

Chapter 9.A

Reconciling Merchandise Trade Data

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9.A.1 Overview of Data Procedures

This document describes various data problems and procedures for the treatment of merchandise trade. Preparation of bilateral merchandise trade for the GTAP 7 Data Base involves different approaches for confronting multiple challenges. Although wide discrepancies in reported bilateral trade flows are not a new problem, some of the largest discrepancies in bilateral trade are the result of re-export activity. With China now playing a more prominent role in world trade there are growing complexities because of indirect trade. Indirect trade is not permitted in the GTAP Data Base and it must be dealt with. Most methods for reconciling trade flows have generally not worked well for China and its trading partners because of the intermediary role of Hong Kong in China's external trade. Nearly every country is a trading partner of China directly or indirectly, including China itself.¹ Transshipment activity presents one of the most complex and growing problems, not just for China and Hong Kong, but for reconciling global bilateral trade flows.²

Ideally, a single-global approach would provide the most consistent means for simultaneously redirecting trade flows and resolving bilateral discrepancies for all countries. However, data availability and irregularities in reporting practices for different countries make this difficult. Furthermore, large and erratic reporting errors prevent estimation of statistical measures for adjusting trade flows appropriately and systematically.

There are basically two approaches for reconciling trade flows for the GTAP 7 Data Base: (i) an optimization procedure using a math programming model and (ii) a selection procedure to accept or disregard reported trade flows.³ A change in methodology for the GTAP 7 Data Base from previous versions was in introducing the optimization procedure. Reported trade flows for China and Hong Kong and their partners are adjusted using this technique. The procedure imposes consistency conditions in the handling of trade between China and Hong Kong and their partners. Trade data for the Netherlands and Singapore are treated separately. All other trade flows are treated using the selection process to reconcile trade flows. The preeminent

¹ This type of trade is referred to as "round-tripping". China reported imports of \$38.8 billion from itself in 2004.

² China is now the second largest supplier of goods to the Netherlands. Adding to this complexity is that there are numerous countries throughout the world that serve as entrepôts for transship of goods. Goods could be re-exported more than once making the source and final destination of goods less certain.

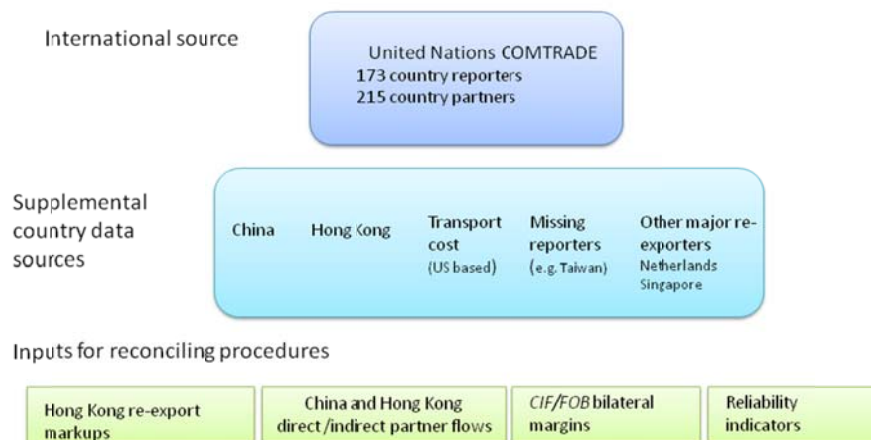
³ Reconciling trade is a decision to accept or reject reported trade flows or a decision to compromise by adjusting data using a weighting scheme. In the selection procedure, erroneous data are disregarded without making adjustments.

goal of reconciling bilateral trade is to utilize the most reliable reported data.⁴ Underlying each approach is the recognition that there are country and commodity-specific differences in reporting reliability.

The procedures for treating merchandise trade draw upon different data sources (Figure 1). The primary source of global bilateral data is the United Nation's COMTRADE dataset. Data from COMTRADE provides the core trade data but it does not provide adequate detailed information for implementing the procedures. Supplemental data from individual country sources are necessary.

The optimization approach requires initial estimates of re-export markups, which are not part of official trade statistics.⁵ Attempts to estimate re-export markups for Hong Kong have been based on either detailed trade statistics used by the Joint Commission on Commerce and Trade (JCCT) (1995) using Hong Kong's data and Feenstra *et al* (1999) using both China's and Hong Kong's data, or on surveys conducted by the Hong Kong Census and Statistical Department (HKCSD). We calculate initial bilateral estimates of re-export markups for Hong Kong based on detailed trade data using both Hong Kong's and China's official trade statistics.⁶ Hong Kong's re-export trade by origin and destination are also provided by HKCSD. Without estimates of re-export margins, it is not possible to implement the optimization approach for other re-exporting countries. Adjustments for re-exports for other countries are based on independent estimates from national data for converting gross exports and imports to domestic exports and retained imports. Chapter 9.B describes the nature of the adjustments for the Netherlands and Singapore.

Figure 1. Key data sources and components for merchandise trade



⁴ The optimization technique makes adjustments to partner trade flows in a consistent manner by explicitly incorporating reliability weights into the model's objective function. See Wang, Gehlhar, and Yao (2007) GTAP Technical Paper No. 27.

⁵ The re-export markup is the difference between the price at which the re-exporter buys goods and the price at which it sells the same goods.

⁶ China's detailed trade statistics (HS8-digit) are obtained from China Customs.

Merchandise trade flows in the GTAP Data Base explicitly take into account transport costs, represented by the difference between the *c.i.f* price and the *f.o.b.* price.⁷ Transportation margin estimates are also needed in reconciling trade flows. However, reliable transport margins are difficult to obtain using partner trade data because of reporting errors.⁸ As with previous versions of the GTAP Data Base, transport margins are developed from detailed bilateral commodity data from the United States. Import charges explicitly represent the aggregate cost of all freight, insurance and other related transport costs in the US data.

Another essential component for reconciling trade data are indicators of reporter reliability. Reporting reliability indicators are developed for each reporting exporter and importer. Indices of reliability are estimated at the most detailed commodity level and can be calculated at a sector level or aggregate merchandise level to provide an overall measure of reporting reliability.

9.A.2 *Reporting and Data Characteristics*

Reported bilateral trade statistics consists of either “mirror” observations where both importer and exporter provide a record for the same transaction or “single-sided” observations where only one reporter provides a record for a given transaction. A high frequency of mirror flows is desirable for assessing the reliability and consistency of bilateral trade flows. However, single-sided observations are more common and there is no attempt to estimate unreported trade flows. At the HS6-digit level, global bilateral trade for all commodities consists of 8,022,666 observations in 2004.⁹ Non-mirror flows comprise mostly of low value transactions conducted between the smaller countries.¹⁰ Although mirror observations account for 42 percent of total transactions, they cover about 92 percent of the total value of merchandise trade. The frequency of mirror transactions varies by year depending on the number of reporting countries and on the amount of unspecified trade reported in a given year.¹¹

The integrity and soundness of global bilateral statistics are reflected in the frequency of accurately reported mirror transactions (table 1).¹² Errors caused by misidentified partners and misclassification of commodities are common causes for low accuracy in reporting. Reporting accuracy varies by commodity and reporting country. The share of accurately reported transactions provides a measure of reporting reliability. A high share of mirror transactions does not always correspond to high reporting accuracy. For example, 43 percent of the trade flow observations for electronic equipment are comprised of mirror trade flows but only 22 percent of these transactions are deemed accurate. Country origin and destination information is weakened

⁷ *C.I.F* stands for Cost, Insurance, and Freight. For the United States the *c.i.f* value is computed by adding the import charges to the Customs value. *F.O.B.* stands for Free On Board, excluding shipping charges.

⁸ Previous estimates using COMTRADE often generate negative transport margins.

⁹ At the time the version 7 GTAP Data Base was prepared there were 164 reporting countries for 2004 using the HS-1992 classification system. The number of reporting countries reporting on the HS-1992 classification increased to 173 countries more recently. Most non-mirror transactions are from reporter’s trade with non-reporting countries.

¹⁰ In some cases, reporting countries may intentionally suppress information due to disclosure issues of individual firms. Certain commodities are more problematic because of confidentiality. For example, only 17 percent of the trade flows for gas are mirror flows.

¹¹ Unspecified trade is when reporting countries fail to classify individual commodities or do not report specific country partners.

¹² A measure of accuracy in this context refers to discrepancies that are no larger than 20 percent.

when goods are transshipped. This is a universal problem for electronic components, which can often be transshipped more than once before reaching their final destination. Other sectors with poor reporting accuracy include leather products, textiles, and wearing apparel.¹³ Misclassification of goods in these sectors also contributes to lower reporting accuracy. For sectors where re-exporting is minimal reporting accuracy generally improves because of identifiable sources and destinations.¹⁴

The reporting of unspecified trade has increased with the growth of global merchandise trade. The extent of the problem varies by country and commodity. Exporters generally are less able or willing to identify partner countries than importers. However, reported imports reported with unidentified partners have grown faster recently. The share of reported exports with unspecified importers rose sharply in 2004 to nearly 3 percent of reported exports (table 3). Reporting practices can change abruptly from year to year.¹⁵ For example, Saudi Arabia reported only 3 percent of its exports to unspecified destinations in 2003 but in 2004 reported nearly all of its exports to unspecified destinations.¹⁶ There is no specific attempt to reallocate each country's unspecified trade. However, in most cases, partner data or historical data is used to identify unclassified commodities and reconstruct a country's bilateral trade flows.

Both exporters and importers report about the same level of unclassified commodities. In 2004, unclassified commodities accounted for \$483 billion or 5.7 percent of total reported exports (table 2). Gas, oil, and petroleum products are among sectors with high proportions of unspecified partners (table 4). Reported data for these commodities is often weaker than other commodities. Over 25 percent of gas exports are reported with unspecified destinations, while 17 percent of imports have unspecified partners.

9.A.3 *Indicators of Reporter Reliability*

Reporting reliability indicators are calculated directly from mirror trade flows. Variability in reporting capability across countries is highly relevant information for resolving discrepancies found in bilateral trade. As stated earlier, the process of reconciling trade flows hinges heavily on the relative reliability of the each reporting country. An indicator of reporter reliability is basically a measure of how consistently a country reports its trade with their trading partner. However, judging a country's trade data based on an individual bilateral flow alone is a poor reference, because any one partner can misrepresent its trade thereby potentially discrediting a reliable reporter. Therefore, a reasonable reporter reliability measure should take all reporting countries into account in assessing a country's reporting reliability. Another issue is what exactly should be captured by the reliability measure. The size of discrepancies could be considered and reflected in a measure of reliability. However, placing emphasis on the magnitude of discrepancies only may over-penalize the reliability of a legitimate reporter. For example, a reporter that has mistaken the identity of one of its partners has implicitly made a mistake for

¹³ Among leather products, footwear in particular is commonly inaccurately reported. These are also goods with high levels of re-exporting activity.

¹⁴ More than 50 percent of transactions are deemed accurate for sectors such as bovine meat, wool, beverages and tobacco, and dairy products.

¹⁵ India, Kuwait, Nigeria, and Saudi Arabia failed to report their trading partners for crude oil in 2004. India stopped reporting country sources for oil in 2001, but then restarted in 2006.

¹⁶ Unspecified trade reported by Saudi Arabia was the main contributor to total unspecified trade in 2004.

others. It brings a systemic error for that reporter.¹⁷ This type of problem should be detected and reflected in the reporter reliability measure, without over penalizing a reliable reporting partner. Another important feature is the capability of the measure to reflect both commodity and country-specific reliability information for each country as an exporter and as an importer. Countries typically have commodity specific strength and weaknesses. For example, one exporting country may have an excellent reporting record on steel exports but at the same time is highly inconsistent in its reporting practice in organic chemical exports.

The issues discussed above are effectively dealt with in the reliability index estimated by Gehlhar (1996). It assesses reporter reliability from a complete set of global reporting partners, captures the reporter's ability to accurately report without interferences from gross discrepancies in reporting, and contains exporter and importer-sector specific reliability information. The size of inaccurate discrepancies becomes immaterial because inaccurate transactions are treated the same regardless of the magnitude of the discrepancy. A country's reporting reliability depends on how well the country can accurately report commodity trade with its reporting partners.

A ranking of the least and most reliable reporters based on estimated mean indices for all commodities is provided in tables 5-8. Among the least reliable reporters are predominantly small and lower-income developing countries.¹⁸ In some cases, countries may report valid trade data but the data can still be highly inconsistent with partners due to differences in trade definitions. There are many cases of highly irregular reporting practices. For example, The Gambia has wide discrepancies with its major partners mainly because it serves as an entrepôt and does not record all goods entering the country.¹⁹ Countries with high ranking comprise of a wide mix of countries including small and both developing and developed countries.

The measure of reliability reflects reporting ability of the country and its partner's. Reporters with the highest rankings generally conduct trade with at least some reliable reporting partners. Countries with the highest ranking conduct a large share of their trade with few reliable partners. Reporters trading with multiple partners also have a greater chance for misidentifying partners, which lowers their reliability. For example, Greenland demonstrates considerable reporting capability, as both an importer and exporter, with the majority of its trade conducted with Denmark.²⁰ Similarly, Canada's high rank as a reporter is because of the large share of accurate transactions reported with the United States.

Commodity specific reliability indicators reveal unique reporting characteristics of individual reporting countries. Countries generally have strengths and weaknesses in reporting different commodities. This point is illustrated from table 9 showing variation of the reliability index across GTAP sectors for selected countries. For example, Cambodia generally has difficulty in accurately reporting its imports for the majority of commodities, but it demonstrates capability in the reporting of oilseeds, vegetable oils, and petroleum products. Although India is

¹⁷ A bilateral discrepancy in a case of mistaken partner identity is often large and a reporter that makes an error for a given trade flow usually makes a similar error with other partners.

¹⁸ Low-income countries may not have sufficient resources for collecting and managing data making them more prone to errors in compiling trade statistics.

¹⁹ Senegal reports exports ten times greater than what The Gambia imports from Senegal, while China and the European Union alone report exports to The Gambia that exceed the country's total imports from the world.

²⁰ Greenland conducts about 85 percent of its trade with Denmark. There is a high frequency of accurately reported transactions for both exports and imports with Denmark.

ranked lower than Switzerland as an importer overall, India has a better reporting record for its imports of other cereal grains and plant-based fibers than for Switzerland. Although the United States and Switzerland generally have high reporting records overall, there are sector-specific reporting weaknesses common to these countries. Both countries have noticeable lower reliability for leather products, wearing apparel, and electronic equipment. These are sectors that are universally poorly reported mainly as a result of heavy re-exporting activity.

9.A.4 *Reconciling Trade Flows with Selection Procedure*

The selection procedure for reconciling trade involves a decision. A decision is made to accept or reject reported trade based upon the relative reliability of each reporter. It is assumed that discrepancies arise in trade data because one of the reporters makes an error. Based on this assumption the actual trade flow is more likely represented by one of the country's reports rather than by an adjusted average of the both reports. The objective is to utilize the most reliable data in each instance. By disregarding errant data, the more reliable data is not compromised.

The basic steps in the selection process are outlined below. The first step is to establish comparability in reported trade flows. This is done by converting all import flows valued at *cif* to *fob* values. Trade flows with non-reporting countries are not included in the calculation of the reliability measure.²¹ The reliability index is designed to measure the share of accurately reported trade only with reporting partners. Each reported trade flow is assigned two reliability indicators: one for the reporting importer and one for the reporting exporter. A choice is made between the reported import flow and the reported export flow. Single-sided observations for trade between reporters are also reconciled based on the reporters reliability indicators. However, non-mirror transactions from non-reporters are accepted as given. This is because there is no means to judge reliability of non-reporting countries. The *cif* value is generated by reapplying the transport margins to the reconciled flows prior to aggregating to the GTAP sector level.

Basic steps in selection procedure:

1. Convert *cif* import flows to *fob*
2. Separate non-reporter trade flows from mirror flows
3. Calculate reliability indicators for each reporter
4. Select most reliable trade flows between reporter countries
5. Select trade flows for non-mirrors observations
6. Reapply transport margin to create *cif* trade flows
7. Aggregate to GTAP sector level

²¹ Including such trade flows could adversely affect the relative reliability of countries that conduct a high share of trade with non-reporters.

9.A.5 *Reconciling partner Trade Flows with China and Hong Kong*

China's reported statistics of total merchandise trade with the world are generally considered credibly. The level of Hong Kong's imports and re-exports corroborates with China's reported exports as well. However, there is a great deal of uncertainty with the size of bilateral trade with major trading partners. Importing partners report a higher value for imported goods from China than what China reports as exports to the same partners. Part of the problem has to do with Hong Kong's re-export markups. For example, U.S. Customs treats all goods from China, directly or indirectly through Hong Kong, as Chinese imports, including the value-added to the goods by Hong Kong middlemen. Although, Hong Kong re-exports most of its imports to other countries, Chinese Customs statistics show that Hong Kong is one of China's largest export destinations, behind the United States. As a result, discrepancies in the official data on the bilateral trade between China and its partners invariably arise.

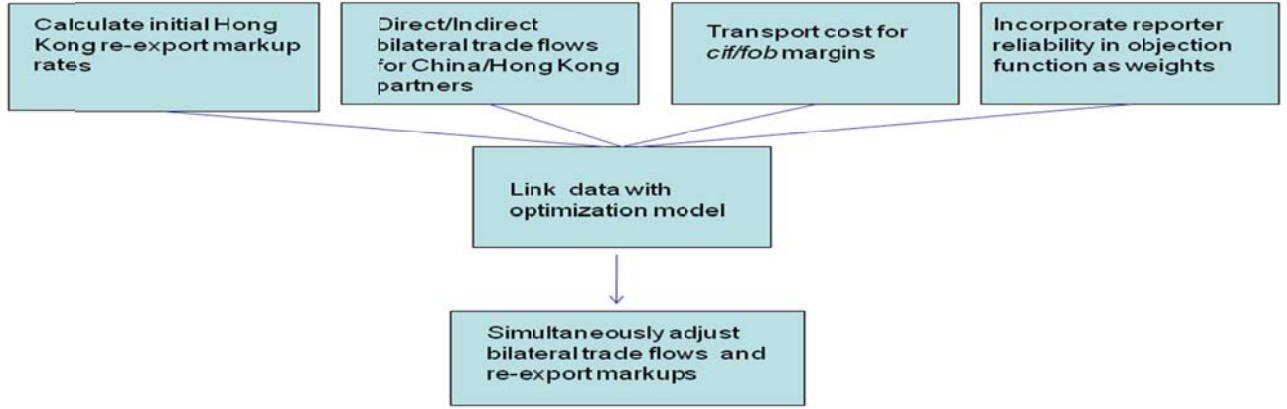
The primary objective of introducing a constrained optimization procedure for resolving discrepancies is to preserve certain data that are generally regarded as valid. Adjustments are made to data that are less reliable or even implausible.²² Ideally, any alterations to the trade data made by the optimization modeling approach would try to preserve the combined trade total for China and Hong Kong while adjusting re-export markups and partners flows in a consistent manner. An important advantage of mathematical programming models over scaling methods is flexibility.²³ The procedure allows for a wide range of initial information to be used efficiently in the data adjustment process. The mathematical programming approach also permits one to routinely introduce relative degrees of reliability for initial estimates. The re-estimates of markups and trade flow adjustments are made in a consistent and simultaneous manner. The model re-directs sources and destinations of China's and Hong's trade, adjusts Hong Kong's re-export markup, and adjusts bilateral trade balances for China and all its partners simultaneously. In doing, so it imposes consistency on the adjusted trade flow data. Key components for the math programming approach include re-export margins, direct and indirect trade reported by China and Hong Kong and their partners, transport margins, and reliability indicators (figure 3). All variables in the model are linked with officially reported statistics.²⁴

²² Mathematical programming methods are explicitly based on a constrained optimization framework, usually minimizing a penalty function, which measures the deviation of the balanced matrix from the initial matrix subject to a set of balance conditions.

²³ Additional constraints can be easily imposed, such as allowing precise upper and lower bounds to be placed on unknown elements.

²⁴ All China and Hong Kong reported trade statistics are obtained from Chinese Customs and the Hong Kong Census and Statistical Department, while partner countries reported data are from UN COMTRADE. There are eight sets of variables required, four of which in each direction can be obtained directly from existing reported trade statistics. The remaining four sets of unobservable variables are directly from the four sets of accounting equations in each direction.

Figure 2. Optimization procedure for China and Hong Kong's trade with partners



9.A.6 Initial and Adjusted Re-Export Margins

The initial estimation of Hong Kong re-export markup rates follows the spirit of Feenstra *et al* (1998, 1999). However, estimates from that approach only provide an overall markup rate for China's trade with the United States and a few other selected countries.²⁵ For implementing the math programming model it is necessary to have sector-specific estimates for all sectors. The approach here uses the same methodology and updated procedures by Yao (2000) to estimate the average 2002-04 markup rates, as well as their trade weighted standard deviations to provide the necessary initial inputs for the mathematical programming model.

The markup rate is defined as the share of value added by Hong Kong middlemen in the total re-export value. Let the unit-value of Hong Kong import be denoted by $PM_i = VM_i / QM_i$ where VM_i is the value and QM_i is the quantity of imports, and i denotes the commodity. Let the unit-value of Hong Kong re-exports be denoted by $PX_i = VX_i / QX_i$, where VX_i is the value and QX_i is the quantity of re-exports. Thus the relationship between the aggregate markup rate ($RXMR$) and disaggregate markup rate ($RXMR_i$) can be shown by the following formulae:

$$\begin{aligned}
 RXMR &= \frac{\sum_i (PX_i QX_i - PM_i QX_i)}{\sum_j PX_j QX_j} = \sum_i \left(1 - \frac{PM_i}{PX_i} \right) \left(\frac{PX_i QX_i}{\sum_j PX_j QX_j} \right) \\
 &= \sum_i RXMR_i \left(\frac{PX_i QX_i}{\sum_j PX_j QX_j} \right) = \sum_i RXMR_i \frac{RX_i}{\sum_j RX_j}
 \end{aligned}$$

²⁵ Alternatively, Yao (2000) is able to produce markup rates at 6-digit HS commodity for multiple partners.

The above formula shows that when using this definition, re-export values should be used as compatible weights. For purposes of using the programming model to solve for the final markup rate estimates, standard deviations are needed to measure the scope of variations of the estimates, and to inform the model how much adjustment should be allowed. The trade weighted variance and standard deviation of the markup rates are given as:

$$Var(RXMR_i) = \frac{\sum_k RX_k (RXMR_k - \overline{RXMR_i})^2}{\sum_j RX_j}, \text{ and } STD(RXMR_i) = \sqrt{Var(RXMR_i)}$$

where indexes j and k represent the group of 6 digit HS codes that in GTAP sector i , and were used to estimate the GTAP sector level mean markup rates, and again, the re-export values are chosen as weights to calculate the weighted variance. To improve these estimates for the trade weighted mean and variance of the markup rates, we add up the annual data on Chinese exports, Hong Kong imports and re-exports over the years 2003, 2004 and 2005.²⁶ The markup rates should be interpreted as the trade weighted average over the three years.

There are considerable differences in Hong Kong's re-export markup rates for different sectors (table 10). Petroleum and coal products have the lowest markup rate (6.4 percent) while paper, and motor vehicles and parts, have substantially higher markup rates (50 percent). The average markup is 31 percent for goods exported from China but only 12 percent for goods bound for China. The magnitude of adjustment varies as well for goods traded to and from China. For eastbound rates (China's exports), the differences are bigger, while westbound (China's imports) re-exports, the differences are smaller. Specifically, the model decreases the markup rate for Chinese goods re-exported to the rest of the world from 30.9 percent to 27.5 percent, while the goods from the rest of the world re-exported to China, the markup rates is decreased slightly from 11.6 percent to 10.2 percent. In terms of sectoral breakdown, in eastbound trade negative adjustments are made for most heavily trade manufacturing goods while upward adjustments are made for primary sectors such as plant-based fibers, dairy products, processed rice, and food products. For westbound trade, there is a similar pattern, but the biggest rise is the markup rate is for wearing apparel.

9.A.7 *China's and Hong Kong's Partner Trade*

Reported goods imported by China's partners (from table 11) are 40 percent higher than what China reports as exports to the world (\$593 billion). Among major trading partners, the United States has the largest bilateral discrepancy, reporting imports of nearly 70 percent more than what China reports as exports to the United States. The European Union also reports imports from China of more than 50 percent higher than what China's reports as its exports to the region. Even after accounting for Hong Kong's re-export markup, there is still an inexplicable discrepancy between China's reported exports and its partner imports. One problem is that importers may inadvertently assign China as the source for goods transshipped from Hong Kong when in fact the goods originated elsewhere. Although China supplies the bulk of Hong Kong's re-exports, other suppliers participate in Hong Kong's re-exporting activity. Hong Kong's reported imports from China are generally consistent with China's reported exports.

²⁶ Both China and Hong Kong data are in 8-digit HS categories, but only comparable at the 6-digit level.

For goods bound for China there are lower bilateral discrepancies than for goods exported from China. China reports imports of \$561 billion in comparison to \$471 billion reported by exporting partners. In this case, however China's partners do not identify China as the final destination when goods pass through Hong Kong. Hong Kong reports total imports including goods for re-exports and it reports retained imports. However, exporters tend to report Hong Kong as the destination. For example, the United States reports a higher value of exports to Hong Kong than what Hong Kong's reports as imports from the United States, even though U.S. goods are transshipped to China.²⁷ Similarly, Hong Kong's second largest supplier (Japan) after China reports higher exports to Hong Kong than what Hong Kong reports as imports. However, China, as an importer, reports goods coming from directly from their original source rather than from Hong Kong. This is evident from the difference between China's reported imports from Hong Kong (\$12 billion) and what Hong Kong reports as exports to China (\$114 billion). According to China's data Japan is the leading supplier of goods. However, Japan's trade data shows it exports nearly 30 percent less than what China is importing from Japan. The reason is that China correctly identifies direct trade from Japan.

Because exporters tend to fail in assigning the actual country destination, while importers tend to report the primary source, this gives rise to difference in bilateral trade balances. In 2004, China reported a trade surplus with the United States of about \$80 billion. However, using data reported by the United States this surplus would be \$176 billion. For some partners, there is uncertainty whether the bilateral trade balance is a surplus or deficit because of differences in each country's reported trade statistics. For example, according to China's reported trade there is a trade deficit with Japan of \$21 billion, however, based on Japan's reported data China has trade surplus with Japan.

If the selection procedure were employed to China and Hong Kong's trading partners and the choice were to completely disregard China's reported trade data, it would result in an implausible outcome. China's exports would be grossly overstated. Its imports would be understated and its trade surplus would be overstated. Instead, a compromise is made by making adjustment using the optimization approach which leads to trade flows that lie between what China reports and its partner's report. For China's exports most of the adjusted bilateral trade falls closer to the partner's reported trade. For example, exports to the United States are increased from China's reported value of \$125 billion to \$178 billion. As an exporting partner, China has a tendency not to report the actual destination of its goods. China's exports to the world are adjusted upward slightly from what it reports. Hong Kong's imports comprise only of goods that it retains for consumption and production. Trade is redirected from Hong Kong to final destinations. For China's imports, adjustments are more closely aligned to China's reported trade while total imports for China are lowered slightly.

China's trade surplus with the world is adjusted upward but significantly lower than the \$368 billion reported by partners. At the bilateral level, trade surpluses are increased for major partners. The trade surplus China reported with the United States is raised from \$80 billion to \$133 billion. The direction of bilateral trade balances with China are generally maintained even with major adjustments taking place. For Japan, the largest supplier to China, the deficit is reduced to reflect higher exports to Japan than from what China reported initially.

²⁷ In 2004 the United States reported exports of \$13.5 billion to Hong Kong while Hong Kong reported gross imports of only \$12.7 billion from the United States.

The optimization procedure relies more heavily on statistics reported by Hong Kong than on its partners.²⁸ Hong Kong's domestic exports and retained imports are considerably lower than what its partner's report (table 12). Hong Kong's retained imports in total merchandise goods are about one third of what its partners report as exports to Hong Kong. Sectors with the largest differences from partners reported data are electronic equipment, machinery and equipment, textiles, and leather products. Electronic equipment is the largest sector contributing to re-exports. Hong Kong's domestic exports of electronic equipments are just 5 percent of the sector's gross exports. Partners report imports of 4 times the amount of electronic equipment than what Hong Kong actually supplies from domestic production. Although the electronic equipment sector is the largest contributor to Hong Kong's re-exports, the wearing apparel sector is the largest sector contributing to Hong Kong's domestic exports. Partners reported nearly 10 times more than Hong Kong's domestic exports in leather products. Domestic exports for the machinery and equipment sector is also significantly lower than what Hong Kong's partner's reports. This exemplifies weaknesses in identifying partners when goods involve re-exports. Reporting importers cannot always distinguish what goods produced are produced from what country.

9.A.8 Summary and Conclusions

New challenges are emerging for reconciling merchandise trade data because of indirect trade. Preparation of merchandise trade for GTAP 7 Data Base involved experimentation with new methodology including an optimization procedure using a math programming model. The advantage of the technique is that it imposes consistency conditions while making adjustments to reported bilateral trade flows. China and Hong Kong's reported trade totals are minimally altered while major bilateral discrepancies are resolved. This approach is still work in progress. The robustness of outcomes require further sensitivity tests. In addition, there is a need to integrate different approaches to impose greater consistency on world merchandise trade.

²⁸ Hong Kong's reported domestic exports and retained imports from the Hong Kong Census and Statistics Department is deemed as the most reliable source for re-exports.

References

- Feenstra, Robert, Wen Hai, Wing Woo and Shunli Yao, 1998, "The U.S.-China Bilateral Trade Balance: Its Size and Determinants," *NBER Working Paper #6598*, June, National Bureau of Economic Research (NBER), Cambridge, MA
- Feenstra, Robert, Wen Hai, Wing Woo and Shunli Yao, 1999, "Discrepancies in International Data: An Application to China-Hong Kong Entrepôt Trade," *American Economic Review*, vol. 89, no. 2, 338-343, May.
- Fung, K C and Lawrence Lau, 2003, "Adjusted Estimates of United States-China Bilateral Trade Balances: 1995-2002, *Asian Economic Journal*, Vol. 14, May/June, pp. 489-496.
- Fung, K C, Lawrence Lau, and Yanyan Xiong, 2006 "Adjusted Estimates of United States-China Bilateral Trade Balances—An Update," *Pacific Economic Review*, vol 11(3), pages 299-314, October
- Gehlhar, Mark, 1996, "Reconciling Bilateral Trade Data for Use in GTAP" GTAP Technical Paper No. 10, Purdue University.
- Harrigan, J. Frank 1990, "The Reconciliation of Inconsistent Economic Data: the Information Gain," *Economic System Research*, Vol.2, No.1, pp. 17-25
- Hong Kong Census and Statistical Department (HKCSD), *Hong Kong Monthly Digest of Statistics*, various issues, Hong Kong
- Joint Commission on Commerce and Trade (JCCT), 1995, "Report of the 'Trade Statistics Subgroup'," Trade and Investment Working Group, Washington DC, October 17, <http://www.census.gov/foreign-trade/reconcile/china.html>
- Mellens, M.C., H.G.A Noordman, and J.P. Verbruggen, 2007, "Re-exports: International Comparisons and Implications for Performance Indicators" Netherlands Bureau for Economic Policy Analysis (CPB) Document No. 149.
- Singapore Department of Statistic, 2005, "Discrepancies in Bilateral Trade Statistics: The Case of Hong Kong and Singapore." Occasional Paper on Economic Statistics.
- Wang, Zhi, M. Gehlhar, and Shunli, Yao (2007). Reconciling trade statistics from China, Hong Kong and their major trading partners — A mathematical programming approach. GTAP Technical Paper No 27, Purdue University.
- Yao, Shunli, 2000, *Three Essays on China's Foreign Trade*, unpublished PhD dissertation, University of California, Davis.

Table 1. Frequency and accuracy of trade flow observations in 2004 by GTAP sector

	Frequency all observations	Share of mirror transactions	Share of accurate mirror transactions
Paddy rice	2,209	0.260	0.281
Wheat	2,137	0.400	0.281
Cereal grains n.e.c.	7,265	0.424	0.384
Vegetables, fruit, nuts	96,011	0.386	0.353
Oil seeds	11,271	0.396	0.514
Sugar cane, sugar beet	195	0.108	0.129
Plant-based fibers	3,579	0.313	0.492
Crops n.e.c.	70,763	0.408	0.411
Bovine cattle, sheep and goat	4,220	0.440	0.460
Animals products n.e.c.	26,097	0.398	0.406
Wool, silk-worm cocoons	2,016	0.331	0.601
Forestry	20,554	0.344	0.290
Fishing	23,821	0.368	0.355
Coal	2,756	0.336	0.344
Oil	1,354	0.292	0.301
Gas	609	0.171	0.420
Minerals	63,932	0.380	0.286
Bovine meat prods	16,454	0.422	0.625
Meat products n.e.c.	32,185	0.407	0.460
Vegetable oils and fats	34,884	0.385	0.365
Dairy products	31,479	0.418	0.500
Processed rice	3,669	0.371	0.305
Sugar	7,793	0.357	0.256
Food products n.e.c.	323,795	0.418	0.424
Beverages and tobacco	53,915	0.415	0.517
Textiles	707,155	0.403	0.277
Wearing apparel	541,131	0.384	0.221
Leather products	148,193	0.413	0.181
Wood products	207,923	0.441	0.410
Paper products, publishing	276,994	0.424	0.419
Petroleum, coal products	20,386	0.414	0.343
Chemical, rubber, plastic	1,300,427	0.450	0.381
Mineral products	283,735	0.424	0.343
Ferrous metals	199,329	0.413	0.361
Metals n.e.c.	141,771	0.422	0.310
Metal products	532,433	0.436	0.302
Motor vehicles and parts	154,577	0.436	0.490
Transport equipment	90,588	0.382	0.220
Electronic equipment	312,283	0.426	0.224
Machinery and equipment	1,861,563	0.449	0.284
Manufactures n.e.c.	336,484	0.415	0.250
Electricity	339	0.434	0.451
Unspecified commodity	64,182	0.053	0.023
Total merchandise	8,022,666	0.424	0.317

Based on HS-6 digit classification

Table 2. Unclassified commodity trade reported for world merchandise

	Unclassified exports \$ billions	Share of exports percent	Unclassified imports \$ billions	Share of imports percent
2000	366.7	6.2	348.1	5.7
2001	334.0	5.9	315.1	5.3
2002	321.2	5.3	295.6	4.8
2003	388.9	5.5	345.4	4.8
2004	483.2	5.7	435.1	4.9
2005	428.8	4.4	380.0	3.8
2006	633.5	5.7	595.3	5.2

Table 3. Unspecified country trade reported for world merchandise

	Unspecified country destination \$ billions	Share of exports percent	Unspecified country source \$ billions	Share of imports percent
2000	84.3	1.3	52.3	0.8
2001	74.6	1.2	52.8	0.8
2002	102.6	1.6	77.8	1.2
2003	103.8	1.4	84.7	1.1
2004	262.2	2.9	105.8	1.1
2005	121.0	1.2	128.6	1.2
2006	184.0	1.6	195.6	1.6

Table 4. Unspecified partner trade by GTAP sector

	Exports		Imports	
	\$ millions	percent	\$ millions	percent
Paddy rice	16	1.7	0	0.0
Wheat	3,179	16.5	12	0.1
Cereal grains n.e.c.	543	3.3	10	0.0
Vegetables, fruit, nuts	189	0.3	83	0.1
Oil seeds	89	0.4	6	0.0
Sugar cane, sugar beet	0	0.0	0	0.0
Plant-based fibers	33	0.3	12	0.1
Crops n.e.c.	67	0.4	107	0.2
Bovine cattle, sheep and goat	4	0.1	2	0.0
Animals products n.e.c.	248	1.4	27	0.2
Wool, silk-worm cocoons	0	0.0	0	0.0
Forestry	9	0.1	39	0.3
Fishing	27	0.2	31	0.2
Coal	195	0.6	130	0.3
Oil	79,493	18.5	30,524	5.3
Gas	24,196	25.6	19,519	17.4
Minerals	859	1.1	1,422	1.3
Bovine meat prods	20	0.1	4	0.0
Meat products n.e.c.	31	0.1	31	0.1
Vegetable oils and fats	338	0.9	75	0.2
Dairy products	82	0.3	18	0.0
Processed rice	53	0.7	8	0.1
Sugar	43	0.4	31	0.3
Food products n.e.c.	389	0.7	295	0.1
Beverages and tobacco	281	0.9	72	0.1
Textiles	655	0.3	769	0.3
Wearing apparel	133	0.1	431	0.2
Leather products	392	0.4	379	0.3
Wood products	148	0.1	135	0.1
Paper products, publishing	203	0.3	424	0.2
Petroleum, coal products	22,871	10.2	5,994	2.2
Chemical, rubber, plastic	4,367	1.2	2,840	0.2
Mineral products	244	0.6	321	0.3
Ferrous metals	130	0.1	344	0.1
Metals n.e.c.	4,571	2.5	575	0.2
Metal products	175	0.2	392	0.2
Motor vehicles and parts	315	0.0	1,209	0.1
Transport equipment	3,566	1.3	763	0.4
Electronic equipment	803	0.1	3,501	0.3
Machinery and equipment	1,339	0.2	3,335	0.2
Manufactures n.e.c.	741	0.5	246	0.1

Table 5. Least reliable importing reporters in 2004

Importer	Rank	Reliability index
Turks and Caicos Isds	1	0.055
Gambia, The	2	0.076
Bahamas	3	0.078
Mauritania	4	0.084
Guinea-Bissau	5	0.092
Burkina Faso	6	0.094
Yemen	7	0.099
Rwanda	8	0.100
Qatar	9	0.102
Ghana	10	0.108
Togo	11	0.110
Sao Tome and Principe	12	0.111
Tonga	13	0.112
Sudan	14	0.113
Macao	15	0.118
Egypt	16	0.119
Swaziland	17	0.120
Anguilla	18	0.120
Seychelles	19	0.121
Ethiopia	20	0.122
Papua New Guinea	21	0.122
Suriname	22	0.125
Comoros	23	0.130
Central African Rep.	24	0.132
Cambodia	25	0.133
Mali	26	0.134
Saudi Arabia	27	0.134
Maldives	28	0.139
Saint Kitts and Nevis	29	0.139
Guinea	30	0.143
Uganda	31	0.144
Cook Isds	32	0.145
Kuwait	33	0.146
Samoa	34	0.149
Jordan	35	0.150
Saint Lucia	36	0.150
Barbados	37	0.151
Fiji	38	0.151
Burundi	39	0.151
Mozambique	40	0.155
Bahrain	41	0.155
Madagascar	42	0.157
Belize	43	0.157
United Rep. of Tanzania	44	0.157
Wallis and Futuna Isds	45	0.160
Philippines	46	0.162
Cuba	47	0.163
Grenada	48	0.164
Trinidad and Tobago	49	0.165
Oman	50	0.166

Table 6. Least reliable exporting reporters in 2004

Exporter	Rank	Reliability index
Anguilla	1	0.000
Central African Rep.	2	0.000
Comoros	3	0.001
Guinea-Bissau	4	0.001
Saudi Arabia	5	0.001
Turks and Caicos Isds	6	0.002
United Arab Emirates	7	0.002
Lesotho	8	0.025
Cambodia	9	0.060
Gambia, The	10	0.061
Yemen	11	0.097
Uganda	12	0.113
Burundi	13	0.113
Ghana	14	0.114
Egypt	15	0.120
Rwanda	16	0.126
Swaziland	17	0.126
Kuwait	18	0.127
Iran	19	0.129
Syria	20	0.129
United Rep. of Tanzania	21	0.130
Gabon	22	0.134
Pakistan	23	0.135
Qatar	24	0.135
Samoa	25	0.136
India	26	0.137
Niger	27	0.137
Oman	28	0.138
Bangladesh	29	0.140
Mozambique	30	0.141
Guinea	31	0.148
Viet Nam	32	0.148
Jordan	33	0.159
Botswana	34	0.161
Togo	35	0.166
Madagascar	36	0.166
Papua New Guinea	37	0.167
Mali	38	0.168
Malta	39	0.172
Lebanon	40	0.174
Israel	41	0.174
Cameroon	42	0.175
Senegal	43	0.179
Kenya	44	0.180
Tunisia	45	0.182
Indonesia	46	0.186
Fiji	47	0.189
Mauritania	48	0.190
Bahamas	49	0.191
Zimbabwe	50	0.191

Table 7. Most reliable importers in 2004

Importer	Rank	Reliability index
Greenland	1	0.914
Andorra	2	0.665
Paraguay	3	0.476
Canada	4	0.472
Uruguay	5	0.460
Switzerland	6	0.439
USA	7	0.402
Argentina	8	0.391
Kyrgyzstan	9	0.388
Kazakhstan	10	0.379
Italy	11	0.369
Rep. of Moldova	12	0.348
Bolivia	13	0.342
Slovenia	14	0.339
Ecuador	15	0.333
Lithuania	16	0.328
Latvia	17	0.323
Chile	18	0.320
Hungary	19	0.316
Belarus	20	0.316
Sweden	21	0.312
Portugal	22	0.311
Austria	23	0.309
Czech Rep.	24	0.308
France	25	0.306
Ukraine	26	0.304
Macedonia	27	0.303
Finland	28	0.301
Poland	29	0.301
Bulgaria	30	0.301
Brazil	31	0.299
El Salvador	32	0.298
Belgium	33	0.296
Peru	34	0.294
Turkey	35	0.294
United Kingdom	36	0.289
Spain	37	0.288
Croatia	38	0.288
Denmark	39	0.286
Greece	40	0.285
Japan	41	0.284
Luxembourg	42	0.278
Armenia	43	0.276
Germany	44	0.272
Estonia	45	0.272
Rep. of Korea	46	0.270
Romania	47	0.269
Honduras	48	0.267
Mexico	49	0.263
Guatemala	50	0.263

Table 8. Most reliable exporters in 2004

Exporter	Rank	Reliability index
Greenland	1	0.752
Canada	2	0.635
Uruguay	3	0.595
Argentina	4	0.522
Belarus	5	0.512
Paraguay	6	0.511
El Salvador	7	0.506
Colombia	8	0.492
Ukraine	9	0.487
Russian Federation	10	0.454
Chile	11	0.448
Brazil	12	0.445
Kyrgyzstan	13	0.444
Faeroe Isds	14	0.444
Andorra	15	0.443
Kazakhstan	16	0.428
Peru	17	0.426
Rep. of Moldova	18	0.406
Bolivia	19	0.405
Grenada	20	0.398
Costa Rica	21	0.398
Nicaragua	22	0.394
Macao	23	0.380
Mexico	24	0.372
Macedonia	25	0.361
Guatemala	26	0.360
Azerbaijan	27	0.358
USA	28	0.350
Armenia	29	0.348
Cape Verde	30	0.346
Algeria	31	0.343
Germany	32	0.342
Bulgaria	33	0.336
Romania	34	0.332
Switzerland	35	0.332
Dominica	36	0.331
Namibia	37	0.330
Croatia	38	0.330
Serbia and Montenegro	39	0.327
Georgia	40	0.324
Ecuador	41	0.323
Saint Lucia	42	0.318
Jamaica	43	0.314
Slovenia	44	0.314
Slovakia	45	0.311
Japan	46	0.309
France	47	0.308
Seychelles	48	0.308
Venezuela	49	0.303
Cuba	50	0.298

Table 9. Importer reliability index by GTAP sector for selected countries

	Greenland	Cambodia	India	Switzerland	USA
Paddy rice	0.500	na	na	0.254	0.083
Wheat	0.000	0.000	na	0.360	1.000
Cereal grains n.e.c.	0.714	0.029	0.550	0.429	0.641
Vegetables, fruit, nuts	0.917	0.242	0.303	0.431	0.415
Oil seeds	1.000	0.500	0.426	0.469	0.622
Sugar cane, sugar beet	na	na	na	1.000	na
Plant-based fibers	1.000	0.000	0.436	0.342	0.064
Crops n.e.c.	0.938	0.189	0.235	0.351	0.451
Bovine cattle, sheep and goat	1.000	na	0.000	0.357	0.549
Animals products n.e.c.	0.875	0.000	0.160	0.498	0.530
Wool, silk-worm cocoons	na	na	0.037	0.612	0.678
Forestry	0.857	na	0.135	0.402	0.416
Fishing	0.909	0.115	0.327	0.264	0.434
Coal	1.000	na	0.000	0.212	0.489
Oil	1.000	na	na	0.500	0.804
Gas	na	0.000	0.000	1.000	0.396
Minerals	0.390	0.163	0.203	0.396	0.379
Bovine meat prods	0.952	0.000	0.000	0.508	0.597
Meat products n.e.c.	0.940	0.000	0.228	0.589	0.700
Vegetable oils and fats	0.917	0.443	0.254	0.399	0.655
Dairy products	0.904	0.149	0.136	0.741	0.726
Processed rice	1.000	0.000	na	0.629	0.877
Sugar	0.696	0.081	0.012	0.766	0.243
Food products n.e.c.	0.894	0.065	0.153	0.477	0.567
Beverages and tobacco	0.807	0.226	0.096	0.474	0.615
Textiles	0.946	0.039	0.125	0.422	0.353
Wearing apparel	0.976	0.106	0.115	0.252	0.250
Leather products	0.937	0.051	0.084	0.233	0.179
Wood products	0.823	0.042	0.168	0.556	0.451
Paper products, publishing	0.921	0.080	0.166	0.485	0.511
Petroleum, coal products	0.788	0.565	0.232	0.714	0.630
Chemical, rubber, plastic	0.912	0.189	0.211	0.490	0.500
Mineral products	0.775	0.234	0.157	0.519	0.399
Ferrous metals	0.886	0.000	0.137	0.565	0.518
Metals n.e.c.	0.935	0.180	0.193	0.594	0.493
Metal products	0.951	0.127	0.103	0.505	0.348
Motor vehicles and parts	0.855	0.071	0.168	0.455	0.623
Transport equipment	0.905	0.112	0.103	0.382	0.485
Electronic equipment	0.941	0.149	0.177	0.328	0.301
Machinery and equipment	0.935	0.138	0.162	0.460	0.378
Manufactures n.e.c.	0.924	0.159	0.156	0.317	0.257
Electricity	na	na	na	0.000	1.000

Table 10. Hong Kong's re-export markup rate by GTAP sector

	<i>Imports from China</i>		<i>Exports to China</i>	
	Initial rate	Adjusted rate	Initial rate	Adjusted rate
Paddy rice	0.0	0.0	0.0	0.0
Wheat	0.0	0.0	0.0	0.0
Cereal grains n.e.c.	61.5	68.5	10.0	0.0
Vegetables, fruit, nuts	24.4	23.7	1.6	0.6
Oil seeds	32.7	11.4	4.6	0.0
Sugar cane, sugar beet	0.0	0.0	0.0	0.0
Plant-based fibers	7.4	53.7	16.2	38.7
Crops n.e.c.	52.4	58.7	9.9	14.5
Bovine cattle, sheep and goat	0.0	0.0	0.0	0.0
Animals products n.e.c.	40.6	38.8	6.2	7.4
Wool, silk-worm cocoons	0.0	1.6	19.7	29.4
Forestry	38.1	39.0	5.0	12.5
Coal	0.0	0.0	0.0	0.0
Oil	0.0	0.0	0.0	0.0
Gas	0.0	0.0	0.0	0.0
Minerals	36.9	32.4	28.8	39.1
Bovine meat prods	0.7	10.6	3.0	35.2
Meat products n.e.c.	20.9	24.9	2.6	4.2
Vegetable oils and fats	32.0	42.6	2.3	2.4
Dairy products	31.4	77.1	30.4	44.5
Processed rice	15.7	32.7	11.6	13.9
Sugar	20.8	16.5	6.5	7.4
Food products n.e.c.	25.6	41.3	5.8	9.4
Beverages and tobacco	35.7	41.7	28.6	31.7
Textiles	30.8	29.1	8.4	7.2
Wearing apparel	39.3	37.3	7.5	64.7
Leather products	15.3	14.8	11.7	11.1
Wood products	31.0	32.6	5.0	8.2
Paper products, publishing	50.4	49.7	6.0	5.4
Petroleum, coal products	6.4	3.5	3.9	1.6
Chemical, rubber, plastic	34.8	34.3	7.9	7.9
Mineral products	32.9	34.3	9.1	9.5
Ferrous metals	36.7	55.6	5.1	15.1
Metals n.e.c.	17.8	11.8	4.2	2.5
Metal products	33.7	31.0	5.4	1.8
Motor vehicles and parts	49.6	41.9	5.2	0.9
Transport equipment	19.1	20.1	2.8	24.4
Electronic equipment	24.1	22.9	16.1	12.6
Machinery and equipment	34.3	21.7	8.7	5.2
Manufactures n.e.c.	40.8	39.7	10.1	10.0
Total	30.9	27.5	11.6	10.2

Table 11. China's reported exports, imports, and bilateral trade balances in 2004

	Reported by China	Reported by partner	Reconciled
China's exports		\$ billions	
EU25	107	168	146
Hong Kong	101	118	20
Japan	74	94	86
United States	125	211	178
ROW	187	248	205
World	593	838	635
China's imports			
EU25	70	60	71
Hong Kong	12	114	17
Japan	94	74	95
United States	45	35	45
ROW	340	188	311
World	561	471	539
China's trade balances with partners			
EU25	37	108	75
Hong Kong	89	4	3
Japan	-21	20	-9
United States	80	176	133
ROW	-154	59	-106
World	32	368	96

Table 12. Hong Kong's trade by GTAP sector

	Partner reported imports from Hong Kong	Hong Kong domestic exports	Partner reported exports to Hong Kong	Hong Kong retained imports
	\$ millions			
Paddy rice	0	0	1	2
Wheat	7	0	0	5
Cereal grains n.e.c.	1	0	13	18
Vegetables, fruit, nuts	15	5	658	1,144
Oil seeds	0	0	16	21
Sugar cane, sugar beet	0	0	0	1
Plant-based fibers	5	0	74	82
Crops n.e.c.	37	2	334	255
Bovine cattle, sheep, and goat	2	2	80	73
Animals products n.e.c.	10	22	1,533	1,118
Raw milk	0	0	0	5
Wool, silk-worm cocoons	0	0	3	3
Forestry	6	0	93	33
Fishing	67	8	743	636
Coal	7	0	266	455
Oil	0	0	4	0
Gas	0	0	187	52
Minerals	543	7	960	289
Bovine meat prods	3	2	315	286
Meat products n.e.c.	6	14	879	834
Vegetable oils and fats	19	2	293	283
Dairy products	5	11	214	254
Processed rice	0	0	137	196
Sugar	1	0	50	49
Food products n.e.c.	305	241	2,670	2,120
Beverages and tobacco	87	301	1,140	775
Textiles	7,063	5,532	17,805	6,054
Wearing apparel	6,715	9,624	8,826	3,480
Leather products	1,254	144	6,143	553
Wood products	344	64	2,212	627
Paper products, publishing	1,567	1,564	3,662	1,547
Petroleum, coal products	154	0	6,126	2,409
Chemical, rubber, plastic	3,583	3,294	22,169	9,887
Mineral products	296	47	2,337	1,257
Ferrous metals	504	615	3,905	2,536
Metals n.e.c.	3,312	4,431	9,544	1,159
Metal products	899	235	3,185	551
Motor vehicles and parts	127	8	3,378	2,220
Transport equipment	700	6	4,533	1,613
Electronic equipment	18,518	4,636	103,626	22,780
Machinery and equipment	9,657	2,597	45,589	11,599
Manufactures n.e.c.	5,629	1,449	15,103	5,366
Total	61,449	34,865	268,807	82,627