is to remove the uncertainty associated with bilateral trade data. It requires generating the most reliable set of bilateral trade flows possible from the existing reported trade data. This is the objective of the work reported here.

Reconciliation of bilateral trade data requires patience and an open mind. Since the first version of GTAP model/database was released in 1993, much time has been spent performing analyses at a detailed level. Various reconciliation methods have been put to test. The results from these methods have been evaluated and scrutinized. As better procedures are found they are made a standard

procedure for GTAP trade data reconciliation. The trade data for version 3 of the GTAP database was produced with a different procedure from previous versions.[1] This document describes the procedure and provides evidence of its effectiveness in generating reliable trade data.

Just as a good recipe is not a substitute for poor quality ingredients, a good method is not a substitute for poor quality data. Even the best method employed in reconciling trade data cannot produce reliable results unless reliable statistics are reported. Reconciliation can only help to distinguish the *less* reliable records from *more* reliable trade records. The first objective in this documentation is to assess the quality of the raw ingredients found in bilateral trade statistics. The second objective is to show how the methodology is used to capitalize on the most reliable information found in reported trade data. The overall quality of bilateral-commodity trade depends both on the initial quality and on the ability of the method to yield the best statistics from the raw data.

The development of the merchandise trade data for GTAP, like other undertakings in this project, is an ongoing process. Not all problems in trade data can be solved at once. The most important problems receive highest priority and lesser problems are solved subsequently. Future work on merchandise trade data in will focus on specific country and commodity problems and less on the general procedures which are now established here.

# *2. Comparisons of International Sources of Trade Statistics*

The reliability of any data source is called into question when there is of lack of comparability. The United Nations COMTRADE database is the primary source of trade data for the construction of the merchandise trade data for GTAP. It seems appropriate to provide comparisons of the COMTRADE trade data with other sources of trade data, and we now turn to such a comparison. The World Bank[2] the International Monetary Fund (IMF),[3] and Food and Agriculture Organization[4] (FAO) of the United Nations publish and disseminate international trade statistics on an annual basis. Using these sources, comparisons are made with the COMTRADE database. Comparisons are possible if there is a common level of aggregation across sources. All four sources provide merchandise totals by

1. For a discussion of the earlier reconciliation method, see GEHLHAR *et al*., "Overview of the GTAP Data Base, Chapter 3 in HERTEL, T. W. (ed.) *Global Trade Analysis: Modifying and Applications*, New York: Cambridge University Press.

2. The World Bank publishes it's own trade statistics in the World Tables. According to the 1995 World Tables, the primary source of foreign trade data is the UNCTAD database. It is supplemented with data from the UN COMTRADE database and the IMF's International Financial Statistics. The balance of payments data for the World Banks trade are from files from the IMF's Balance of Payments Statistics Yearbook.

3. The IMF maintains that its source of trade data is in general customs statistics reported under the general trade system according to the recommendations of the UN.

4. FAO maintains trade statistics in the FAOSTAT database and claims its source of trade data is supplied by governments through magnetic tapes, national publications and FAO questionnaires. For EU members, FAO trade data is obtained from EUROSTAT.

individual country. The World Bank and the IMF publish a some non-agriculture aggregates but these are not comparable those found in COMTRADE. FAO publishes trade data for aggregate agriculture sectors as well as individual agriculture commodities. FAO's FAOSTAT database contains individual agricultural commodities some of which are comparable to categories in UN SITC categories. This permits us to compare COMTRADE and FAO individual agricultural commodity totals. FAO, World Bank, and IMF unfortunately do not provide bilateral trade flows which are comparable to COMTRADE. So, comparisons are made only with merchandise trade totals for all sources, and for agricultural commodity totals with FAO as the only source.

The COMTRADE database contains source-destination trade flows of individual commodities classified in accordance with the Standard International Trade Classification (SITC). The SITC system provides a 5-tier system of aggregation (1-5 digit levels). In order to generate merchandise trade totals, COMTRADE's bilateral-commodity trade must be aggregated by source for imports and by destination in the case of exports. This is done starting at the 4-digit SITC level with bilateral trade.

The UN maintains a data set for *reported exports* and a separate data set for *reported imports.* The two data sets are reported and maintained independently of each other. A country "trade total" can be calculated in two ways. An export total can be calculated as the sum of a country's reported exports across all of its partners. The data for this total is from reported exports and is referred to as a *country-reported* total because it is reported by the country itself. Another calculation representing the same country total is made by taking the sum of the of all partner's reported imports from the given exporting country. This total is referred to as a *partner-reported* total. Trade totals published by international organizations are generally country-reported totals.

From the COMTRADE database country-reported merchandise totals are obtained by aggregating across commodities and partners. Here we denote the reported export flows as $X_{i,r,s}^{rp}$ where *I* is a commodity exported from region $r$ to region $s$. Likewise we denote the reported import flows as $M_{i,r,s}^{rp}$ where *I* is a commodity exported from region *r* to region *s.* Exports of the country reported totals is shown below as:

$$X_r^{rp} = \sum_i \sum_s X_{i,r,s}^{rp}$$

Similarly country- reported import totals is calculated as :

$$M_s^{rp} = \sum_i \sum_r M_{i,r,s}^{rp}$$

Table 1 shows the total merchandise export totals from FAO, World Bank, IMF and UN COMTRADE. Countries for this comparison include the top 25 exporting countries in the world. For most of these countries there is little difference in totals across sources with the exception of Mexico. In the Mexican case both the United Nations and the World Bank have comparable figures of $46.2 billion and $46.3 billion, respectively. FAO and IMF also have comparable figures of $27.5 billion and $27.6 billion,

Table 1. Comparison Across International Sources of the Value of Exports For Top 25 Countries (in 1992 $US bill )

| | FAO | WB | IFS | UN | WB b.o.p. |
|---|---|---|---|---|---|
| United States | 448.2 | 448.0 | 448.2 | 444.2 | 440.4 |
| Germany | 429.7 | 422.0 | 422.3 | 425.7 | 406.7 |
| Japan | 339.9 | 340.0 | 339.8 | 339.5 | 330.9 |
| France | 249.7 | 236.0 | 235.9 | 231.5 | 225.3 |
| United Kingdom | 187.6 | 190.0 | 190.0 | 181.1 | 188.5 |
| Italy | 178.6 | 178.0 | 178.2 | 178.8 | 178.2 |
| Netherlands | 141.0 | 140.0 | 139.9 | 139.9 | 129.2 |
| Canada | 134.8 | 134.0 | 134.4 | 132.2 | 132.4 |
| Belgium-Lux. | 123.9 | 123.0 | 123.1 | 123.1 | 113.6 |
| China | 85.0 | 80.5 | 84.9 | 84.9 | 69.6 |
| Korea, Republic of | 76.6 | 76.6 | 76.6 | 76.4 | 75.2 |
| Switzerland | 65.8 | 61.4 | 61.4 | 65.6 | 79.4 |
| Spain | 64.7 | 64.3 | 64.3 | 64.4 | 63.9 |
| Singapore | 63.4 | 63.5 | 63.5 | 63.4 | 62.1 |
| Sweden | 56.3 | 56.1 | 56.1 | 55.8 | 55.4 |
| Mexico | 27.5 | 46.3 | 27.6 | 46.2 | 27.5 |
| Austria | 40.9 | 47.3 | 47.3 | 44.4 | 43.4 |
| Malaysia | 40.7 | 40.7 | 40.7 | 40.8 | 39.6 |
| Denmark | 40.3 | 41.1 | 39.6 | 39.8 | 40.7 |
| Australia | 42.3 | 42.8 | 42.8 | 41.9 | 42.4 |
| Brazil | 36.2 | 35.8 | 35.9 | 36.0 | 35.8 |
| Norway | 35.2 | 35.2 | 35.2 | 34.0 | 35.2 |
| Indonesia | 34.0 | 33.9 | 33.9 | 33.8 | 33.8 |
| Thailand | 32.5 | 32.5 | 32.5 | 32.5 | 32.1 |
| Ireland | 28.3 | 28.3 | 28.3 | 28.3 | 27.9 |
| Total | 3003.2 | 2997.3 | 2982.4 | 2988.1 | 2908.7 |

Includes re-exports and intra-EU trade

*Sources*: Food and Agriculture Organization (FAO)
World Bank WB World Tables 1995 Customs and Balance of Payments b.o.p.
International Financial Statistics (IFS)
United Nations (UN) COMTRADE

Table 2. Comparison Across International Sources of the Value of Imports For Top 25 Countries (in 1992 $US bill)

| | FAO | WB | IFS | UN | WB b.o.p. |
|---|---|---|---|---|---|
| United States | 554.0 | 554.0 | 553.9 | 551.6 | 536.5 |
| Germany | 409.9 | 402.0 | 402.4 | 406.7 | 373.9 |
| France | 258.8 | 240.0 | 239.7 | 238.3 | 223.6 |
| Japan | 233.4 | 233.0 | 233.2 | 231.0 | 198.5 |
| United Kingdom | 222.5 | 222.0 | 221.5 | 216.5 | 211.9 |
| Italy | 189.2 | 188.0 | 188.5 | 184.5 | 175.1 |
| Netherlands | 147.9 | 134.0 | 133.8 | 134.4 | 117.9 |
| Belgium-Lux. | 132.3 | 125.0 | 125.0 | 124.7 | 112.3 |
| Canada | 122.6 | 129.0 | 129.3 | 122.0 | 126.4 |
| Spain | 100.0 | 99.8 | 99.8 | 99.5 | 95.0 |
| Korea, Republic of | 81.8 | 81.8 | 81.8 | 81.4 | 77.3 |
| China | 80.6 | 76.4 | 80.6 | 80.6 | 64.4 |
| Singapore | 72.1 | 72.2 | 72.2 | 72.1 | 67.9 |
| Switzerland | 65.9 | 61.7 | 61.7 | 65.6 | 78.9 |
| Mexico | 48.1 | 62.1 | 48.2 | 61.9 | 48.2 |
| Austria | 53.2 | 54.1 | 54.1 | 54.1 | 52.2 |
| Sweden | 50.2 | 50.0 | 50.0 | 49.6 | 48.6 |
| Australia | 39.2 | 43.8 | 43.8 | 42.1 | 40.8 |
| Malaysia | 39.8 | 39.9 | 39.9 | 39.1 | 36.2 |
| Thailand | 40.7 | 40.7 | 40.7 | 38.7 | 36.3 |
| Denmark | 34.7 | 35.2 | 33.7 | 33.6 | 33.4 |
| Portugal | 29.5 | 29.6 | 29.6 | 30.5 | 27.7 |
| Indonesia | 27.3 | 27.3 | 27.3 | 27.3 | 26.8 |
| Norway | 26.1 | 25.9 | 25.9 | 25.8 | 25.9 |
| India | 24.1 | 23.6 | 23.6 | 24.2 | 23.2 |
| Total | 3084.0 | 3051.1 | 3040.2 | 3035.7 | 2858.7 |

Includes intra-EU trade.

*Sources*: Food and Agriculture Organization (FAO)
World Bank WB World Tables 1995 Customs and Balance of Payments (b.o.p.)
International Financial Statistics (IFS)
United Nations (UN) COMTRADE

respectively. The reason for the difference is that FAO and IMF apparently disregard Mexico's reported export value and use the *balance of payment* level of trade. The same can be said for Mexican imports shown in table 2. FAO and IMF use level of imports shown for balance of payment of approximately $48 billion rather than the Mexican reported import value of $62 billion which is the World Bank publishes.

FAO merchandise total are generally higher for both imports and exports. The reason for this is that the country totals are not strictly *country-reported* totals. FAO substitutes partner reported trade flows when a country fails to report their own trade flows. This is done at the detailed agriculture commodity level. By filling-in holes n country reported trade by partner reported trade higher levels of trade are obtained in the aggregate.

Overall we find there is a high degree of comparability in total merchandise trade across different sources. The main reason for this is that there is actually only one source of trade data -- namely the customs trade files from individual countries which are submitted to the United Nations and shared by all international organizations. International organization is aggregate data for their own purposes and disseminate it as such.

We now turn to specific agriculture commodities using the FAO as the source for comparisons with UN COMTRADE. Exports of wheat, bovine meat, and bananas are used in this comparison. Table 3 shows reported exports for FAO and COMTRADE. In the last column the ratio of FAO to COMTRADE is given. There is much similarity in the these commodity totals. The only exception is the case for Australia. The reason for the difference is that FAO does not use a calendar year for Australian agriculture trade. Agricultural commodity data is provided to the UN and FAO on a monthly basis but FAO places Australia on a fiscal year beginning June 30 of the year in question.

We turn now to major agricultural importer using the commodities wheat, bovine meat, coffee, and bananas. The comparison of agricultural import totals are shown in table 4. Again as with exports the totals are nearly identical for FAO and COMTRADE. The exceptions are Brazilian imports of wheat and Italian imports of bananas. The exact reason for the differences for Brazilian wheat not known. But it is known that partner data would give a total closer to the FAO level than the COMTRADE level which strictly used Brazil's reported imports. For the case of imports of bananas for Italy, FAO has made adjustments for transhipments from Italy. This will reduce the level of imports from what is officially reported. Transhipments pose a problem for data reconciliation and will be addressed for the case of Hong Kong.

As with merchandise trade it is not surprising to find comparability between FAO and COMTRADE, in light of the fact that they share primary data sources. But comparable trade totals across sources is not by itself evidence of reliable bilateral trade data. One major problem in reported trade is the misidentification of trading partners. This type of reporting error would not affect the country-reported total. But it does suggest that country totals for export and import totals will not be consistent with one another. We examine a specific example of why this is so.

We examine individual wheat import flows to China reported both by China and the associated exporters. Table 5 provides this information. We disaggregate Chinese wheat imports by 5 partners.

The partners are shown in table 5 as Canada, the US, France, Poland, and other. The first column of values shows the reported values reported by these exporters. Canada reported exports to China of $1,020,897 thousand. But China reported imports from Canada of $847,553 thousand. The third column gives the ratio of reported imports to reported exports. For Canadian wheat exports it is 0.83. Because of this discrepancy, the trade total of Canadian wheat exports and Chinese wheat imports are not consistent. The China-reported total from the world for wheat imports is $1,503,730 thousand. This value is the same for both COMTRADE and FAO. The Canadian-reported total for its wheat exports is $3,870,900 thousand. Again this value is the same for both COMTRADE and FAO. These totals are the sum of the individual bilateral flows. But China cannot be importing wheat from Canada valued at $847,553 thousand while Canada is exporting wheat to China valued at $1,020,897 thousand. Both totals cannot be correct. If we accept what is reported by the Chinese, we must use the Chinese value in the calculation of the Canadian wheat import total. This is shown in the fifth column in table 5. Canada's total must drop at lease by 6% to accept the reported Chinese values.

The above illustration highlights the problem in using totals for imports and exports which are derived from different bilateral trade flows. This problem applies international totals for all merchandise trade. Import and export country reported totals as they are published by FAO, the World Bank and the IMF are inconsistent. This is because reported bilateral trade flows have not been reconciled. Because of the inconsistency problem there is no reason to use published trade totals as *targeted* totals in the development of the GTAP trade data.

# *3. Assessment of the Reliability of Bilateral Trade*

The source of uncertainty in trade data is linked directly to discrepancies in bilateral-commodity trade data. Discrepancies make country totals unreliable and lessen the overall integrity of the reported structure of world trade. Discrepant transactions have caused some to call into question the reliability of the entire United Nations COMTRADE system. It is not always recognized that *the UN is not the source of reporting errors*. Individual countries contribute reporting errors. One unreliable reporter can generate a multitude of discrepant trade transactions. And if one unreliable reporter trades with every country in the world in every commodity, it makes the entire world trade structure appear unreliable. Identification of the unreliable reporters is essential in data reconciliation. Reporting problems and their significance in COMTRADE can be better understood with specific examples. We now turn to specific examples found in the COMTRADE database.

## *3.1 The Case of a Simple Unreliable Reporter*

It is impractical to examine all bilateral-commodity trade for all regions at a detailed level. However, it is instructive to provide selected examples illustrating typical problems found in at the detailed level in COMTRADE. Most aggregated sectors in GTAP comprise a variety of goods from various industries. We start with the GTAP sector **C**hemicals, **R**ubber, and **P**lastic products (CRP) and focus on Australian exports. There is no particular reason for us to believe that Australian reporting of CRP products is any more biased than for other products. We also have no particular reason why products found *within* CRP should be reported with a common bias because they belong to the CRP sector. As far as the reporting goes, products within sectors are reported independently without any association to the GTAP sector classification ie., Australia reports CRP products at the individual SITC level. Biases in reporting tend to be product-specific rather than sector-specific. Observations on reported on sectors lead to less informative generalizations than observations on individual products. We are interested in observing the CRP products at the individual level rather than as an aggregated CRP sector.

Table 6 displays bilateral transactions of Australia's exports for selected CRP transactions. There are 5 examples of 4-digit SITC product classes: inorganic bases, medicaments, rubber tires and tubes, and articles of plastic. Six importing-partner countries are shown. Each of the importing countries reports a value for each product as imports from Australia. The ratio of reported imports to Australia's reported exports for each transactions is provided in the last column in table 6. Subtotals are given for the sum of Australia's reported trade across the 6 partners, as well as for the sum of partners' reported imports from Australia. Except for Canada, all importing countries report imports on a *cif* basis. Australia reports the value of exports for each of the partners on an *fob* basis.

Let us start at the top of table 6 with the product category shown as 4-digit SITC 5136 with the description 'inorganic bases'. Of the 6 transactions there is only one *non-discrepant* transaction. This transaction is with the United Kingdom. Shown in the last column for the U.K. we see that ratio of reported imports to reported exports is 1.10 meaning the reported import value is 10% greater than the reported export value. The 10% difference could accurately represent the difference between *fob* and *cif* values. I contend that the consistency found in this transaction is not a mere coincidence but is the result of reliable reporting by both countries. This comparability in reporting lends a high degree of confidence to the reported trade flow.

What can be said for the U.K. transaction unfortunately cannot be said for the other transactions. Brazil reports imports of $5,443 thousand from Australia, while Australia reports exports of $41 thousand to Brazil. Reported imports are 134 times larger than reported exports! Because this discrepancy is unreasonably large by any measure, it is deemed *unreliable*. The information from this transaction alone does not however suggest that both reporters are unreliable, or, which reporter is unreliable. It shows only that reported exports are small compared to reported imports. More information is necessary to link reliability to a specific reporter.

Table 3. Comparisons of FAO and COMTRADE of Major Agricultural Commodities For Major Exporters (value of trade in $US thousand)

| | Commodity | FAO Value | COMTRADE Value | FAO / COMTRADE |
|---|---|---|---|---|
| Argentina | Wheat | 715,788 | 715,788 | 1.00 |
| Australia | Wheat | 1,161,310 | 1,081,292 | 1.07 |
| Canada | Wheat | 3,870,900 | 3,890,187 | 1.00 |
| France | Wheat | 3,302,000 | 3,290,320 | 1.00 |
| Germany | Wheat | 882,820 | 878,038 | 1.01 |
| USA | Wheat | 4,498,630 | 4,496,443 | 1.00 |
| Argentina | Maize | 636,604 | 636,604 | 1.00 |
| Australia | Maize | 2,256 | 2,799 | 0.81 |
| Brazil | Maize | 515 | 515 | 1.00 |
| Canada | Maize | 51,484 | 52,083 | 0.99 |
| France | Maize | 1,910,610 | 1,907,133 | 1.00 |
| Germany | Maize | 79,454 | 79,034 | 1.01 |
| USA | Maize | 4,951,000 | 4,943,654 | 1.00 |
| Argentina | Bovine Meat | 337,947 | 337,948 | 1.00 |
| Australia | Bovine Meat | 2,128,280 | 2,165,235 | 0.98 |
| Brazil | Bovine Meat | 283,347 | 283,348 | 1.00 |
| Canada | Bovine Meat | 305,202 | 304,834 | 1.00 |
| France | Bovine Meat | 1,575,340 | 1,569,706 | 1.00 |
| Germany | Bovine Meat | 1,657,600 | 1,661,473 | 1.00 |
| USA | Bovine Meat | 2,000,550 | 1,998,102 | 1.00 |
| Honduras | Bananas | 286,500 | 292,828 | 0.98 |
| Ecuador | Bananas | 667,917 | 675,917 | 0.99 |
| Philippines | Bananas | 157,734 | 157,776 | 1.00 |

Table 4. Comparisons of FAO and COMTRADE of Major Agricultural Commodities For Major Importing Countries (value of trade in $US thousand)

| Country | Commodity | FAO | COMTRADE | FAO / COMTRADE |
|---|---|---|---|---|
| Italy | Wheat | 1,650,900 | 1,647,552 | 1.00 |
| China | Wheat | 1,503,730 | 1,503,725 | 1.00 |
| Japan | Wheat | 1,176,970 | 1,175,282 | 1.00 |
| Brazil | Wheat | 617,553 | 390,313 | 0.63 |
| Korea | Wheat | 543,690 | 543,690 | 1.00 |
| United Kingdom | Wheat | 311,583 | 320,841 | 1.03 |
| Germany | Wheat | 271,069 | 270,676 | 1.00 |
| USA | Wheat | 200,107 | 200,107 | 1.00 |
| Switzerland | Wheat | 49,719 | 49,582 | 1.00 |
| France | Wheat | 40,363 | 40,009 | 0.99 |
| Italy | Bovine Meat | 2,220,580 | 2,209,268 | 0.99 |
| Japan | Bovine Meat | 2,090,520 | 2,087,533 | 1.00 |
| USA | Bovine Meat | 1,889,160 | 1,889,160 | 1.00 |
| Germany | Bovine Meat | 1,639,970 | 1,630,791 | 0.99 |
| France | Bovine Meat | 1,631,590 | 1,623,397 | 1.00 |
| United Kingdom | Bovine Meat | 666,560 | 677,813 | 1.02 |
| Korea | Bovine Meat | 477,830 | 477,830 | 1.00 |
| Brazil | Bovine Meat | 120,818 | 120,831 | 1.00 |
| Switzerland | Bovine Meat | 47,663 | 47,531 | 1.00 |
| China | Bovine Meat | 4,004 | 4,005 | 1.00 |
| USA | Coffee Green & Roasted | 1,746,570 | 1,746,732 | 1.00 |
| Germany | Coffee Green & Roasted | 1,309,680 | 1,302,885 | 0.99 |
| France | Coffee Green & Roasted | 543,326 | 541,362 | 1.00 |
| Japan | Coffee Green & Roasted | 485,205 | 484,510 | 1.00 |
| Italy | Coffee Green & Roasted | 376,931 | 375,462 | 1.00 |
| United Kingdom | Coffee Green & Roasted | 204,305 | 203,742 | 1.00 |
| Switzerland | Coffee Green & Roasted | 135,099 | 134,724 | 1.00 |
| Korea | Coffee Green & Roasted | 73,477 | 73,478 | 1.00 |
| China | Coffee Green & Roasted | 4,824 | 5,766 | 1.20 |
| Brazil | Coffee Green & Roasted | 205 | 205 | 1.00 |
| USA | Bananas | 1,280,000 | 1,342,057 | 1.05 |
| Germany | Bananas | 784,325 | 783,017 | 1.00 |
| Japan | Bananas | 523,326 | 523,395 | 1.00 |
| France | Bananas | 417,969 | 399,893 | 0.96 |
| Untied Kingdom | Bananas | 417,781 | 415,994 | 1.00 |
| Italy | Bananas | 319,871 | 529,311 | 1.65 |
| Korea | Bananas | 80,811 | 80,811 | 1.00 |
| Switzerland | Bananas | 66,053 | 65,870 | 1.00 |
| China | Bananas | 5,301 | 5,301 | 1.00 |

Table 5. Country Reported Totals and Bilateral Trade: The Case of Chinese Wheat Imports ($US thousand)

| Exporter | Reported By Exporter | Reported By | | China's Share of Partner Total | Total Reported By Exporter | Exporter Total With China Reported Bilateral | Percent Difference In Country Totals |
|---|---|---|---|---|---|---|---|
| | | China | Imports / Exports | | | | |
| Canada | 1,020,897 | 847,553 | 0.83 | 26.2 | 3,890,187 | 3,666,780 | -5.7 |
| U.S.A. | 272,951 | 447,412 | 1.64 | 6.1 | 4,496,443 | 4,644,476 | 3.3 |
| France | 77,570 | 170,195 | 2.19 | 2.4 | 3,290,320 | 3,372,892 | 2.5 |
| Poland | 1,943 | 2,459 | 1.27 | 3.4 | 57,837 | 58,208 | 0.6 |
| Other | 41,542 | 36,106 | 0.87 | na | na | na | na |
| Total | 1,414,903 | 1,503,725 | 1.06 | na | na | na | na |

*Note:* Australia and Russian Federation are part of 'Other' which do not report bilateral wheat trade

Other transactions for inorganic bases show a pattern similar to the Brazilian case where the import value is much larger than Australia's export value. Canada, Germany, New Zealand, and the United States all report import values several times larger than Australia's export value. The largest trading partner, the United States, reports an import value of 73.7 times larger than Australia's export value. For all 6 importers shown in the subtotal, reported imports are 83.7 times larger than Australia's reported exports of inorganic bases. Is Australia an unreliable reporter ? The answer is still uncertain without further information.

The other examples of CRP categories include medicaments, pharmaceutical goods, rubber tires, and articles of plastic. Transactions involving these categories do not exhibit the same reporting pattern as inorganic bases. In fact, several transactions appear quite reliable. For medicaments, New Zealand's reported imports of $76.1 million while Australia reported exports of $64.2. million giving a 1.2 ratio of imports to exports . All other transactions involving New Zealand, other than inorganic bases, appear to be more reliable.

The reporting of other transactions is rather mixed. Australia reports export values substantially higher than Germany's import values for medicaments and pharmaceutical goods. But Australia reports values only slightly less for rubber and articles of plastic than does Germany. For US imports of medicaments, Australia reports $25,530 thousand, which is broadly consistent with the US report of $23,776. For US imports of articles of plastic, Australia reports $4,448, while the US also reports $4,448 -- an exact match. For the entire aggregated CRP sector (includes 2,873 transactions), Australia's partners reported an import value that is twice the value of what Australia reports as exports to these partners. Does this mean Australia an unreliable reporter ? The information shown here for Australian reported exports of CRP is inconclusive. There are several examples of apparently accurate transactions. And, we cannot

Table 6. Selected Examples of Reported Trade for Chemicals, Rubber, and Plastics : The Case of Australia's Exports ($US thousand)

| Commodity Codes | Commodity Description | Importing Country | Reported by Importer | Reported by Australia | Imports /Exports |
|---|---|---|---|---|---|
| SITC 5136 | Inorganic Bases | Brazil | 5,443 | 41 | 134.1 |
| SITC 5136 | Inorganic Bases | Canada | 192,499 | 1,070 | 179.9 |
| SITC 5136 | Inorganic Bases | Germany | 38,875 | 27 | 1425.0 |
| SITC 5136 | Inorganic Bases | New Zealand | 107,427 | 461 | 232.8 |
| SITC 5136 | Inorganic Bases | United Kingdom | 1,639 | 1,506 | 1.1 |
| SITC 5136 | Inorganic Bases | United States | 637,489 | 8,649 | 73.7 |
| | | Subtotal | 983,371 | 11,755 | 83.7 |
| SITC 5417 | Medicaments | Brazil | na. | 15 | 0.0 |
| SITC 5417 | Medicaments | Canada | 8,746 | 7,903 | 1.1 |
| SITC 5417 | Medicaments | Germany | 127 | 863 | 0.1 |
| SITC 5417 | Medicaments | New Zealand | 76,184 | 64,201 | 1.2 |
| SITC 5417 | Medicaments | United Kingdom | 23,776 | 25,530 | 0.9 |
| SITC 5417 | Medicaments | United States | 2,964 | 4,241 | 0.7 |
| | | Subtotal | 111,796 | 102,753 | 1.1 |
| SITC 5419 | Pharmaceutical Goods | Canada | 540 | 246 | 2.2 |
| SITC 5419 | Pharmaceutical Goods | Germany | 393 | 1,080 | 0.4 |
| SITC 5419 | Pharmaceutical Goods | New Zealand | 4,343 | 3,724 | 1.2 |
| SITC 5419 | Pharmaceutical Goods | United Kingdom | 616 | 1,201 | 0.5 |
| SITC 5419 | Pharmaceutical Goods | United States | 1,316 | 3,490 | 0.4 |
| | | Subtotal | 7,208 | 9,742 | 0.7 |
| SITC 6291 | Rubber Tires, Tubes | Canada | 15 | 9 | 1.6 |
| SITC 6291 | Rubber Tires, Tubes | Germany | 468 | 359 | 1.3 |
| SITC 6291 | Rubber Tires, Tubes | New Zealand | 9,880 | 8,718 | 1.1 |
| SITC 6291 | Rubber Tires, Tubes | United Kingdom | 2,580 | 2,727 | 0.9 |
| SITC 6291 | Rubber Tires, Tubes | United States | 4,010 | 4,488 | 0.9 |
| | | Subtotal | 16,954 | 16,301 | 1.0 |
| SITC 8930 | Articles of Plastic | Brazil | 19 | 12 | 1.6 |
| SITC 8930 | Articles of Plastic | Canada | 581 | 724 | 0.8 |
| SITC 8930 | Articles of Plastic | Germany | 1,017 | 680 | 1.5 |
| SITC 8930 | Articles of Plastic | New Zealand | 38,491 | 34,868 | 1.1 |
| SITC 8930 | Articles of Plastic | United Kingdom | 8,452 | 8,734 | 1.0 |
| SITC 8930 | Articles of Plastic | United States | 4,448 | 4,448 | 1.0 |
| | | Subtotal | 53,007 | 49,467 | 1.1 |
| GTAP 24 | Chem.,Rubb.,&Plast. | World | 2,853,485 | 1,475,079 | 1.9 |

Table 7. Selected Examples of Reported Trade for Chemicals, Rubber, Plastics: Importers Trade with the World excluding Australia ($US thousand)

| Commodity Codes | Commodity Description | Importing Country | Reported by Importer | Reported by World excl. Australia | Imports / Exports |
|---|---|---|---|---|---|
| SITC 5136 | Inorganic Bases | Canada | 259270 | 261224 | 1.0 |
| SITC 5136 | Inorganic Bases | Germany | 342932 | 214097 | 1.6 |
| SITC 5136 | Inorganic Bases | New Zealand | 12211 | 9966 | 1.2 |
| SITC 5136 | Inorganic Bases | United | 103320 | 209293 | 0.5 |
| SITC 5136 | Inorganic Bases | United States | 861230 | 761874 | 1.1 |
| | | Subtotal | 1707558 | 1566481 | 1.1 |
| SITC 5417 | Medicaments | Brazil | 113476 | 112648 | 1.0 |
| SITC 5417 | Medicaments | Canada | 855317 | 812304 | 1.1 |
| SITC 5417 | Medicaments | Germany | 2810298 | 2775369 | 1.0 |
| SITC 5417 | Medicaments | New Zealand | 150462 | 98775 | 1.5 |
| SITC 5417 | Medicaments | United | 1967038 | 1818117 | 1.1 |
| SITC 5417 | Medicaments | United States | 1777985 | 1855452 | 1.0 |
| | | Subtotal | 7674576 | 7472665 | 1.0 |
| SITC 5419 | Pharmaceutical Goods | Brazil | 11324 | 13765 | 0.8 |
| SITC 5419 | Pharmaceutical Goods | Canada | 110150 | 126213 | 0.9 |
| SITC 5419 | Pharmaceutical Goods | Germany | 429500 | 453121 | 0.9 |
| SITC 5419 | Pharmaceutical Goods | New Zealand | 14597 | 15504 | 0.9 |
| SITC 5419 | Pharmaceutical Goods | United | 203093 | 231341 | 0.9 |
| SITC 5419 | Pharmaceutical Goods | United States | 333598 | 321226 | 1.0 |
| | | Subtotal | 1102263 | 1161169 | 0.9 |
| SITC 6291 | Rubber Tyres,Tubes | Brazil | 25258 | 21735 | 1.2 |
| SITC 6291 | Rubber Tyres,Tubes | Canada | 775300 | 787082 | 1.0 |
| SITC 6291 | Rubber Tyres,Tubes | Germany | 2455113 | 2365530 | 1.0 |
| SITC 6291 | Rubber Tyres,Tubes | New Zealand | 41559 | 34304 | 1.2 |
| SITC 6291 | Rubber Tyres,Tubes | United | 1128570 | 1044123 | 1.1 |
| SITC 6291 | Rubber Tyres,Tubes | United States | 2484929 | 2351559 | 1.1 |
| | | Subtotal | 6910730 | 6604333 | 1.0 |
| SITC 8930 | Articles of Plastic | Brazil | 97075 | 63066 | 1.5 |
| SITC 8930 | Articles of Plastic | Canada | 1136053 | 1127425 | 1.0 |
| SITC 8930 | Articles of Plastic | Germany | 4248353 | 3965656 | 1.1 |
| SITC 8930 | Articles of Plastic | New Zealand | 72612 | 45579 | 1.6 |
| SITC 8930 | Articles of Plastic | United | 2502667 | 2126550 | 1.2 |
| SITC 8930 | Articles of Plastic | United States | 3492439 | 2943766 | 1.2 |
| | | Subtotal | 11549199 | 10272042 | 1.1 |

generalize and say Australia systematically under-reports its exports f CRP. There are cases where reported exports were significantly higher than reported imports.

The most obvious problem for Australian reported trade is in the reporting of inorganic bases which happens to be a large component of CRP exports for Australia. But from what was observed in the data we can only say there is probable cause to *suspect* that Australia severely and systematically under- reports exports inorganic bases. We therefore must investigate further before reaching a firm conclusion.

A key question is whether the reporting problem lies with Australia or with her trading partners. Perhaps these importers are systematically over-reporting ? That assertion can be challenged. To do this we examine exports of the same products to the same importers but exclude Australia as an exporter from the aggregated partner. Table 7 shows reports data in a similar format to that in table 6. The exporter comprises all non-Australian exporters. We do not observe large discrepancies for inorganic bases as we did in table 6. Brazil reports imports of $128,596 thousand and the aggregate exporter reports $110,027 thousand giving a ratio of reported import to reported exports of 1.2 . This ratio does not indicate systematic over-reporting by Brazil. The US, which reported an import value 74 times greater than Australia's export value, reports imports only 10 percent greater than reported exports from its aggregate partner. Importers together report a value only 10% greater than the non-Australian exporters, as shown in the subtotal for inorganic bases.

We view the all the above information as evidence that Australia systematically and severely under-reports exports of inorganic bases. The precise reason why Australia reports the way it does is not known, nor is it necessary to know this for the purposes at hand. Throughout the COMTRADE database there are numerous examples of this sort. Some transactions have extreme discrepancies and some have less extreme discrepancies, and some are non-discrepant transactions.

## *3.2 The Role of Transport Costs*

Part of the problem in evaluating reported trade is knowing when there is a "problem," and when there isn't. We now turn to another GTAP sector and country reporter. For this case we focus on the GTAP sector **N**on-**G**rain **C**rops (NGC). Like the CRP sector, NGC contains a variety of SITC categories. Five selected 4-digit SITC commodities belonging to the NGC sector are examined. These include bananas, fresh fruit n.e.s., manila fibre, live plants, and vegetable matter n.e.s. We focus here on Philippine exports of NGC.

Table 8 displays the reported values of NGC imports and the Philippine-reported value of exports. For almost all transactions in Table 8, the import value is greater than the export value. Looking at the subtotals by commodity, for bananas the import value is 3.1 times greater than the export value, and for fresh fruit it is twice as large. These values seem high for transport margins. For other NGC commodities, the import value is less than 20% greater the reported export value, which seems

acceptable. As was the case with Australian exports, it appears that there could be a problem of systematic under-reporting of exports. But what is different here is that the discrepancies are less severe and more uniform than for the case of Australian exports of inorganic bases. Despite that reported imports are 2-3 times larger than reported exports, the uniformity in the discrepancy is curious.

It is commonly known that fresh fruit, and in particular bananas, are typically more *bulky* ie., the price per unit of weight or volume is comparatively low. These products are also highly perishable. For such commodities transportation costs adds a proportionately higher value to the *fob* export value than it does for other nonbulk goods. Transportation cost can sometimes help explain discrepancies between the *cif* value and the *fob* value. It is instructive to examine transportation cost in some detail to gain a better understanding of what is represented in reported trade values.

A comprehensive examination of transport cost requires data on reported values, quantities , and unit values. Table 9 provides this data. We focus on Philippine banana exports to Japan and Korea. In order to gain a better perspective of the role of transportation cost over time, we examine a 10- year time-series (1985-1994). Table 9 contains four columns of reported trade data. The first column is the reported quantity in metric tons (MT) reported by the importer. The second column is the reported quantity in metric tons reported by the Philippines. The third and fourth columns contain the value reported by the importer and the value reported by the Philippines, respectively.

The fifth column in table 9 is the ratio of the quantity of reported imports to reported exports. What is clear from this ratio is that reported trade of the quantity of bananas for the is consistent for the most part. There is no evidence of the Philippines under-reporting banana exports. On average, the Philippines reports a higher export quantity than the importers. A slightly higher quantity of exports over import quantity is typically for fresh fruits given that some spoilage occurs in transit.

The sixth column in table 9 shows the ratio of the reported value of imports to exports. In 1994, Korea reported twice the *value* of bananas reported by Philippines, while reporting exactly the same *quantity* of bananas as the Philippines. How can this be explained? Transportation cost is a major factor here. It is explained by the difference between the export unit-value reported by the Philippines and the import unit-value reported by Korea. Import and export unit values are shown in the seventh and eighth columns of table 9. The ratio of the import unit-value to the export unit-value is given in the tenth column in table 9. The difference between the import and export unit-value is the unit-transportation cost. In 1994, the unit-transportation cost was $174/MT was for shipping bananas from the Philippines to Korea. There were 117.8 thousand metric tons shipped giving a transportation cost of $20,440 thousand. This explains the difference in the *cif* and *fob* reported values.

The discrepancy in the reported value of bananas varies by the ratio of unit-value of imports to unit-value of exports. For Korea the largest discrepancy was in 1985 with import/export value of 4.10 (sixth column) this corresponds to the largest unit-price ratio of 4.55 (ninth column). For Japan, the

Table 8. Selected Examples of Reported Trade for Non-Grain Crops: The Case of Philippine Exports ($US thousand)

| Commodity Codes | Commodity Description | Importing Country | Reported by Importer | Reported by the Philippines | Imports / Exports |
|---|---|---|---|---|---|
| SITC 0513 | Bananas,Plantains,Fresh | Japan | 364,428 | 115,126 | 3.17 |
| SITC 0513 | Bananas,Plantains,Fresh | Korea | 38,195 | 14,049 | 2.72 |
| SITC 0513 | Bananas,Plantains,Fresh | Singapore | 961 | 475 | 2.02 |
| SITC 0513 | Bananas,Plantains,Fresh | United States | 942 | 39 | 24.18 |
| | | Subtotal | 404,526 | 129,690 | 3.12 |
| SITC 0519 | Fresh Fruit nes. | Japan | 71,730 | 36,154 | 1.98 |
| SITC 0519 | Fresh Fruit nes. | Korea | 2,145 | 694 | 3.09 |
| SITC 0519 | Fresh Fruit nes. | Singapore | 1,570 | 1,327 | 1.18 |
| SITC 0519 | Fresh Fruit nes. | United States | 544 | 571 | 0.95 |
| | | Subtotal | 75,989 | 38,747 | 1.96 |
| SITC 2655 | Manila Fibre | Indonesia | 129 | 149 | 0.86 |
| SITC 2655 | Manila Fibre | Japan | 4,059 | 3,250 | 1.25 |
| SITC 2655 | Manila Fibre | Korea | 271 | 226 | 1.19 |
| SITC 2655 | Manila Fibre | United States | 8,390 | 7,137 | 1.18 |
| | | Subtotal | 12,849 | 10,763 | 1.19 |
| SITC 2926 | Live Plants,Bulbs,etc. | Japan | 178 | 170 | 1.05 |
| SITC 2926 | Live Plants,Bulbs,etc. | Korea | 193 | 149 | 1.30 |
| SITC 2926 | Live Plants,Bulbs,etc. | Singapore | 3 | 1 | 2.43 |
| SITC 2926 | Live Plants,Bulbs,etc. | United States | 13 | 11 | 1.20 |
| | | Subtotal | 388 | 331 | 1.17 |
| SITC 2929 | Vegetable Matter nes. | Indonesia | 117 | 95 | 1.23 |
| SITC 2929 | Vegetable Matter nes. | Japan | 3,608 | 3,028 | 1.19 |
| SITC 2929 | Vegetable Matter nes. | Korea | 3,247 | 2,105 | 1.54 |
| SITC 2929 | Vegetable Matter nes. | Singapore | 275 | 232 | 1.19 |
| SITC 2929 | Vegetable Matter nes. | United States | 6,065 | 5,991 | 1.01 |
| | | Subtotal | 13,311 | 11,450 | 1.16 |
| GTAP 4 | Non-Grain Crops | World | 746,180 | 409,022 | 1.82 |

The Philippines exports to the world for non-grain crops includes a total of 531 transactions.

Table 9. Selected Examples of Reported Values and Quantities From 1985 to 1994 : The Case of Philippine Banana Exports

| Year | Importing Country | Reported By the Importer | Reported by the Phillippines | Reported By the Importer | Reported by the Phillippines | Quantity of Imports /Exports | Value of Imports/ Exports | Import Unit Value | Export Unit Value | Imp.Unit Value/ Exp. Unit Value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | metric tons | metric tons | $US 1000 | $US 1000 | ratio | ratio | $ US 1000 per metric ton | $ US 1000 per metric ton | ratio |
| 1994 | Korea | 117,559 | 117,825 | 40,711 | 20,279 | 1.00 | 2.01 | 0.35 | 0.17 | 2.01 |
| 1993 | Korea | 110,361 | 105,068 | 42,682 | 19,715 | 1.05 | 2.16 | 0.39 | 0.19 | 2.06 |
| 1992 | Korea | 76,676 | 72,617 | 38,195 | 14,049 | 1.06 | 2.72 | 0.50 | 0.19 | 2.57 |
| 1991 | Korea | 129,500 | 126,267 | 88,058 | 23,850 | 1.03 | 3.69 | 0.68 | 0.19 | 3.60 |
| 1990 | Korea | 7,004 | 10,046 | 5,420 | 2,464 | 0.70 | 2.20 | 0.77 | 0.25 | 3.16 |
| 1989 | Korea | 1,043 | 1,013 | 663 | 165 | 1.03 | 4.02 | 0.64 | 0.16 | 3.90 |
| 1988 | Korea | 3,307 | 3,397 | 2,132 | 1,261 | 0.97 | 1.69 | 0.64 | 0.37 | 1.74 |
| 1987 | Korea | 3,290 | 3,370 | 1,899 | 1,097 | 0.98 | 1.73 | 0.58 | 0.33 | 1.77 |
| 1986 | Korea | 904 | 947 | 576 | 142 | 0.95 | 4.05 | 0.64 | 0.15 | 4.24 |
| 1985 | Korea | 757 | 839 | 482 | 118 | 0.90 | 4.10 | 0.64 | 0.14 | 4.55 |
| 1994 | Japan | 684,608 | 768,813 | 289,148 | 148,652 | 0.89 | 1.95 | 0.42 | 0.19 | 2.18 |
| 1993 | Japan | 668,840 | 745,384 | 331,933 | 148,924 | 0.90 | 2.23 | 0.50 | 0.20 | 2.48 |
| 1992 | Japan | 546,670 | 589,126 | 364,428 | 115,126 | 0.93 | 3.17 | 0.67 | 0.20 | 3.41 |
| 1991 | Japan | 586,856 | 661,048 | 328,300 | 119,453 | 0.89 | 2.75 | 0.56 | 0.18 | 3.10 |
| 1990 | Japan | 585,224 | 622,819 | 311,083 | 110,675 | 0.94 | 2.81 | 0.53 | 0.18 | 2.99 |
| 1989 | Japan | 620,477 | 654,991 | 341,613 | 112,369 | 0.95 | 3.04 | 0.55 | 0.17 | 3.21 |
| 1988 | Japan | 600,352 | 639,059 | 340,058 | 106,815 | 0.94 | 3.18 | 0.57 | 0.17 | 3.39 |
| 1987 | Japan | 569,976 | 603,407 | 263,544 | 93,876 | 0.94 | 2.81 | 0.46 | 0.16 | 2.97 |
| 1986 | Japan | 620,488 | 647,635 | 308,071 | 97,742 | 0.96 | 3.15 | 0.50 | 0.15 | 3.29 |
| 1985 | Japan | 559,739 | 598,008 | 247,436 | 85,713 | 0.94 | 2.89 | 0.44 | 0.14 | 3.08 |

Table 10. Average Discrepancy and Distribution of Transactions Across Size Classes for 4-Digit SITC Level of Aggregation

| Size Class in $US mill. | Simple Average Discrepancy % | Value-Weighted Average Discrepancy % | Share of Transactions in Total % | Share of Value in World Total % |
|---|---|---|---|---|
| < 1 | 7793.7 | 146.30 | 73.1 | 2 |
| 1 < and < 10 | 61.4 | 55.10 | 19.2 | 10.3 |
| 10 < and < 25 | 37.1 | 36.50 | 3.8 | 9.6 |
| 25 < and < 75 | 31.6 | 31.00 | 2.5 | 16.5 |
| 75 < | 25.4 | 23.20 | 1.4 | 61.6 |
| | | | 100 | 100 |

Table 11. Average Discrepancy and Distribution of Transactions Across Size Classes for GTAP Sector Level of Aggregation

| Size Class in $US mill. | Simple Average Discrepancy % | Value-Weighted Average Discrepancy % | Share of Transactions in Total % | Share of Value in World Total % |
|---|---|---|---|---|
| < 1 | 1457 | 1092 | 32.0 | 0.04 |
| 1 < and < 10 | 276 | 202 | 27.9 | 0.56 |
| 10 < and < 25 | 78 | 77 | 11.4 | 0.92 |
| 25 < and < 75 | 53 | 51 | 11.8 | 2.59 |
| 75 < | 38 | 20 | 16.9 | 95.89 |

largest discrepancy was in 1988 with an import/export value of 3.18 and a unit-price ratio of 3.39. Table 9 also shows that transportation costs are route-specific. In particular, the importer unit-price (seventh column) differs between Japan and Korea for identical years.

## *3.3 Summary Statistics*

We now turn to a few summary statistics giving an overall assessment of reliability of reported bilateral trade. Thus far specific examples have been provided showing reported bilateral trade. These specific examples are helpful in understanding the nature and probable source of the discrepancies. For assessing the overall reliability of bilateral trade it is useful to show summary statistics that provide information on the extent of the problem of discrepant trade data. We know there can be extremely large discrepancies as was shown in the case of Australian inorganic bases

exports. A question worth pursuing is: How pervasive are such discrepancies in the COMTRADE system?

Table 10 displays summary statistics on the size and frequency of discrepancies found in COMTRADE at the 4-digit SITC level of aggregation. Transactions are classified by 5 sizes. The reported import value is used as a measure of size for transactions. For each size class there four summary statistics are given. The first column is the average discrepancy for the class of transactions. It is calculated as a simple average. We see that for class of transactions under 1 million the average discrepancy is 7,794%. Clearly there are wide disparities in reported imports and exports, giving much uncertainty to trade flows in this smallest class. Since the size of transactions varies within each class, it is useful to calculate a value-weighed average. This is provided in the second column. For the "less than 1 million" class, the weighted- average is 146% as compared to 7,773% for the simple-average.

In comparing the simple average with the weighted average for other classes we see that the weighted-average is lower for the simple-average. Larger discrepancies tend to be more reliable than smaller transactions. This can be seen within classes and between classes.

The frequency and the value of transactions belonging to each class are also given in the third and fourth columns of table 10. Frequency of transactions by class is expressed as a share of the total number of transactions in the data set. The smallest three size classes claims 73.1 percent of total transactions. Because this class represents the bulk of transactions one could easily come to the conclusion that most transactions in COMTRADE are unreliable. This is true. But what is often not recognized, as shown in table 10, is that although 73% of the number of bilateral flows could be viewed as unreliable these transactions contribute only 2% of the total value of trade. Over 75% of the value of individual transactions are reported with less than a 25% discrepancy even without accounting for the *cif/fob* difference. (Not shown in table.)

# *4. Methodology*

The large share of discrepant transactions found in COMTRADE makes the task of reconciling bilateral-commodity trade seem almost impossible. Partners rarely communicate with each other regarding one another one is reporting.[5] There are no rules coordinating the reporting process. Reported exports are independent of reported imports. Tackling this task requires some optimistic forethought. It is useful to draw an analogy between trade data reconciliation and another "art form".

5. One exception is provided by the United States and Canada which share reported trade information. This makes them consistent reporters.

## *4.1 Motivation for the Approach*

What comes to mind after observing partner trade is a ballroom filled with people performing couples dances.[6] Consider what would happen if there was no communication between dance partners. Each dancer attempts to lead regardless of whether their partner knows the dance. It would only be when *both* partners know the dance very well when the couple is *in-step*. Those couples knowing the dance would gracefully move across the floor *in-step*. Even if one partner knows the correct dance steps the couple painfully stumbles over one another *out-of-step*. And so it is for trade reporting.

What can be done with a noncommunicative group of pathetic ballroom dancers ? Rules must be imposed. One rule is to have all women follow exactly what the men do, analogous to choosing reported imports over reported exports. This would at least help to keep partners *in-step* with each other . But it gives no assurance that the correct dance is being performed. Not all men know the dance steps for every dance. And the same goes for women. Another solution is to work out a compromise. Women could lead the first half of a given dance and men lead the second half. This is analogous to taking an average of the two reported values of trade. So, if Brazil reports 5,442 and Australia reports 41 we end-up with 2,742. But there is no reason to believe that the average is the actual trade flow. The objective in ballroom dancing is not simply to have everyone *in-step* with each other, but to perform the correct dance *in-step*. The same goes for bilateral trade where the correct trade flow is most important. It seems only logical that the dancer who knows the dance should lead regardless of gender. This approach makes use of all dance talent found in the entire group. This is the approach taken in reconciling trade data.

Misrepresentation of reported bilateral trade by reporting countries can either be intentional or unintentional. There are numerous explanations for discrepant transactions but the reasons for reporting behavior are not important. All that is important for this exercise is that countries which systematically misrepresent their reported bilateral trade are identified. Identification of unreliable reporters requires empirical evidence.

## *4.2 An Index of Reliability*

An appropriate measure of reliability is of utmost importance for a successful method to yield quality results. There are numerous statistics that might be thought of as representing reliability. A measure of the difference between country-reported totals and partner-reported totals can be used to measure biased reporting. But totals can be misleading and are of limited value in measuring the reliability of reporter's bilateral trade. The reason for this is that countries can incorrectly report all of their

6. While ballroom dancing and trade data reconciliation are worlds apart, this type of analogy is useful in understanding the rationale for the proposed reconciliation methodology.

bilateral trade flows but still report correct totals. The most common reporting problem is misidentifying partners and misclassifying commodities. Some countries cannot, or do not, identify all of their partners and commodities. Recognizing this problem the UN reporting system provides residual categories for unidentified partners and commodities. These are generally referred to as "not elsewhere specified" (n.e.s.) categories. Countries can under-report trade with specific partners but can make up for it by reporting to the n.e.s. partner category. In that case using the reported trade total for the world would not reveal a bilateral reporting problem. Unreliable reporters can correctly report totals without the use of an n.e.s. category as well. This is done by confusing partners. Misidentifying partners leads to under-reporting for one partner and over-reporting for another without affecting total trade. As before, the reported trade total would not reveal a bilateral reporting problem. For these reasons country- reported totals of are of little help in revealing unreliable reporter countries.

Measuring the consistency found in individual bilateral trade flows is most useful for establishing reporter reliability. But this is not as straightforward as one would hope. What exactly should be measured with regard to bilateral trade requires some thought. One could simply calculate an average of discrepancies across bilateral trade flows for each reporter. But as shown in the last section, the average size of discrepancies can vary widely and the size of discrepancy is not correlated with reliability. Suppose there are 2 reporters: reporter A and reporter B. Reporter A has large and small trading partners. Reporter B has fairly uniformly sized partners. Both reporters make the same mistake by misidentifying their partners. Reporter A confuses only two of its partners. But reporter B confuses all of its partners. But the mistake of A would result in a much larger average discrepancy than B's average discrepancy even with misrepresentation of all trade flows. The larger average discrepancy is because reporter A has both large and small partners and when A *mismatches* just 2 partners it produces very large discrepancies. For reporter B, even by mismatching all partners this does not result in a large average discrepancy since the partners are more uniform in their trade flows. But the size of A's average discrepancies does not make A a less reliable reporter than B. If anything, reporter B is less reliable because it has mismatched all of its bilateral trade flows.

Average size of discrepancies is not a good indicator of reliability. It is like judging a dance partner based on just how bad their worst partner dances were. Conventional wisdom would suggest that it is the rate of successful dances that reflects knowledge of dance talent. A better measure of bilateral reliability would measure the rate of successful transactions.

The sum of the total value of *accurate* partner matches as a share of total reported trade is well-suited for measuring reliability. We now formalize this index. First, what is an accurate partner match? Rarely does a reported export value match perfectly with a corresponding reported import value. Although there are no perfect matches, some discrepancies are small enough to be considered accurate matches. A threshold level must be established. It is the difference as a percentage between reported exports and reported imports. This level as been established at 20%.

There are a few preliminary steps that must take place prior to checking for accuracy in reporting. As we saw in the last section reported imports can differ from each other due to the *cif/fob* transport margin. Some margins can be over 100% as was shown for the case of bananas. Before determining whether a transaction is accurate imports when reported on a *cif* basis must be converted to *fob*. This is done using a *cif/fob* conversion factor at the SITC commodity level.[7]

Once imports have been converted to an *fob* basis the accuracy level $AL_{i,r,s}$ of each transaction is calculated. This is shown below as:

$$AL_{i,r,s}^{fob} = \frac{|M_{i,r,s}^{fob} - X_{i,r,s}^{fob}|}{M_{i,r,s}^{fob}}$$

The value of trade reported by the importer for commodity $i$ exported from region $r$ to region $s$ is denoted as $M_{i,r,s}^{fob}$. Likewise the trade reported by the exporter for commodity $i$ from region $r$ to region $s$ is denoted as $X_{i,r,s}^{fob}$. Whether exports exceed imports or vice versa is not relevant, so accuracy is not sign-specific. Only the magnitude of the difference matters. Our goal is to measure a reliability index which is importer-commodity specific and exporter-commodity specific. The reliability index is rather simple to construct but very rich in the information it provides. We start with construction of the importer-commodity specific index. First we calculate the total trade $M_{i,s}^{T}$ reported by the importer $s$ for commodity $i$. This is shown as:

$$M_{i,s}^{T} = \sum_{r} M_{i,r,s}^{fob} \qquad \forall s$$

Next we calculate the reported imports that were accurately matched with partner's reported export value denoted as $M_{i,s}^{A}$. This is calculated below as:

$$M_{i,s}^{A} = \sum_{r} M_{i,r,s}^{fob} \qquad \forall s \quad where \quad AL_{i,r,s}^{fob} \leq 0.20$$

We can now calculate the importer-commodity reliability index as the share of accurate transactions, denoted $RIM_{i,s}$, where:

$$RIM_{i,s} = \frac{M_{i,s}^{A}}{M_{i,s}^{T}} * 100 \qquad \forall s$$

Likewise we calculate the exporter-commodity specific reliability index where:

$$X_{i,r}^{T} = \sum_{s} X_{i,r,s}^{fob} \qquad \forall r$$

$$X_{i,r}^{A} = \sum_{s} X_{i,r,s}^{fob} \qquad \forall r \quad where \quad AL_{i,r,s}^{fob} \leq 0.20$$

7. The *cif/fob* conversion factor by individual commodities is first estimated using all transactions. Once a subset of most reliable reporters are found it is then re-estimated using only transactions reported by most reliable reporters. This conversion factor is not the same as the bilateral margins found in the GTAP database and documented elsewhere.

$$RIX_{i,r} = \frac{X_{i,r}^{A}}{X_{i,r}^{T}} \qquad \forall s$$

There is one important detail left out of the above. Each reporter is given an opportunity to disregard the value reported by its *worst partner*. The reason for this is to give some "saving grace" to reliable reporters who happen to trade with a large unreliable partner. A good dancer who has a bad experience with a particular dance partner should not have her record blemished. The good dancer should option to drop this particular dance from the record. Equal treatment must be given to all dancers. So all dancers good or bade disregard their worst dance experience.

A quantitative measure is needed to identify the *worst partner*, so that the associated transactions maybe dropped. This is measured in a rather straightforward manner as the value-weighted accuracy level, calculated for the importer and exporter as follows:

$$WAL_{i,r,s}^{M} = \frac{M_{i,r,s}^{fob}}{M_{i,r,s}^{T}} \; AL_{i,r,s}$$

$$WAL_{i,r,s}^{X} = \frac{X_{i,r,s}^{fob}}{X_{i,r,s}^{T}} \; AL_{i,r,s}$$

For each importer and exporter, for a given commodity, the partner which produces the largest $WAL$ is dropped from their set of transactions before computing their reliability index. By dropping a large and less accurate transaction it raises the reliability index (RI) for all countries. But it has a greater positive effect on better reporting countries than it does for poor reporting countries. This provides more accurate information for the reconciliation process. Once reliability indices are generated, the actual reconciliation is nothing more than accepting the reported trade flows of the more reliable partners. No adjustments are made to reported bilateral trade flows.

## *4.3 Illustrative Examples*

We now turn to specific examples showing the calculated RIM and RIX and how they are used in reconciling individual bilateral trade flows. Recall that in section 3.1, we noted a problem with Australian exports in the CRP sector. We can now see exactly how this problem was resolved. Table 12 displays selected transactions. Reported values from the importer

Table 12. Selected Examples of Reported and Reconciled Transactions at the SITC Level of Aggregation (Part 1)

| Commodity | Importer | Exporter | Reported By Importer | Reported By Exporter | Reliability Index of Importer | Reliability Index of Exporter | Most Reliable Reporter |
|---|---|---|---|---|---|---|---|
| Inorganic Bases | Brazil | Australia | 5,443 | 41 | 54.0 | 5.3 | Brazil |
| Inorganic Bases | Canada | Australia | 192,499 | 1,070 | 97.5 | 5.3 | Canada |
| Inorganic Bases | United Kingdom | Australia | 1,639 | 1,506 | 35.9 | 5.3 | United Kingdom |
| Inorganic Bases | United States | Australia | 637,489 | 8,649 | 77.3 | 5.3 | United States |
| Medicaments | Germany | Australia | 127 | 863 | 89.4 | 42.2 | Germany |
| Medicaments | New Zealand | Australia | 76,184 | 64,201 | 27.2 | 42.2 | Australia |
| Pharmaceutical Goods | Germany | Australia | 393 | 1,080 | 78.1 | 41.9 | Germany |
| Pharmaceutical Goods | United Kingdom | Australia | 616 | 1,201 | 30.5 | 41.9 | Australia |
| Pharmaceutical Goods | United States | Australia | 1,316 | 3,490 | 37.0 | 41.9 | Australia |
| Rubber Tires,Tubes | Canada | Australia | 15 | 9 | 89.3 | 58.5 | Canada |
| Rubber Tires,Tubes | Germany | Australia | 468 | 359 | 93.9 | 58.5 | Germany |
| Rubber Tires,Tubes | New Zealand | Australia | 9,880 | 8,718 | 41.3 | 58.5 | Australia |
| Articles of Plastic | Brazil | Australia | 19 | 12 | 46.8 | 47.9 | Brazil |
| Articles of Plastic | New Zealand | Australia | 38,491 | 34,868 | 52.6 | 47.9 | New Zealand |

Table 12. Selected Examples of Reported and Reconciled Transactions at the SITC Level of Aggregation (Part 2)

| Commodity | Importer | Exporter | Reported By Importer | Reported By Exporter | Reliability Index of Importer | Reliability Index of Exporter | Most Reliable Reporter |
|---|---|---|---|---|---|---|---|
| Wheat | Peru | Argentina | 59,625 | 65,982 | 78.1 | 89.0 | Argentina |
| Wheat | Syria | Argentina | 5,946 | 5,007 | 100.0 | 89.0 | Syria |
| Wheat | Algeria | Canada | 60,873 | 41,666 | 66.0 | 69.4 | Canada |
| Wheat | China | Canada | 847,553 | 1,020,897 | 83.3 | 69.4 | China |
| Wheat | Italy | Canada | 72,813 | 47,382 | 90.5 | 69.4 | Italy |
| Wheat | Japan | Canada | 326,178 | 244,386 | 100.0 | 69.4 | Japan |
| Wheat | Algeria | France | 115,045 | 98,412 | 66.0 | 89.7 | France |
| Wheat | China | France | 170,195 | 77,570 | 83.3 | 89.7 | France |
| Wheat | Italy | France | 890,233 | 831,887 | 90.5 | 89.7 | Italy |
| Wheat | Morocco | France | 97,036 | 86,234 | 76.0 | 89.7 | France |
| Wheat | Peru | France | 2,052 | 3,202 | 78.1 | 89.7 | France |
| Wheat | Syria | France | 4,609 | 7,733 | 100.0 | 89.7 | Syria |
| Wheat | China | Poland | 2,459 | 1,943 | 83.3 | 78.8 | China |
| Wheat | Algeria | USA | 142,047 | 69,125 | 66.0 | 67.1 | USA |
| Wheat | Sri Lanka | USA | 47,489 | 84,351 | 0.0 | 67.1 | USA |
| Wheat | Italy | USA | 65,920 | 46,760 | 90.5 | 67.1 | Italy |
| Wheat | Japan | USA | 652,570 | 584,317 | 100.0 | 67.1 | Japan |
| Wheat | Korea | USA | 274,796 | 235,559 | 69.4 | 67.1 | Korea |
| Wheat | Morocco | USA | 76,539 | 77,879 | 76.0 | 67.1 | Morocco |
| Wheat | Peru | USA | 32,698 | 33,576 | 78.1 | 67.1 | Peru |
| Wheat | Switzerland | USA | 7,403 | 223 | 65.7 | 67.1 | USA |

and exporter, the RIM and RIX, and the most reliable reporter for each transaction are also provided. Not surprisingly, Australia received a very low RIX of 5.3 for inorganic bases. This means that only 5.3% of the value of inorganic bases were reported accurately by Australia. The Brazilian RIM is 54. Since this is larger than Australian RIX of 5.3 we reject Australia's reported value of $41 thousand and accept Brazil's reported value of $5,443 thousand. Of the exporters listed for inorganic bases, Canada received the highest reliability rating of 97.5.

The worst partner for Australia as an importer of inorganic bases was United States. But even excluding the United States from Australia's total exports of inorganic bases did not seem to help the RIX much. The worst partner for the United States as an exporter of inorganic bases was Australia. Removing Australia as an exporter for inorganic bases to the US gave a boost to the RIM for the United States.

Australia's reporting record is, however, not at all bad news. Australia's reliability for medicaments was 42.2 which was greater than New Zealand's reliability of index of 27.2. Australia is also a better reporting exporter of pharmaceutical goods than are the UK and the US on the import side. Consequently, Australia's exports are selected for the data base.

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We also noted above that there was a discrepancy between Canadian wheat exports to China and Chinese imports from Canada. From table 12 we can see that China has a higher reliability index as an importer of wheat than Canada has an exporter of wheat. Therefore we accept the value reported by China and reject the value reported by Canada. Of course, this also means that we must simultaneously reject FAO's total for Canadian wheat exports.

In some cases the reliability index can be 100. This means that all of the individual trade flows were deemed accurate. This was the case for Japanese and Syrian wheat imports. Therefore, all Japanese wheat imports would be reported by Japan in the reconciled GTAP data set. The same goes for Syria. In some cases, the reliability index can be zero. This means none of the trade flows were deemed accurate enough for use in the calculation. In the examples listed this occurred for Sri Lankan wheat imports. Therefore all imports of Sri Lankan wheat would be reported by the exporter in the reconciled data for GTAP.

What is important to recognize in this method is that it is based solely on the evidence of reliable reporting on a case by case level. Each reported trade flow goes to trial and is judged. Generalization and inferences are not made. A country's reporting ability as an exporter can differ from its ability

as an importer. A country's individual reporting ability varies by commodity. The method is tailored to account for the specific problems encountered. The process is very much a *bottom's up* approach where the totals are the sum of the most reliable bilateral commodity trade flows. When each and every trade flow is reconciled using this "ballroom dancing" approach, the 4 digit SITC data is then aggregated up to the GTAP concordance. This is the origin of all bilateral merchandise trade in the version 3 GTAP data base.