

Reconciling Trade Statistics from China, Hong Kong and Their Major Trading Partners -- A Mathematical Programming Approach¹

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ABSTRACT

This paper develops a mathematical programming model to simultaneously estimate re-export markups and reconcile bilateral trade statistics between China, Hong Kong, and their trading partners. The model is applied to sector level trade flows to resolve discrepant reporting in an efficient manner. Adjustments in trade flows are based upon statistical reporters' reliability information. The program is implemented in GAMS and retains many desirable theoretical and empirical properties. Estimates are used for generating trade flows and markups for Hong Kong's re-exports used in the forthcoming version 7 GTAP database. The model's flexibility has potential for expanded use in other regions where re-exports and associated markup cause discrepant trade flows.

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I. Introduction

It has long been known that bilateral trade statistics reported by importing and exporting countries are unlikely to be the same, and in fact they often vary greatly for a variety of reasons. Economists and statistical agencies around the globe working on reconciling bilateral trade have adopted methods for choosing either the importer's or exporter's data, or some weighted average of the two, as more reliable (e.g. Gehlhar, 1996, for the GTAP model, and the documentation for Statistics Canada's World Trade Analyzer). However, the standard methods for data reconciliation have generally not worked well for China and its major trading partners because of the intermediary role of Hong Kong in China's external trade.

A large share of China's trade with the world passes through Hong Kong. Yet current reporting practices in China and her trading partners do not fully reflect this fact. This is in part because traders often do not know the final destination when their goods leave China. In these cases, they are recorded as exports to Hong Kong by the Chinese Customs authorities. For this reason, Chinese Customs statistics show that Hong Kong is one of China's largest export destinations, behind the Unites States but on a par with the EU 15 countries in recent years. In fact, Hong Kong re-exports most of its imports from China to other countries. On the other hand, US 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. As a result, discrepancies in the official data on the bilateral trade between the US and China invariably arise, and its increasingly large magnitude has not only caused concerns among policy makers in the two countries, but it has also motivated quite a few studies aimed at reconciling the conflicting official trade statistics between China and her major trading partners.

Key components of any effort at trade data reconciliation in the case of China and Hong Kong include both estimation of Hong Kong re-export markups, which are key information but not part of the Hong Kong official trade statistics, as well as the cif/fob ratios which are a part of any attempt to reconcile discrepancies in official trade statistics reported by exporting and importing countries. On the re-export markup estimation, there are two threads in the literature. One is based on detailed trade data, including studies by the Joint Commission on Commerce and Trade (JCCT) (1995), using solely Hong Kong trade data, and by Feenstra et al (1998, 1999), using both China and Hong Kong trade data; and the other is based on surveys conducted by the Hong Kong Census and Statistical Department (HKCSD) and published in various issues of the *Hong Kong Monthly Digest of Statistics*, and interviews reported in Fung (1996) and Fung and Lau (1998). Among these estimates, Feenstra et al (1998, 1999) are able to produce origin- and destination-specific markups to reconcile various aggregate estimates reported in JCCT (1995), HKCSD, Fung (1996) and Fung and Lau (1998). Subsequent studies on the reconciliation of Chinese trade flows with the US, Canada and 69 trading partners follow either the survey and interview approach (Fung and Lau, 2001, 2003; Fung, Lau and Xiong, 2006; Schindler and Beckett, 2005), or combine it with the JCCT approach (Bohatyretz and Santarossa, 2005).

On the estimation of cif/fob ratios, almost all of the above-mentioned studies use an $ad\ hoc$, one size-fits-all estimate, though differing in value across studies. Fung, Lau and Xiong (2006) even undertake to convert the fas to fob value for US exports, and seek to include the services trade in their China-US trade data reconciliation.

These studies aim to use a large amount of trade statistics to estimate the Hong Kong reexport markups, and include a wide range of factors contributing to the discrepancies and
to identify behaviors of traders that may lead to mis-invoicing of China and Hong Kong's
trade statistics. They constitute valuable contributions to improving our understanding of
the complicated issues underpinning trade data discrepancies. In these studies, however,
estimation of Hong Kong's re-export markups and adjustment of Chinese bilateral trade are
undertaken independently, and do not take account of data adjustment with other countries.
Therefore, global consistency is not ensured. In addition, these earlier studies never fully
utilize all official trade statistics from China, Hong Kong and their trading partners
simultaneously. Doing so requires a new approach to trade data reconciliation, which is the
very motivation of this paper.

The paper has two specific goals. First, it develops and implements a formal model to simultaneously estimate Hong Kong re-export markups and to reconcile the Chinese and Hong Kong trade statistics in a globally consistent optimization framework. Second, it applies the model to 2004 bilateral world trade data to produce a set of trade estimates for the next version of the Global Trade Analysis Project (GTAP) database (version 7). To enhance its empirical quality, this paper also draws on more detailed information on trade related shipping costs to estimate cif/fob ratios as well as the most up-to-date research on the estimation of Hong Kong re-export markups.

The paper is organized as follows. Section two specifies the optimization framework and discusses its theoretical and empirical properties. Section three outlines the major steps to implement the model with real world trade statistics, including the preparation of initial cif/fob ratios and Hong Kong's re-export markup estimates, aggregation issues and the estimation of reliability weights for major variables in the model. Modeling results are presented and compared with the initial estimates in section four. The paper concludes with a discussion on limitations of the study and directions of future research.

II. The Mathematical Programming Model

2.1 Reconciling international trade statistics via optimization

Reconciling international trade statistics in an optimization framework is an application of the constrained matrix balancing procedure² (Bacharach, 1970). It involves obtaining the best estimates of conflicting data from more than one source.

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²The constrained matrix balancing procedure appears as a core mathematical structure in diverse applications. These applications include the estimation of input-output tables (Bachem and Korte, 1981; Harrigan and Buchanan, 1984; Miller and Blair, 1985; Kaneko, 1988; Nagurney, 1989; Antonello, 1990) and interregional trade flows in regional science (Batten, 1982; Byron et al., 1993), balancing of social/national accounts in economics (Byron, 1978; Van der Ploeg, 1982, 1984,1988; Zenios, Drud, and Mulvey, 1989;

Procedures for matrix balancing can be classified into two broad classes -- bi-proportional scaling and mathematical programming. The scaling methods involve adjusting the initial matrix by multiplying its row and column by positive constants until the matrix is balanced. It was developed by Stone and other members of the Cambridge Growth Project (Stone et al., 1963) and is usually known as RAS. The basic method was originally applied to known row and column totals but has been extended to cases where the totals themselves are not known with certainty (Senesen and Bates, 1988; Lahr, 2001). 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.

An important advantage of mathematical programming models over scaling methods is flexibility. They allow a wide range of initial information to be used efficiently in the data adjustment process. Additional constraints can be easily imposed, such as allowing precise upper and lower bounds to be placed on unknown elements. Inequality conditions or incorporation of a penalty term in the objective function are used to minimize deviations from the initial row or column total estimates when they are not known with certainty. This flexibility results in improved information content of the balanced estimates as shown by Robinson, Cattaneo and El-said (2001).

The mathematical programming approach also permits one to routinely introduce relative degrees of reliability for initial estimates. The idea of including data reliability metrics in matrix balancing can be traced back over a half century to Richard Stone and his colleagues (1942) when they explored procedures for compiling national income accounts. Their ideas were formalized into a mathematical procedure to balance the system of accounts after assigning reliability weights to each entry in the system. The minimization of the sum of squares of the adjustments between initial and balanced entries in the system, weighted by the reliabilities or the reciprocal of the variances of the entries is carried out subject to linear (accounting) constraints. This approach was first implemented by Byron (1978) and applied to the System of National Accounts of the UK by Ploeg (1982, 1984). Zenios and his collaborators (1989) further extended this approach to balance a large social accounting matrix in a nonlinear network-programming framework. Robinson and his colleagues (2001) provided a way to handle measurement error in cross entropy minimization via an error-in-variables formulation. Although computational burden is no longer a problem today, the estimation of error variances in large data set in such approaches remains problematic.

Nagurney, Kim, and Robinson, 1990), estimating interregional migration in demography (Plane, 1982), the analysis of voting patterns in political science (Johnson, Hay, and Taylor, 1982), the treatment of census data and estimation of contingency tables in statistics (Friedlander, 1961), the estimation of transition probabilities in stochastic modeling (Theil and Rey, 1966), and the projection of traffic within telecommunication and transportation networks (Florian, 1986; Klincewicz, 1989). A survey of this literature can be found in Schneider and Zenios (1990).

There is a large and growing literature on the use of matrix balancing procedures to estimate input/output tables or Social Accounting Matrices (SAMs), but only a few studies have used them to adjust/estimate bilateral trade statistics³. There are some important differences in the conditions for adjusting an unbalanced SAM and reconciling bilateral trade data. First, SAMs are square matrices and their rows and columns represent the same accounts, so that all their row sums equal the corresponding column sums. In contrast, bilateral trade matrices are usually rectangular, and their row and column sum represent different types of accounts (for example, reporter and partner sums or export and import totals); therefore the row and column sums are not generally equal. Second, SAMs usually have common structure in terms of their zero and nonzero elements. However, this structure may differ significantly from region to region in the trade matrix, depending on the dominant trade pattern in the region under concern.

The final area in which SAMs and bilateral trade matrices differ is with regard to the issue of multiple, conflicting data sources. In SAMs, estimates of the same entries can often be obtained from income, expenditure or production data, and typically data gathered from one source is not consistent with that obtained from a different source. The common practice in removing the account inconsistencies is by assigning relative degrees of reliability to entries in the SAM and using constrained matrix balancing procedures with available information to adjust the data to ensure consistency in the accounts. On the other hand, international trade statistics are often obtained from two sources: reporting countries and their partner's official trade flow statistics. In most cases, even with apparently "good" data from both sides, the discrepancies can be significant. This is because the exporter and importer may have very different reporting criteria and systems for valuation of bilateral trade. For example, the initial destination of a shipment may not be sole and may be different with the actual destination of its components; and the importer may not be able to assign a unique origin. Because international trade statistics are inherently inconsistent, a systematic procedure is needed to ensure the balance between imports and exports of multiple partners.

The TESSY (trade estimation system) used by UNSTAT is the first mathematical procedure to find estimates of trade data by commodity and partner for non-reporting countries. It can calculate estimates for all the missing values in a bilateral trade matrix, including missing commodity totals, partner totals. By scaling and re-scaling estimates other than the "true reported" figures, a balanced trade matrix can be achieved. Baras and Panoutsopoulos (1993) developed a progressive elimination and quadratic programming procedure to estimate missing value in bilateral trade flows. They tested their procedure by using several selected countries. Unfortunately, they devoted most of their efforts to filling in the missing values in the trade matrix, and did not focus on the reliability of different reporters. In addition, this approach has little to offer for dealing with the increasingly important phenomena of entrepot

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³ Waelbroeck(1964) applied the RAS procedure on trade flows for the world with the flows grouped into nine regions. Using 1938 trade flows as base, he estimated 1948, 1951-52, and 1959-60 trade flows. Mohr, Crown and Polenske (1987) discussed the problems encountered when the RAS procedure is used to adjust trade flow data. They pointed out that the special properties of interregional trade data increase the likelihood of non-convergence of the RAS procedure and proposed a linear programming approach that incorporates exogenous information to override the infeasibility of RAS problem.

trade and transshipments. To the best of our knowledge, our paper's formulation of international trade statistics reconciliation problem into an optimization framework in the context of China's trade with other nations, via Hong Kong, is the first attempt of this kind in both the international trade and the constrained matrix balancing literature. We turn now to a formal exposition of our approach.

2.2 General Assumptions and Mathematical Notation

China and Hong Kong both engage in bilateral trade with N partner countries and each other on M commodities for time period T. Hong Kong is assumed to be the only *entrepot* between China and the N partner countries engaging re-export activities to transship both China's and its N partner countries' exports to each others. Hong Kong earns a markup by conducting such *entrepot* activities. This markup is the difference between the price at which Hong Kong buys goods and the price at which it sells the same goods. Let us assume that all partner countries except one report their exports to and imports from China and Hong Kong. China and Hong Kong also report their exports to, and imports from, all their partner countries and trade flows between them. In addition, Hong Kong reports the origin and destination of all commodities it re-exports bound for, and coming from, China and other partner countries. The markup from such activities is unreported; it must be estimated. We assume that all reporting countries, including China, can correctly identify the country of origin of their imports, either the imports are directly from the partners or indirectly via Hong Kong. Reporting countries however can not determine the final destination when exports leave their ports (Schindler and Beckett, 2005).

The notation used to describe the reported trade statistics and their relationships are as follows (expressed in annual flows, in dollar values):

 DX_{it}^{sr} = Direct exports of commodity i from country s to country r at time t. When the source country, s, denotes Hong Kong, this flow comprises domestic exports, inclusive of earnings from re-exportation of that commodity. When the destination country, r denotes Hong Kong, it is the partner countries' exports that remain in Hong Kong

 RX_{ii}^{sr} = Indirect exports of commodity i via Hong Kong from origin country s to destination country r at time t, inclusive of Hong Kong's re-export earnings

 TX_{ii}^{sr} = Total exports of commodity i from country s to country r at time t. For s equals Hong Kong, this corresponds to domestic exports plus re-exports

 DM_{ii}^{sr} = Direct imports of commodity i by country r from country s at time t. When r corresponds to Hong Kong, it is imports for domestic use, for s equals Hong Kong it is partner's imports originated from Hong Kong

 TM_{it}^{sr} = Total imports of commodity i by country s from country r at time t

 RXM_{it}^{sr} = Hong Kong markup earnings by re-export commodity i originated from country s to final destination country r at time t

WEX	$\frac{s}{it}$ = Total reported exports of commodity i to the world by country s at time t
WMX	$\frac{r}{it}$ = Total reported imports of commodity i from the world by country r at
t	time
XER	$_{it}^{r}$ = Statistical discrepancy of commodity i in China and Hong Kong's east bound trade with partner country r at time t
MER	$_{it}^{r}$ = Statistical discrepancy of commodity i

$$TX_{it}^{CH,r} = DX_{it}^{CH,r} + \frac{(RX_{it}^{CH,r} - RXM_{it}^{CH,r})}{cif_{it}^{CH,HK}}$$
(2)

Equation (2) defines that China's total exports to a particular partner equal China's direct exports plus Hong Kong's re-exports for China to that partner minus Hong Kong's re-export makeup adjusted by China-Hong Kong cif/fob ratio.

$$DX_{it}^{HK,r} = TX_{it}^{HK,r} - \sum_{s} (RX_{it}^{sr} - RXM_{it}^{sr})$$
(3)

In equation (3) Hong Kong's domestic exports to a particular partner equals to its total exports to that partner minus its re-exports for all other countries to the particular partner and plus its markup earnings from re-exports.

$$TM_{it}^{HK,r} = DM_{it}^{HK,r} + cif_{it}^{HK,r} \sum_{s} (RX_{it}^{sr} - RXM_{it}^{sr})$$
(4)

Equation (4) indicates partner's total imports from Hong Kong equals partners' imports of Hong Kong domestic products plus Hong Kong's re-exports to the partner from all sources adjusted by Hong Kong re-export markup and the *cif/fob* ratio from Hong Kong to the partner.

$$DM_{it}^{CH,r} = TM_{it}^{CH,r} - cif_{it}^{HK,r} (RX_{it}^{CH,r} - RXM_{it}^{CH,r})$$
(5)

Equation (5) indicates that a partner's direct imports from China equal its total imports from China minus Hong Kong's re-exports for China to that partner adjusted by Hong Kong's re-exports markup and Hong Kong to partner *cif/fob* ratios.

2.4 Westbound flows: China and Hong Kong imports, partner exports

For all $s \in \{1, 2, ..., N\}$ and all $r \in \{1, 2, ..., N, CH\}$:

$$DM_{it}^{s,CH} + TM_{it}^{s,HK} - MER_{it}^{s} = cif_{it}^{s,CH}DX_{it}^{s,CH} + cif_{it}^{s,HK}TX_{it}^{s,HK}$$
(6)

Equation (6) states that the sum of China's direct and Hong Kong's total imports of products originated from any particular partner should equal to the sum of that partner's direct exports to China and its total exports to Hong Kong adjusted by *cif/fob* margin, plus a statistical discrepancy. Similar to equation (1), left hand of this equation is actual imports by China and Hong Kong while right hand is the exports statistics published by partner countries.

$$DM_{it}^{s,HK} = TM_{it}^{s,HK} - \sum_{r} (RX_{it}^{sr} - RXM_{it}^{sr})$$
 (7)

Equation (7) requires Hong Kong's domestic use of imports plus its re-exports for a particular partner minus re-exports markup equals Hong Kong's total imports from that partner country.

$$DM_{it}^{s,CH} = TM_{it}^{s,CH} - cif_{it}^{HK,CH} (RX_{it}^{s,CH} - RXM_{it}^{s,CH})$$
(8)

Equation (8) states that China's direct imports from a partner equals China's total imports from that partner minus Hong Kong's re-exports to China for that partner adjusted by Hong Kong's re-export earnings, as well as Hong Kong to China *cif/fob* ratios.

$$TX_{it}^{s,CH} = DX_{it}^{s,CH} + \frac{(RX_{it}^{s,CH} - RXM_{it}^{s,CH})}{cif_{it}^{s,HK}}$$
(9)

Equation (9) reveals that partner's total exports to China equals partner's direct exports to China plus Hong Kong's re-exports to China for that partner, adjusted by Hong Kong's re-export markup and the *cif/fob* ratio from the partner to Hong Kong.

$$DX_{it}^{s,HK} = TX_{it}^{s,HK} - \frac{\sum_{r} (RX_{it}^{sr} - RXM_{it}^{sr})}{cif_{it}^{s,HK}}$$
(10)

From equation (10) we see that a partner's exports to Hong Kong, destined for Hong Kong domestic use, must equal its total export to Hong Kong minus its re-exports via Hong Kong to all destinations, adjusted by Hong Kong's re-export markup and the partner to Hong Kong's cifffob ratio.

2.5 China-Hong Kong bilateral trade

Equation (11) states that China's actual exports to Hong Kong for Hong Kong domestic use must equal its direct exports to Hong Kong minus Hong Kong's re-exports for China to all other trading partners adjusted by the Hong Kong re-export markup and the China to Hong Kong *cif/fob* ratio.

$$TX_{it}^{CH,HK} = DX_{it}^{CH,HK} - \frac{\sum_{r} (RX_{it}^{CH,r} - RXM_{it}^{CH,r})}{cif_{it}^{CH,HK}}$$
(11)

$$DM_{it}^{CH,HK} = TM_{it}^{CH,HK} - \sum_{r} (RX_{it}^{CH,r} - RXM_{it}^{CH,r})$$
 (12)

Equation (12) defines Hong Kong's imports from China for domestic use as equaling its total imports from China minus its re-exports for China to all destinations adjusted by its markup earnings.

$$DX_{it}^{HK,CH} = TX_{it}^{HK,CH} - \sum_{r} (RX_{it}^{s,CH} - RXM_{it}^{s,CH})$$
 (13)

$$TM_{it}^{HK,CH} = DM_{it}^{HK,CH} + cif_{it}^{HK,CH} \sum_{r} (RX_{it}^{s,CH} - RXM_{it}^{s,CH})$$
(14)

Equation (13) indicates that Hong Kong's domestic export to China equals its total exports to China minus its re-exports to China from all other partners adjusted by its markup earnings. Equation (14) states that China's total imports from Hong Kong equal its imports of goods with Hong Kong origin plus Hong Kong's re-exports to China from all sources adjusted by re-exports markup and the Hong Kong to China *cif/fob* ratio.

2.6 Global balance and objective function

For all $r \in \{1, 2, ..., N, CH, HK\}$:

$$\sum_{r} DX_{it}^{CH,r} + \sum_{s} \sum_{r} (RX_{it}^{sr} - RXM_{it}^{sr}) + \sum_{r} DX_{it}^{HK,r} = WEX_{it}^{HK} + WEX_{it}^{CH}$$
 (15)

$$\sum_{s} TM_{it}^{s,CH} + \sum_{s} \sum_{r} (RX_{it}^{sr} - RXM_{it}^{sr}) + \sum_{s} DM_{it}^{s,HK} = WMX_{it}^{HK} + WMX_{it}^{CH}$$
(16)

Equation (15) describes that the sum of after-adjustment actual exports from China and Hong Kong to all its partners should still equal the sum of their reported total exports to the world. This means that the adjustments made by the model do not change the total exports to the world reported by China and Hong Kong, it merely estimates Hong Kong's re-export markup and rearranges the destinations of China's exports to account for these re-exports. Equation (16) states that China and Hong Kong imports and Hong Kong's re-exports minus the re-export markups after adjustment should still equal the sum of China and Hong Kong's total imports from the world. The adjustments made by the model only change the markup estimates and rearrange the sources of China and Hong Kong's imports, not the total.

In addition, China and Hong Kong's total exports to, and imports from, the world should satisfy following conditions: total world exports by all trading countries equal total world imports after cif/fob adjustment:

$$\sum_{s} cif_{it}^{r} WEX_{it}^{s} = \sum_{r} WMX_{it}^{r}$$
(17)

Given these accounting relationships among trade flow statistics, what remains is to formulate the reconciliation problem within an optimization framework, for which we must develop a criterion for changing the reported statistics so that they conform with the linear accounting constraints. Either a cross-entropy (Harrigan & Buchanan, 1984, Golan et al.,

1994) or a quadratic objective penalty function can be specified. We choose to use a quadratic function as follows for computational efficiency reasons⁵:

$$Min \qquad S = \frac{1}{2} \left\{ \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(DX_{it}^{sr} - DX O_{it}^{sr} \right)^{2}}{w dx_{it}^{sr}} + \sum_{i \in m} \sum_{s \in W} \sum_{r \in W} \frac{\left(DM_{it}^{sr} - DM O_{it}^{sr} \right)^{2}}{w dm_{it}^{sr}} + \sum_{i \in m} \sum_{s \in W} \sum_{r \in W} \frac{\left(TX_{it}^{sr} - TX O_{it}^{sr} \right)^{2}}{w tx_{it}^{sr}} + \sum_{i \in m} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in m} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum_{r \in W} \frac{\left(TM_{it}^{sr} - TM O_{it}^{sr} \right)^{2}}{w tm_{it}^{sr}} + \sum_{i \in M} \sum_{s \in W} \sum$$

Where variables with a 0 at the end denote initial estimates and an additional "w" before the variable in lower case indicates the reliability measure for that variable.

In short, the reconciliation problem is to modify a given set of bilateral trade flow statistics with equation (18) as the objective function and equations (1) - (16) as constraints.

2.7 Properties of the reconciliation model

There are several desirable analytical properties of the optimization model specified above. Firstly, the 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 Kong's exports and imports, estimates Hong Kong's re-export markup, allocates statistical discrepancies to trade flows among China, Hong Kong and their trading partners, and adjusts bilateral trade balances for China and all its partners simultaneously. In so doing it imposes global consistency on the adjusted trade flow data, which is a necessary condition for any world trade data set destined for analytical purposes (such at GTAP).

Secondly, the model is formulated as a nonlinear programming problem subject only to linear constraints. Therefore, depending on the reliability weights chosen, the model solutions can represent a broad range of linear statistical estimators. For instance, if the weights are all equal to one, the solution of the model gives a constrained least squares estimator. If initial estimates are taken as the weights, the solution of the model gives a weighted constrained least square estimator, which is identical to the Friedlander-solution, and a good approximation of the RAS solution. If the weights are proportional to the variances of the initial estimates, and the initial estimates are statistically independent, the solution of the model yields best linear unbiased estimates of the true unknown matrix (Byron, 1978), which is identical to the Generalized Least Squares estimator if the weights are equal to the variance of initial estimates (Stone, 1984, Ploeg, 1984). Furthermore, as

⁵ The quadratic function has a numerical advantage in implementing the model. It is easier to solve than the entropy function in very large models because they can use software specifically designed for quadratic programming. As showed by Canning and Wang (2005), the quadratic function is equivalent to the entropy

noted by Stone et al. (1942) and proven by Weale (1985), in cases where the error distributions of the initial estimates are normal, the solution also satisfies the maximum likelihood criteria.

Thirdly, by understanding the model's solution as estimators of an underlying statistical model, and assuming the initial estimates are unbiased estimates of the true unknown values, in all but the trivial case, the adjusted estimates from the model solution will always better approximate the unknown true values than do the associated initial estimates (Harrigan, 1990). This is because adding valid constraints or further restricting the feasible set through the narrowing of interval constraints cannot move the adjusted estimates away from the true values unless the additional constraints are non-binding (i.e., they have no information value). The optimization process has the effect of reducing, or at least not increasing, the variance of the initial estimates. This desirable property is simple to show by using matrix notation. Define ${\bf W}$ as the variance matrix of initial estimates $\overline{{\bf D}}$, ${\bf R}$ as the coefficient matrix of all linear constraints. The least squares solution (equivalent to the solution of the quadratic programming model described above) to the problem of adjusting $\overline{{\bf D}}$ to ${\bf D}$ that satisfies the linear constraint. ${\bf R} \cdot {\bf D} = {\bf 0}$ can be written as:

$$\mathbf{D} = (\mathbf{I} - \mathbf{W} \mathbf{R}^{\mathsf{T}} (\mathbf{R} \mathbf{W} \mathbf{R}^{\mathsf{T}})^{-1} \mathbf{R}) \ \overline{\mathbf{D}}$$
 (19)

Thus,

$$Var(\mathbf{D}) = (\mathbf{I} - \mathbf{W}\mathbf{R}^{\mathsf{T}}(\mathbf{A}\mathbf{W}\mathbf{A}^{\mathsf{T}})^{-1}\mathbf{R})\mathbf{W} = \mathbf{W} - \mathbf{W}\mathbf{R}^{\mathsf{T}}(\mathbf{R}\mathbf{W}\mathbf{R}^{\mathsf{T}})^{-1}\mathbf{R})\mathbf{W}$$
(20)

Since $WR^T(RWR^T)^{-1}R)W$ is a positive semi-definite matrix, the variance of adjusted estimates will always be less, or at least not greater than the variance of the initial estimates as long as $R \cdot D = 0$ holds⁶. This is the fundamental reason why such a reconciliation framework will provide improved trade statistics. In summary, imposing equations (1) to (16) will definitely improve, or at least not worsen, the initial statistics, since we are sure from international economics that those constraints must be true for any well defined trade statistics.

Finally, we turn to the choice of weights ($wdx_{ii}^{sr}wtx_{ii}^{sr}wdm_{ii}^{sr}wtm_{ii}^{sr}wrm_{ii}^{sr}$) in the objective function. They have a very important impact on the model solution. The model uses these weights to determine by how much an initial estimate may be changed. For instance, using the initial trade statistics as weights has the advantage that each entry of the trade flow data is adjusted in proportion to its magnitude, in order to satisfy those consistency constraints. The variables can not change signs and the larger the trade flows, the more adjustment takes place. However, while these features are intuitively appealing, the drawback is that the adjustment relates directly to the size of the initial trade statistics, and does not force the unreliable trade data to absorb the bulk of the required adjustment. Indeed, it is only under very special assumptions that this commonly used weighting scheme (and the one underlying RAS) will yield best unbiased estimates. Specifically this requires the following two assumptions: (1) the initial estimates for different trade flows are statistically independent, and

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⁶ Details of the derivation of equation (19) and (20) can be found in classic textbook of econometrics, such as of *Econometric Methods*, *second edition* by Johnston, pp 157-158.

(2) each error variance is proportional to the corresponding initial estimates. In practice these do not hold for trade data. Therefore, the efficiency of the model will be improved if the error structure of the initial trade statistics is available. So, in a more sophisticated weighting scheme, the larger the variance, the smaller its contribution to the objective function, and hence the lesser the penalty for each adjusted trade statistics to move away from their initial value (only the relative, not the absolute size of the variance affects the solution). A small variance of the initial trade statistics indicates, other things equal, that it is more reliably reported data and thus should not be required to change by as much. In contrast, a large variance of the initiate estimates indicates unreliably reported data that may be adjusted considerably. In sum, we would like to adjust the trade data on an unreliably reported route more than the reliably reported one.

Advantages of such an optimization framework in adjusting international trade statistics are also significant from an empirical perspective. Firstly, it offers valuable additional detail, specifically: Hong Kong's re-export markup rate on each country's re-exports via Hong Kong as percent of the country's total exports and imports is estimated, along with the adjusted bilateral balance of trade among China, Hong Kong and their partner countries by each covered commodity.

Secondly, it provides considerable flexibility. It permits a wider variety and volume of information to be brought into the reconciliation process. For example, the ability to introduce upper and/or lower bounds is one of the flexibilities not offered by commonly used scaling procedures such as RAS. Therefore, it is very easy to restrict the value of the adjusted trade statistics to be nonnegative. This is a very desirable property in adjusting bilateral trade flow data. It is also very flexible regarding to the required known information. For example, it allows the possibility that some of the bilateral trade statistics are missing and the total exports and imports by China and Hong Kong to the world are not known with certainty. In the real world, missing bilateral trade is common and a country's total exports or imports generally lie within some range. By incorporating terms similar to bilateral trade variables in the objective function to penalize solution deviations of the world totals from statistical sources, the optimization approach allows reconciliation of these world totals with bilateral trade flows.

A final advantage of the optimization approach is that alternative measures of the reliability of the initial data can be easily included in the reconciliation process. As noted before, these weights should reflect the relative reliability of the original trade statistics. The interpretation is straightforward. Statistics with higher reliability should be changed less than statistics with a lower reliability, thus the best available information can always be used to insure that statistics reported by reliable trade routes or reporters are not perturbed by the reconciliation process as much as statistics reported by unreliable trade routes or reporters.

III. Linking the Model with Trade Statistics

There are several key steps in implementing this optimization model with actual trade statistics. First, all variables in the model need to be correctly linked with officially

reported statistics; second, Hong Kong's markup earnings from its re-exports and all bilateral *cif/fob* margins have to be computed independently or estimated based on information from other sources, so that the optimization model can be properly specified; third, an appropriate commodity and country aggregation needs to be determined based on data availability and computation capacities; and finally, a full set of reliability weights in the objective function need to be selected in order to obtain a meaningful solution from the model. We will discuss those issues one by one in five steps below.

3.1 Obtaining initial estimates for all bilateral trade variables in the model from observed or derived trade statistics

In east bound trade, initial estimates can be directly obtained from existing bilateral trade statistics for four sets of variables in the model. They are: China's direct exports to partner countries ($DX \, 0_{ii}^{CH,r}$), Hong Kong's total exports to partner countries ($TX \, 0_{ii}^{HK,r}$), and partner's total imports from China ($TM \, 0_{ii}^{CH,r}$) and imports of product originated from Hong Kong ($DM \, 0_{ii}^{HK,r}$). Similarly, there are also four sets of variables for which initial estimates may be obtained directly from existing data in westbound trade. They are: partner countries total exports to Hong Kong and direct exports to China ($TX \, 0_{ii}^{s,HK}$ and $DX \, 0_{ii}^{s,CH}$), and China and Hong Kong's total imports from partner countries ($TM \, 0_{ii}^{s,CH}$ and $TM \, 0_{ii}^{s,HK}$). All China and Hong Kong reported trade statistics are obtained from Chinese Customs authorities and the Hong Kong Census and Statistical Department at the HS 8-digit level of detail. All partner countries' reported data are downloaded from UN COMTRADE at the HS 6-digit level.

We obtain initial estimates of Hong Kong's re-exports by origin and destination ($RX0_{it}^{sr}$) from Hong Kong re-exports statistics provided by the Hong Kong Census and Statistical Department at the HS 8-digit level. However, there are still nine sets of variables for which we need initial estimates before the model can be implemented. There are four sets each for eastbound and westbound trade respectively, plus the Hong Kong re-export markup ($RXM0_{it}^{sr}$). However, if we can obtain initial estimates for $RXM0_{it}^{sr}$ and if we also know the cif/fob margin for all bilateral routes, then the rest of the eight sets of variables all can be derived from existing trade statistics based on the accounting identities specified in the optimization model.

The four sets unobservable variables in eastbound trade are China's total exports to partner countries ($TX \, 0_{it}^{Ch,r}$), Hong Kong's domestic exports to partner countries ($DX \, 0_{it}^{HK,r}$), 7 partner countries' direct imports from China ($DM \, 0_{it}^{CH,r}$), and partner countries' total imports from Hong Kong ($TM \, 0_{it}^{HK,r}$). Their initial estimates can be derived from observed

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⁷ Although Hong Kong Census and Statistics Department also publishes Hong Kong's domestic exports to all its partner countries, but the definition is different with what we defined in this paper. We include Hong Kong's re-exports markup into Hong Kong's domestic exports.

data according to equations (2), (3), (4) and (5) respectively (they are left hand variables in these equations). The four sets of unobservable variables in westbound trade are Hong Kong's imports from partner countries for domestic use ($DM \, 0_{it}^{s,HK}$), China's direct imports from partner countries ($DM \, 0_{it}^{s,CH}$), and partner countries' total exports to China and their exports for Hong Kong's domestic market ($TX \, 0_{it}^{s,CH}$ and $DX \, 0_{it}^{s,HK}$). Their initial estimates can be computed from observed data according to equations (7), (8), (9) and (10) respectively (they are left hand variables in these equations).

The initial estimates for bilateral trade variables between Hong Kong and China can be obtained from existing trade statistics reported by China and Hong Kong or calculated from observed trade data in the same fashion as unobserved variables in east and west bound trade according to equations (11) to (14). The observed statistics are $DX \, 0_{ii}^{CH,HK}$, $TX \, 0_{ii}^{HK,CH}$, $TM \, 0_{ii}^{CH,HK}$, and $DM \, 0_{ii}^{HK,CH}$. The only difference is that $TX \, 0_{ii}^{CH,HK}$ is China's actual exports to Hong Kong, equals its direct exports to Hong Kong minus all its re-export to other countries via Hong Kong.

In summary, 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 unobservable variables can be obtained from the four sets of equations in each trade direction. Therefore, as long as we can obtain estimates for Hong Kong's re-exports markup ($RXM\ 0_{it}^{sr}$) and cif/fob margins (cif_{it}^{sr}), all variables in the optimization model specified in this paper are fully initialized.

3.2 Calculate initial Hong Kong re-export markup rates

The initial estimation of Hong Kong re-export markup rates follows the spirit of Feenstra et al (1998, 1999), the SAS programming procedures of which are documented in Chapter 2 of Yao (2000). While Feenstra et al (1998, 1999) only report overall markup rates for China trade with the US and a few other selected countries, Yao (2000) is able to produce markup rates at 6-digit HS commodity and individual country levels. Yao (2000) also provides the markup rates tailored for trade data reconciliation in the GTAP version 5 database. This paper uses the same methodology and updated SAS procedures 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 key features of Feenstra et al (1998, 1999) include:

- They use very detailed China and Hong Kong trade data at both the commodity level (SITC for early years and 6-digit HS for 1994 and onward) and country level. As a result, the markup rate estimates are also at the same detailed levels. The overall markup rate is just weighted average of those disaggregate markup rates.
- 2. The Hong Kong import data does not have information on the final destination countries but with China trade data, which identifies the final destination countries and origin countries that go through Hong Kong, they are able to produce better

- markup rate estimates for China-originated goods; for China-bound goods, the markup rate estimates do not show any regular patterns.
- 3. The markup rate estimates are sensitive to outliers. By assuming that Hong Kong cannot re-export significantly more than it imports in the same year, records with re-export quantity more than double import quantity are treated as erroneous observations and are deleted from the markup rate calculations.
- 4. Three methods produce three sets of markup rates and their aggregate values coincide with findings from JCCT (1995), which are based on the analysis of Hong Kong trade data only, Hong Kong Census surveys and Fung and Lau (1998) interviews. They reconcile all three sets of markup rates with precise economic interpretations. Specifically, Method A markup rates refer to those based on source generic Hong Kong import unit values but destination specific Hong Kong reexport unit values, and coincide with JCCT (1995) findings; Method B markup rates are based on Hong Kong import and re-export unit values both of which are source or destination generic, and coincide with Hong Kong Census survey results; and coinciding interview results reported in Fung and Lau (1998), Method C markup rates are based on Hong Kong import unit value (adjusted with China export data) and Hong Kong re-export unit values, both of which are source or destination specific and therefore are more accurate for China-US trade.

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 HS codes. 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) can be shown by the following formulae:

$$RXMR = \frac{\sum_{i} (PX_{i}QX_{i} - PM_{i}QX_{i})}{\sum_{j} PX_{j}QX_{j}} = \sum_{i} \left(1 - \frac{PM_{i}}{PX_{i}}\right) \left(\frac{PX_{i}QX_{i}}{\sum_{j} PX_{j}QX_{j}}\right)$$

$$= \sum_{i} RXMR_{i} \left(\frac{PX_{i}QX_{i}}{\sum_{j} PX_{j}QX_{j}}\right) = \sum_{i} RXMR_{i} \frac{RX_{i}}{\sum_{j} RX_{j}}$$
(21)

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:

$$Var(RXMR_i) = \frac{\sum_{k} RX_k (RXMR_k - \overline{RXMR}_i)^2}{\sum_{i} RX_j}, \text{ and } STD(RXMR_i) = \sqrt{Var(RXMR_i)}$$
 (22)

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 have better estimates for the trade weighted mean and variance of the markup rates, we first add up the annual data on Chinese exports, Hong Kong imports and re-exports over the years 2002, 2003 and 2004. So the markup rates should be interpreted as the trade weighted average over the three years. Both China and Hong Kong data are in 8-digit HS

2.6 of Fung $\it{et~al}$ (2006), or within the range of unreported initial estimates for the westbound US-China trade over 2001-05.

3.3 Bilateral trade cost and estimates of cif/fob margins

transportation margins in the range of 20 to 40 percent. The cost of shipping raw or bulky-type goods is relatively expensive compared to goods with a high unit value which can be shipped in compact forms. Goods with high unit value such as computer components, precious metals, and jewelry commonly have transportation margins below 1 percent. However, within each aggregate GTAP sector there are both high-unit value goods and low unit value good which largely affects the range of bilateral aggregate margins. Thus longer distance between partner pairs does not necessarily correspond to a higher margin at the aggregate sector level.

The bilateral sector margins between China (or Hong Kong) and a particular partner are calculated using their bilateral trade as weights to sum up their corresponding transport margins estimated from US Census data set at the 6-digit HS level. Because of differences in commodity composition of trade flows, bilateral cif/fob margins for any aggregate sector will vary. For example, bilateral margins for the machinery and equipment sector (Table 1) fall above or below the global merchandise average of 4 percent. The bilateral margins at the aggregate sector level are largely determined by the detailed content of the underlying bilateral trade flows. High unit value goods such as turbo-jets and other high-technology components (belonging to HS categories 8409-8411) can be shipped long distances even by air because the shipping cost represents a relatively small share of total value. Timeliness of delivery is critical for such high value goods

][J-0.0135 Tc 0-.0901 Tw -1.741 0 Td[(t Incosnt)-5(in1(s)t,-3()ano)-6(h)r h][J-0.01357Tc -0.0004 Tw -.92670 Td[(s)-4(subgrop)

Each exporting country differs in its proportion of high value and low-value content supplied which, in turn, has implications for the aggregate bilateral transport margins. To illustrate this point we use the two HS categories shown in table 1 and show how the trade ratio of low value (LV) to high value (HV) goods differs substantially by exporting country. Generally the content of developing countries' manufactures differs from ygat of high income countries within any aggregated sector. For example Japan, Canada, Germany and the United Kingdom export a higher proportion high-value machinery and equipment than do China, Hong Kong, Mexico, and India. In fact China exports nearly 9 times more of the low-value category in machinery equipment ygan for the high-value category. Because of the higher transport margins on low-value goods, China's transport margin for exports is relatively high for its aggregate machinery and equipment sector (1.066). Although Brazil, India, and Mexico export a similar proportion of low value machinery and equipment, the aggregate cif/fob margin for Mexico is substantially lower (1.011) tgan for India and Brazil. This is largely because of the close proximity to the United States where efficient ground transportation is relatively cheap in comparison to ocean shipping by vessel transportation required for India and Brazil.

Table 2. Bilateral transport margins on selected U.S. import flows for other manufacturers

manufacturers				
	High unit	Lower unit value	Traded	Aggregate
	value (HV)	(LV)	content	
HS category	7101-7118	9501-9508	Ratio	Other
				manufacturers
	cif/fob	cif/fob	LV / HV	cif/fob
Canada	1.006	1.056	1.27	1.034
Mexico	1.003	1.063	1.67	1.051
Costa Rica	1.002	1.000	0.67	1.043
Brazil	1.014	1.176	0.17	1.038
United	1.004	1.044	0.50	1.014
Kingdom				
Germany	1.008	1.045	1.43	1.034
India	1.004	1.093	0.01	1.005
China	1.039	1.088	9.63	1.086
Hong Kong	1.008	1.101	0.33	1.036
South Korea	1.027	1.037	1.37	1.049
Taiwan	1.052	1.073	17.37	1.093
Japan	1.005	1.020	5.58	1.039
Australia	1.002	1.029	0.63	1.022
South Africa	1.000	1.078	0.01	1.005
World	1.006	1.079	0.89	

Source: U.S. Census, foreign trade statistics using transport costs (c.i.f. / customs value).

Note: HS categories of high unit value goods consist of precious stones, metals, and jewelry categories in low unit value goods are primarily toys, sporting goods, and accessories.

Bilateral *cif/fob* margins for the other manufactures (Table 2) differ substantially more than other aggregate GTAP sectors because of the wide range goods in this sector. This sector is comprised of goods with high unit value such as precious stones, metals, and jewelry and products with low unit value such as toys and sporting goods. As a result of mixing

manufactures with precious minerals, the general pattern of higher transport margins for developing country goods does not hold. For example, India and South Africa have the lowest transport margins. The aggregate margins are driven primarily by the high proportion of precious stones such as diamonds and gold items in both countries exports of other manufacturers. Both countries have a very low LV/HV ratio as shown in Table 2. China on the other hand exports a high proportion of low value goods (toys and sporting goods) and once again this is the reason for China's high transport margin (1.086) for the other manufactures sector as a whole.

The lowest and most uniform transportation sectors margins are those of the electronic equipment sector (Table 3). This, despite the fact that computer components such as chip sets and circuit boards are most often transported by air rather than vessel because of the time sensitive nature of these goods in the supply-chain management. Most countries supply a wide array of electronic items within the electronics sector where there is no clear specialization. These high-technology goods have some of the highest unit values of all merchandise goods. Slight bilateral differences arise because only from subtle differences in the electronic content such as the lower value products of microphone, speakers, telephones and parts which have a higher transport margins than computer components. For example Costa Rica supplies a higher content of high-value computer chip sets than does India and China, making its aggregate margin for electronic equipment lower.

Table 3. Transport margins on selected U.S. import flows for electronic equipment sector

HS	8471	8518	8517	Aggregate
	Computer/part	Microphones/part	Telephone/part	Electronic
	S	S	S	equip.
Canada	1.006	1.004	1.005	1.004
Mexico	1.002	1.003	1.002	1.003
Costa Rica	0.996	1.020	1.017	1.012
Brazil	1.026	1.077	1.022	1.019
United	1.017	1.022	1.016	1.022
Kingdom				
Germany	1.020	1.026	1.011	1.020
India	1.039	1.093	1.057	1.026
China	1.024	1.067	1.022	1.023
Hong	1.029	1.078	1.018	1.022
Kong				
South	1.025	1.043	1.028	1.016
Korea				
Taiwan	1.022	1.053	1.028	1.019
Japan	1.018	1.034	1.018	1.022
Australia	1.018	1.018	1.015	1.020
South	1.023	1.029	1.015	1.031
Africa				
World	1.019	1.047	1.013	

A full set estimate for transport margins between China (Hong Kong) and their trading partners is required to initialize the model, including many non-U.S. bilateral trade flows. To complete the estimation, specific margins are first calculated at the 6-digit HS level for all HS categories from U.S. Census' data but are grouped into two sets. One set is for countries that border each other and the other is for non-bordering countries. Then cif/fob margins for each route between China & Hong Kong and their trading partners at each GTAP sector is calculated as associated trade flow weighted average from 6-digit HS level based on whether the pair borders each other. For instance, the same 6-digit HS margin between U.S. and Mexico is applied to China and Hong Kong's trade, while the same 6-digit HS margin between U.S. and China is used to China and Brazil trade. Table 4 lists aggregate cif/fob margins for China's major exporting sectors to the U.S. and its other major partner countries. China's cif/fob margins with Hong Kong are considerably lower than trade with other partners due to the close proximity. There are some variations by importer due to the content of trade. We also assume that trans-Pacific and trans-Atlantic trade routes for the same goods would have the same margins. Although we do not have route specific information on freight rates, it is reasonable to assume that international shipping services are supplied by transportation firms outside the U.S. and that the same carrier shipping machinery from China to Brazil likely provides shipping services for goods shipped from China to the United States. Thus, we can assume transport margins for the same goods would be similar as goods carried on similar vessels from China to Brazil as China's exports to the United States.

Table 4. Bilateral aggregate transport margins for China's exports to its major trading partners

	Footwear	Chemicals, Rubber,	Electronic	Machinery &
		plastics	equipment	equip.
Canada	1.076	1.085	1.024	1.065
Mexico	1.109	1.084	1.025	1.048
United States	1.072	1.093	1.023	1.066
Costa Rica	1.080	1.080	1.028	1.067
Brazil	1.091	1.062	1.028	1.041
United Kingdom	1.091	1.095	1.026	1.066
Germany	1.094	1.082	1.022	1.054
India	1.080	1.054	1.020	1.046
Hong Kong	1.020	1.019	1.007	1.016
Taiwan	1.074	1.080	1.021	1.040
Japan	1.084	1.089	1.023	1.048
Korea	1.072	1.092	1.024	1.039
Australia	1.079	1.091	1.024	1.064
South Africa	1.075	1.084	1.029	1.059

Source: U.S. Census, foreign trade statistics using transport costs (c.i.f. / customs value).

3.4 Determine appropriate country and commodity aggregation level based on the issue at hand and data availability

Because one of the objectives of this study is to produce Hong Kong re-export-adjusted trade flows as a contribution to the version 7 GTAP database, trade data reported by China, Hong Kong and their partners were aggregated from 8 and 6 digit HS to the 42 GTAP merchandise trade commodities respectively.

There are 215 countries identified in the GTAP global bilateral trade data base, while only 159 countries reported their exports to or import from China and Hong Kong during 2004. 9 To determine the country aggregation used in our optimization model, we first aggregate all the non-reporting countries into one block to be consistent with the model assumption that only one partner country does not report their trade with China and Hong Kong. Then we use the difference between China reported imports (exports) and the sum of all partner reported exports (imports) adjusted by the associated cif/fob margin to approximate the partner reported data for this aggregate non reporting country block. Then we use two cutoff criteria to separate the 159 reporting country into two blocks. The first block has 95 countries outside of China and Hong Kong, including all single countries in the version 6 GTAP database, and countries not in version 6 GTAP but with total exports from China and Hong Kong greater than \$300 million in 2004 as identified either by China and Hong Kong reported data or their partner reported data. The selected model country list and initial value of corresponding model variables for eastbound and westbound trade are listed Table 5 and Table 6 respectively. The second block is consisted of 64 remaining reporting countries. Their names are listed in Appendix Table A.

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⁹ There are about 120 countries reported their trade with China and Hong Kong in 2004 in current WITS with missing data for China's several important trading partners such as Viet Nam. Therefore, additional data for 2002 to 2005 pulled directly from UN COMTRADE database were also used and growth rates between 2002 and 2003 were calculated at the 6-digit HS level to project missing data in 2004 before being aggregated into GTAP sectoral classifications.

Table 5. Initial Estimates of Bilateral Trade Between China, Hong Kong and their Partner Countries, Eastbound Flows, 2004, in Millions of U.S. Dollars

							Partners		Partner		Re-exports as			Partners	China	Partner	Partners balance of	Hong Kong	Partner reported		cif/fob
	China actual	China direc		Hong Kong domestic		Hong Kong re	total -imports	Partners actual	imports of Hong Kong		percent of partner total	Statistical	Hong Kong	balance of trade with	reported balance of	reported balance of	trade with Hong Kong	reported balance of	balance of trade with		ratio, Hong
	exports to		exports to	export to	partner via	export	from Hong		domestic	import from		discrepanc		China after			after	trade with		China to	
Country Name	partners	Partners	partner	partner	Hong kong	markup	Kong	from China	products	China	China	ies	markup rate	adjustment	partners	China	adjustment	partners	Kong	partner	partner
											(RX0(CH,r)-										
Mariabla in the medal	TV0/CU r)	DX0(CH.r)	TV0/UK 4	DAU(PK 4)	DV0(c CH)	RXM0(CH,r)	TMO/UK r)	TMO(CH r)	DMO/HK r) DM0(CH t)	RXM0(CH,r))/TX0(CH,r)	SDX(r)	RXM0(CH,r) /RX0(CH,r)						- TX0(r,HK)- - TM0(HK,r)		-: t/1 11/ -\
Variable in the model United States	148.395	- (- , ,	- (, ,	,	. ,	(, ,	,	,		, , ,	, , ,	- (/	33.0		80.396		8,745			,	
Canada	10,060	-, -	- , -	,	,	, -	,	,	- ,	- ,					816	,					
Mexico	5,658						,						13.6	, -	2,831	-13,529					
Australia	10,499			1,098	3 2,493	3 798							32.0					1,334	-1,109	1.068	
New Zealand	1,315	1,077	413	3 138	355	5 113	393	2,180	10-	4 1,925	18.1	30.1	31.8	113	-336	-1,080	-121	84	-20	1.074	4 1.053
Japan	81,678		-, -			-,	,	,	, -	- ,			28.0	- ,	-21,036	,	-7,923	- ,	,		
Korea Rep	29,199														-34,350						
Taiwan China	15,351 14.969												24.1 33.0		-51,289						
Singapore Macao	1,778	,							- , -					,	-1,281 1,387	-1,016 -1,140					
Indonesia	6,912												21.6	,	-942				,		
Malaysia	9,036												40.8		-10,072						
Philippines	5,296	4,268	2,514	1,055	1,679	633	3,347	2,841	1,82	3 1,748	19.4	-35.1	37.7	1,077	-4,807	-188	2	-1,821	-128	3 1.061	1 1.042
Thailand	6,808	5,786	2,639	1,085	1,838	801	2,943	8,184	1,32	7,102	15.0	10.9	43.6	-2,216	-5,757	-1,158	-1,134	-2,210	1,771	1.060	1.040
Vietnam	4,833												21.5								
Cambodia	768												18.1		422						
Bangladesh	2,195 6,610							,					26.5 14.6		1,825 -1,776						
India Sri Lanka	905												39.5		668						
Pakistan	2,293												23.8		1,635						
Austria	1,122												32.5			-1,454					
Belgium	6,577	5,860	1,610	504	1,047	7 315	1,933	8,286	79	8 7,528	10.9	15.8	30.1	3,549	2,327	-5,548	-779	-187	' -10	1.070	1.026
Germany	28,633												28.1	,	-6,624						
Denmark	2,304														392						
Spain	6,669												25.7		3,715						
Finland France	2,971 12.080									- ,-			41.1 26.2		-602 2.252						
United Kingdom	19,438	- , -	-, -	,	,		8,550	-,					33.2	- /	10,141	-22,087		,			
Greece	1,557												20.8		1,293						
Ireland	2,343														946						
Italy	11,042	9,224	3,001	993	3 2,654	798	2,783	14,696	69	5 12,764	16.5	15.4	30.1	4,297	2,731	-9,246	-1,151	-336	874	1.071	1 1.042
Luxembourg	945												21.4		788						
Netherlands	20,893						,						32.3		15,534	-15,077					
Portugal	685												26.5		307	-453					
Sweden Switzerland	2,303 1,851												30.9 56.6		-1,481 -1,663	105 200					
Norway	1,214									,			40.8	,	-1,003	-1,630					
Cyprus	207												17.7		183			24			
Czech Republic	1,512	2 1,351	274	103	3 252	2 88	340	3,512	16	2 3,341	10.7	53.9	34.9	1,193	909	-3,241	-4	128	-158	3 1.046	3 1.041
Estonia	246												31.2		181	-344					
Hungary	3,156												31.7		2,174						
Lithuania	290												24.6		260						
Latvia	196									9 73			31.5		159						
Malta Poland	288 2.033												23.0 27.2		21 1,353	-58 -3,509					
Slovak Republic	2,030	, -											16.8	,	31	-719					
Slovenia	235						Ű.			9 157			22.0		165						
Albania	64			. (38.1		57	-100					
Bulgaria	370										8.6		14.9		270						
Croatia	365												30.1		323						
Romania	1,087						٠.						18.1		730						
Yugoslavia	172	2 163	13	3	3 12	2 3	14	541		4 532	5.0	68.8	26.5	170	150	-540	3	10) -11	1.075	5 1.048

	China actual exports to	China direc		g Hong Kor domestic export to	ng China re- exports to partner via		Partners total re-imports from Hon	Partners actual g imports	Partner imports of Hong Kong domestic	g direct	Re-exports a percent of partner total exports to			trade with	balance o	Partner reported f balance of trade with		balance of	Partner reported balance of trade with Hong	cif/fob ratio, China to	cif/fob ratio, Hong Kong to
Country Name	partners	Partners	partner	partner	Hong kong	markup	Kong	from China	a products	China	China	ies	markup rate	adjustment	partners	China	adjustment	partners	Kong	partner	partner
Ukraine	1,488	3 1,444	4 62	2 <i>'</i>	13 5	57	12 5	i6 73	1	6 68	5 3.	-119.1	20.8	812	403	3 -69	-89	9 42	. 61	1.073	1.049
Russian Federation	9,371	9,103	3 427	7 1	13 36	1	88 33	7 4,73	4 1	0 4,45	0 2.	9 -117.5	24.3	828	-3,009	9 3,635	5 14	1 -125	; 8	3 1.078	1.041
Kazakhstan	2,217	7 2,212	2 10)	5 1	0	5	7 75	8	2 75	3 0.	2 -232.3	51.3	449	-74	4 1,006	5 5	5 7		1.078	1.082
Kyrgyz Republic	492	2 492	2 .	1	0	1	0	0 8	0	0 8	0.	1 -608.5	16.3	451	381	1 -41	1 () -1	1	1.075	1.077
Argentina	982	2 852	2 174	4 3	32 15	1	19 17	6 1,40	1 2	8 1,26	3 13.	2 23.8	12.9	-1,774	-2,407	7 1,229	9 -2	2 -50	-11	1.057	1.045
Brazil	4,338	3,675	5 833	3 12	29 77	'8 1	05 1,10	3 4,04	9 36	9 3,34	8 15.	3 -6.7	13.5	-1,420	-5,030	1,388	3 -263	3 -61	-329	1.061	1.041
Chile	1,956	1,689	313	3 3	35 30	13	30 29	3 1,84	7	0 1,55	8 13.	7 -13.8	9.8	-1,354	-1,989	9 1,363	3 -6	3 121	-155	1.067	1.057
Colombia	702	2 629	9 9	1 '	15 8	86	13 10	3 1,23	4 2	3 1,15	6 10.	39.0	14.6	559	453	3 -1,096	6	5 71	-83	3 1.068	1.054
Ecuador	370	344	4 36	6	8 3	34															

Table 6. Initial Estimates of Bilateral Trade Between China, Hong Kong and their Partner Countries, Westbound Flows, 2004, in Millions of U.S. Dollars

Country Name	Partner actual exports to China	Partner direct exports to China	Partner total exports to Hong Kong	Partner exports remain in Hong Kong	Hong	Hong Kong re-export markup	Hong Kong total imports from partners	China actual imports from partners	Hong Kong retained imports from partner	China direct import from partner	Re-exports as percent of partner total exports to China	Statistical discrepan cies		Partners balance of trade with China after adjustment	Partners balance of trade with Hong Kong after adjustment	partner to	cif/fob ratio, partner to Hong Kong
				<u> </u>	<u> </u>						(RX0(r,CH)-		<u> </u>				
Variable in the model	TX0(s CH)	DX0(s CH) TX0(s Hk)	DX0(s Hk)	RX0(s CH)	RXM0(s,CH)	TM0(s HK	TM0(s CH) DMO(s Hk	O DMO(s CH	RXM0(r,CH))/ nTX0(r,CH)	SDX(s)	/RX0(CH,r)	TX0(CH,r)- TX0(r,CH)	TX0(HK,r)- TX0(r,HK)	cif(s,CH)	cif(s,HK)
United States	39,049				5,795	674						. ,	, ,	, , ,		, ,	
Canada	5,546	,		531	585	78											
Mexico	734					39											
Australia	6,823		,			31	,							-,			
New Zealand	1,202					19											
Japan Karan Ban	88,122	,	,	12,064	20,625	,								,			
Korea Rep Taiwan China	55,894 46.444				6,730 14,773	345 1,828											
Singapore	17,277	,	,			233											
Macao	402		,											,			
Indonesia	5,132																
Malaysia	11,667																
Philippines	4,219				1,879		,	-,	,								
Thailand	9,024		,		,	299	,							,			
Vietnam	1,414					11											
Cambodia	14					0				5 29							
Bangladesh India	68 5,813		-			7 66								,			
Sri Lanka	27		,				,										
Pakistan	684																
Austria	1,264					20											
Belgium	3,028			1,283	387	84	1,796	3,533	3 1,12	2 3,223	9.8	2.2	21.8	3,549	779	1.053	1.051
Germany	27,456	24,847	5,253	2,184	2,923	228	5,131	30,378	1,96	27,643	9.7	4.9	7.8	3 -1,177	-569	1.033	1.034
Denmark	1,383					59											
Spain	1,513																
Finland	2,655					19		- ,		,							
France	6,852 4,938			, -			,	,	,	, -				- /			
United Kingdom Greece	4,936			2,925 52		118 5											
Ireland	1,027			691	484	222								,			
Italy	6,745				1,537	173											
Luxembourg	127		,		13		,							,			
Netherlands	3,019	2,749	1,059	736		21	1,550	2,985			9.1	6.8	7.0	-17,874	-916	1.038	1.038
Portugal	133					4			1 3	9 263	12.9	38.2	17.2				
Sweden	2,728			318													
Switzerland	2,931																
Norway	821																
Cyprus Czech Republic	4 320			6 107	1 56	C 5		_		5 1 3 391	28.0 15.7						
Estonia	320									3 391 4 19				,			
Hungary	459									9 404							
Lithuania	12									2 13							
Latvia	11					Ċ) 20							
Malta	63		80									57.0	16.6				
Poland	570				17	2											
Slovak Republic	81				3					9 126							
Slovenia	39					1				3 37							
Albania	1					C) 6							
Bulgaria	40			-		1	_			3 65							
Croatia Romania	7 203					12				2 22 5 318							
Yugoslavia	203				1	12) 12							

									Hong						Partners		
			Partner	Partner	Partner re-		Hong	China	Kong	China	Re-exports			Partners	balance of		cif/fob
	Partner	Partner	total	exports	exports to		Kong total	actual	retained	direct	as percent of			balance of	trade with	cif/fob	ratio,
	actual	direct	exports to	remain in	China via	Hong Kong	imports	imports	imports	import	partner total	Statistical	Hong Kong	trade with	Hong Kong	ratio,	partner to
	exports to	exports to	Hong	Hong	Hong	re-export	from	from	from	from	exports to	discrepan	re-export	China after	after	partner to	Hong
Country Name	China	China	Kong	Kong	kong	markup	partners	partners	partner	partner	China	cies	markup rate	adjustment	adjustment	China	Kong
Ukraine	676	663	117	102				1,04	1 4	1,026	3.	1 20.8	8.9	-812	2 89	1.085	1.058
Russian Federation	8,543	8,369	345	99	195	8	3 552	12,11	1 286	11,917	7 2.	1 26.2	2 4.0	-828	3 -14	1.077	7 1.068
Kazakhstan	1,767	1,764	3	0	4	. () 4	2,286	6 (2,282	2 0.2	2 19.2	2.5	-449		1.058	3 1.067
Kyrgyz Republic	41	39	1	0		(111									
Argentina	2,755	2,630	165	34													
Brazil	5,758	5,437	773	392													
Chile	3,309	3,210	138	41		3		3,677		- ,				,			
Colombia	143	138	20	9		1											
Ecuador	51	50	7	5) 12										
Peru	1,250	1,236	31	15													
Paraguay	49	44	10	5		,											
Venezuela	230	224	10	1	6												
Uruguay	122	112	19	8		(
Costa Rica	246	163	137	9													
Guatemala	20	19	1	0		(
Panama	12	11	8	7) 16										
Cuba	81	80	10	3		-) 12										
Algeria	249	249	0	0		-											
Egypt Arab Rep	126	117	20	11													
Iran Islamic Rep	238	210	108	74		2		, -		, -				, .			
Israel	960	780	1,911	1,380													
Jordan	40	39	2	1	1	(
Lebanon	16	12	12	8		-											
Morocco	118	50	88	1	82												
Nigeria	83	76	7	0													
Saudi Arabia	7,617	7,447	371	200				7,525									
Syrian Arab Republic	22	21	1	0) 1	28									
Tunisia	30	26	7	1	6			_	-								
Turkey	363	323	144	100													
Yemen	1,171	1,169	9	6		-) 16										
Benin	93	93	0	0) (
Ghana	20	20	83	1	0) 110										
Kenya	33	11	25	2				34									
Mozambique	27	21	6	0		1											
Malawi	0	0	0	0) () (
Madagascar	13	9	8	4	. 4	-) 9										
Sudan	2,317	2,312	7	2		-		.,									
Togo	18	17	1	0		(
Tanzania	86	71	27	4													
Uganda	20	5	24	8													
South Africa	1,221	1,054	564	282													
Zambia	31	29	11	1		(
Zimbabwe	113	110	9	405													
Other reporting countries	2,039	1,944	265	105		10											
No reporting partner countries	173	0	7,944	7,691	191	18											
Partner Total	410,388	347,209	181,251	101,863										,			
Hong Kong, China	13,312	78,989	100.245	0 4 422	-	,		11,539		-, -							
China World Total	422.000	400 400	100,215	34,433			,		,								
World Total	423,699	426,198	281,466	136,296	74,329	8,652	2 237,394	527,235	5 85,095	527,235	5 13.2	2 5.6	11.6	-177,285	71,364	1.244	0.624

Although the initial estimates listed in Tables 5 and 6 still suffer from some unsolved data problems, ¹⁰ they do show several interesting features of the data. First, reported westbound trade seems less problematic than reported eastbound trade, reflected by the more volatile statistical discrepancies in eastbound trade. The overall discrepancies are 6.4 percent in eastbound trade and 5.6 percent in westbound trade. However, 14 of the 98 reported bilateral routes in the model have more than 100 percent statistical discrepancies in the eastbound trade, while only one route in the westbound trade shows such large discrepancies. On the other hand, there are only eight bilateral routes in eastbound trade with less than five percent discrepancies, while more than 17 routes in the westbound trade have small discrepancies. Second, trade flows with developing country partners show greater discrepancies than developed countries in general, reflecting the poor quality of data reported from those nations. Finally, extremely large discrepancies usually are associated with partners that have small trade values with China and Hong Kong, such as Benin, Nigeria, Togo and Kyrgyz Republic in eastbound trade and Cambodia in westbound trade. The combined exports reported by China and Hong Kong are small in the 14 bilateral routes with more than 100 percent discrepancies in eastbound trade, and in all those countries their reported imports are less significantly than what China and Hong Kong reported exports to them.

There are three types of trade balances reported in Table 5. They include: China and Hong Kong's officially reported trade balance with their partner countries (difference between China and Hong Kong reported exports and imports before any adjustment), the partner countries' officially reported trade balance with China and Hong Kong (difference between partner reported exports to and imports from China and Hong Kong before any adjustment), and the balance of trade after initial Hong Kong re-exports and <code>cif/fob</code> adjustments. As expected, China's trading partners reported much larger trade deficits with China than China reported trade surpluses with its partners. More strikingly, if excluding Hong Kong, China's other trading partners reported a deficit with China of \$324.5 billion, while China also reported a trade deficit of \$24.3 billion with these partners! Most of the initial adjusted trade balances fall between those two numbers. For example, the United Stases reported a \$174 billion trade deficit with China, while China only report about \$80.4 billion trade surplus with the United States. This number, after initial adjustment for Hong Kong reexports markup earnings and cif/fob margins, becomes \$109.4 billion, 36 percent higher than the Chinese data, but 37 percent lower than data reported by the United States.

Having specified initial values for all the variables in the model, there is only one issue left before we can solve the optimization model: How should the reliability weights in the

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¹⁰ For example, the no reporting partners block has a very large discrepancy in west bound trade, because the difference between China and Hong reported total exports with the sum of all their reported exports to reporting partner is too small, therefore will underestimate what these non- reporting countries actually import from them. This implies that China and Hong Kong reported total exports to and imports from the world also subject to reporting errors which should be reconciled at global level with all importing and exporting countries.

Note that only the adjusted trade balances are listed in Table 6 and they are calculated in an opposite

objective function ($wdx_{it}^{sr}wtx_{it}^{sr}wdm_{it}^{sr}wtm_{it}^{sr}wrxm_{it}^{sr}$ in equation 18) be determined? These will, in turn, determine which and how much of the initial estimates should be adjusted to reconcile these trade data from different sources. This is the topic of the next section.

3.5 The choice and estimation of reliability weights

From statistical point of view, the best way to systematically assign reliability weights in the objective function is to obtain estimates of the variance-covariance matrix of the initial trade flow statistics. Then the inverted variance-covariance matrix may be justified as the best index of the reliability of entries in the trade flow matrix. However, the lack of consistent historical data often makes the estimation of the variance-covariance matrix associated with the initial trade flow statistics very difficult to implement. For example, the common practice in SAM balancing exercises is assign differing degrees of subjective reliabilities to the initial entries of the matrix follow the method proposed by Stone (1984), 12 almost no attempt to date has been made to statistically estimate data reliability such as error variance of the initial estimates from historical data, except Weale (1989), who developed a statistical method that uses time series information on accounting discrepancies to infer data reliability in a system of national accounts. Theoretically speaking, a similar statistical method can be applied to the reporting discrepancies of bilateral trade data to derive those variances associated with international trade statistics.

Trade data reported by each country and its partners are often used in the international economic literature to check the quality of trade statistics. An approximate match of mirror statistics suggests that trade data reported via that route are reliable. Therefore, an analysis of discrepancies between two "reported" trade flows for the same trade route may provide a means of determining data reliability and historical mirror trade statistics could be used as a major data source to estimate the variance of reported bilateral trade statistics.

Auto regression with dummy variables

Assuming the discrepancies in any pair of mirror trade statistics are a function of a systematic bias, last period's discrepancies and N dummy variables plus an error term as follows:

$$e_{it} = a_i e_{it-1} + b_i^0 + \sum_{k=1}^n b_i^k D^k + \mu_{it}$$
 (25)

where $e_{\scriptscriptstyle it}$ is the mirror trade statistical

$$V(e_{it}) = V(a_i e_{it-1} + b_i^0 + \sum_{k=1}^n b_i^k D^k + \mu_{it}) = V(a_i e_{it-1}) + V(\mu_{it}) = a_i^2 V(e_{it-1}) + V(\mu)$$
(26)

At stationary assumption in long run, $V(e_{t})=V(e_{t-1})$

$$V(e_{it}) - a_i^2 V(e_{it}) = V(\mu)$$
(27)

Therefore

$$V(e_{ii}) = \frac{V(\mu)}{(1 - a_i^2)}$$
 (28)

As long as we have enough historical mirror trade statistics and sufficient knowledge on the change in related country's trade reporting system to estimate $V(e_{it})$ for each pair of mirrored trade variables in our optimization model, then they can be assigned as weights in equation (18), the objective function. Although theoretically elegant and doable, the historical data and knowledge of the changes in related country's trade reporting system are too demanding and make such a method less attractable in large empirical applications like ours. Therefore, we adopted the following two types of reliability indexes as a practical alternative.

Route Reliability Indexes

As described earlier, in adjusting inconsistent bilateral trade flow statistics to satisfy the consistency requirements, it is crucial for the reconciliation procedure to more favorable towards changing the less reliable route than the more reliable route. For example, past statistical information suggested that US-Japan trade is one of the most consistently reported trade flows. Thus, minor or no adjustment is needed on this particular route while more adjustment should occur where there is less certainty about the reported trade flow. Because a small discrepancy in mirror trade statistics may indicate a reliable trade route, while a large discrepancy may indicate unreliable reported data, mirror statistics and their discrepancies also directly provide useful information to construct some sort of reliability index to inform the model how the initial estimates should be adjust in the reconciliation dure ss.

In fact, when we assign initial estimates for the 16 sets of trade flow variables in both east bound and westbound trade in the optimization model either directly from reported trade statistics or by derivations from them, we also obtain 8 sets of mirrored trade data. The discrepancies computed from each mirrored pair divided by corresponding sum of mirrored flows thus can be used to construct an index which reflects the reliability of the associate initial estimates of the reported trade flows in some extent, although we are not sure how large the associated variance really may be. Using mathematical notation:

$$PDX_{it}^{cs} = PDM_{it}^{cs} = 2 \times \frac{\left| cif_{it}^{cs}DM \, O_{it}^{cs} - DX \, O_{it}^{cs} \right|}{DX \, O_{it}^{cs} + cif_{it}^{cs}DM \, O_{it}^{cs}}$$
(29)

$$PTX_{it}^{cs} = PTM_{it}^{cs} = 2 \times \frac{\left| cif_{it}^{cs}TM \, 0_{it}^{cs} - TX \, 0_{it}^{cs} \right|}{TX \, 0_{it}^{cs} + cif_{it}^{cs}TM \, 0_{it}^{cs}}$$
(30)

$$PDX_{it}^{sc} = PDM_{it}^{sc} = 2 \times \frac{\left| cif_{it}^{sc}DM \, O_{it}^{sc} - DX \, O_{it}^{sc} \right|}{DX \, O_{it}^{sc} + cif_{it}^{sc}DM \, O_{it}^{sc}}$$
(31)

$$PTX_{it}^{sc} = PTM_{it}^{sc} = 2 \times \frac{\left| cif_{it}^{sc}TM \, O_{it}^{sc} - TX \, O_{it}^{sc} \right|}{TX \, O_{it}^{sc} + cif_{it}^{sc}TM \, O_{it}^{sc}}$$
(32)

Where indexes "c" is indexed over set {CH, HK} and variable with a prefix "P" are reliability index for that variables.

All these reliability indexes defined above have a value between 0 and 2, defined in the sprit of Ferrantino and Wang (2007). A smaller value of the indexes indicates the initial estimates are relatively reliable for the associated trade route. The weights in the objective function (equation 18) of the model can be assigned by multiplying these indexes by their corresponding initial values, e.g., $wtx_{ii}^{sr} = PTX_{ii}^{sr} \times TX \, 0_{ii}^{sr}$. With such a weighting scheme, we encourage the model to change initial estimates of those unreliable trade routes more than those reliable ones in the reconciliation process, because a larger index makes the weights larger thus adjustment of the corresponding initial estimates has a smaller contribution to the value of the objective function and will be adjusted more in the reconciliation process. For instance, China-Japan trade in both directions will adjust less proportionally than China-Togo trade, because China and Togo reported trade has a much larger absolute discrepancy than China and Japan reported trade.

Reporter reliability indexes

The reliability weights defined above only consider the relative quality of initial estimates among all the bilateral routes. Such weights treat the reported trade statistics from both reporters equally and do not distinguish which reporter is more reliable. In the case there is very unreliable reporter in the pair, it may adjust the reliable data reported by the partner too much thus loss original accurate information from the reliable partner. This is undesirable. To correct this problem, a reporter's reliability index needs to be developed. Such an index should be able to deal with three critical issues.

The first issue is related to the difference of reporting countries in their ability to report bilateral commodity trade. Variability in reporting quality across countries is highly relevant information for the problem we try to solve in our proposed modeling approach. As discussed earlier, the adjustment process hinges heavily on the relative reliability of the

each reporting countries. An indicator of reporter reliability is basically a measure of how consistency a country reports its trade relative to their trading partners. However, judging a country's trade data based on a single bilateral flow alone is a poor reference, because a partner can misrepresent its trade thereby potentially discrediting a reliable reporter. Therefore, a good reporter reliability measure should take all reporting countries in the world into account in assessing a country's reporting reliability.

The second issue is what exactly should be captured by the reliability measure. The size of discrepancies could be incorporated into a measure of reliability such as relative route reliability index we defined earlier. However, placing emphasis on the magnitude of discrepancies only may over-penalize the reliability of a legitimate reporter. A poor reporter that makes an error for a given trade flow usually makes a similar error with other partners. For example a reporter that has mistaken the identity of one of its partners has implicitly made a mistake for others. It brings a systemic bias for that reporter. This type of problem should be detected and reflected in the reporter reliability measure without penalizing the reliable reporter.

The third issue is the capability of the measure to reflect both sector- 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 but at the same time is highly inconsistent in its reporting practice in organic chemical trade.

All three issues discussed above are effectively dealt with in the reliability index developed by Gehlhar (1996) where reporter reliability indices were used to make a discreet choice whether to disregard or accept reported trade flows. The index is calculated as the share of accurately reported transactions of a reporter's total trade using a threshold level. 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. Specifically, the importer-sector specific and exporter-sector specific reliability indexes are defined as:

$$RIM_{it}^{r} = \frac{MA_{it}^{r}}{\sum M_{it}^{sr}} \qquad where \qquad MA_{it}^{r} = \sum_{s \in AL_{it}^{sr} \le 0.20} M_{it}^{sr} \qquad AL_{it}^{sr} = \frac{\left| M_{it}^{sr} - X_{it}^{sr} \right|}{M_{it}^{sr}}$$
(33)

$$RIX_{it}^{r} = \frac{XA_{it}^{r}}{\sum_{s} X_{it}^{rs}} \qquad where \qquad XA_{it}^{r} = \sum_{s \in AL_{it}^{sr} \le 0.20} X_{it}^{rs} \qquad AL_{it}^{rs} = \frac{\left| M_{it}^{rs} - X_{it}^{rs} \right|}{M_{it}^{rs}}$$
(34)

where M_{it}^{sr} and X_{it}^{sr} are sector i imports and exports reported by country r and s in year t respectively, both measured at fob prices. Under such defined reporter reliability indexes, the size of the discrepancies becomes immaterial because inaccurate transactions are treated the same regardless of the magnitude of the inaccuracy. The indexes have the flexibility of being implemented at the detailed 6-digit HS level and can be aggregated to

any sector level. We computed such reporter reliability measures for China & Hong Kong and all their partners at the GTAP sector level. Major data are from UN COMTRADE with supplements from country sources.

After RIM and RIX calculated for each of the 99 countries including China and Hong Kong in the model for each GTAP sectors, the weights in the objective function (equation 18) of the model can be assigned by multiplying one minus these indexes by their corresponding initial values for each variable in the model. The complete set of weights in equation 18 is defined as follows:

$$wtx_{it}^{sr} = (1 - RIX_{it}^{s})PTX_{it}^{sr} \times TX O_{it}^{sr}$$
(35)

$$wtm_{it}^{sr} = (1 - RIM_{it}^{r})PTX_{it}^{sr} \times TMO_{it}^{sr}$$
(36)

$$wdx_{it}^{sr} = (1 - RIX_{it}^{s})PDX_{it}^{sr} \times DX0_{it}^{sr}$$
(37)

$$wdm_{it}^{sr} = (1 - RIM_{it}^{r})PDX_{it}^{sr} \times DMO_{it}^{sr}$$
(38)

$$wrxm_{it}^{sr} = \lambda_{it}^{sr} \frac{STD(RXMR_{it}^{sr})}{RXMR_{ir}^{sr}} RXM O_{it}^{sr}$$
(39)

Where λ_{it}^{sr} are scale parameters to transfer $wrxm_{it}^{sr}$ into numerical value between zero and two, $STD(RXMR_{it}^{sr})$ is defined by equation (22).

With such a weighting scheme, we also encourage the model to change those unreliable initial data more than those reliable ones in the reconciliation process. It means the reconciled solution from the model not only adjust less to the reliable routes than the unreliable ones, but also adjust more to the relative unreliable reporter than the relative reliable reporter in each trade route, although in a rough manner.

IV. Results from the Model

The optimization model is coded in GAMS (Brooke *et al*, 2005), with more than 2.5 million equations and variables in its current aggregation. It was solved using barrier method of the Cplex solver (GAMS Development Corporation, 2005) in a 32 bit dell computer with 3 GB memory. There are 13 input data files, all automatically produced by three SAS programs.

Adjusted estimates for the sum of all sectors aggregated int2(rre)-4(nt)-6(05) in -7(a)o4(nt)-6(i)o4)6(a)-prles G

Table 7. Initial and Adjusted Estimates of Bilateral Trade Between China, Hong Kong and their Partner Countries, Eastbound Flows, 2004, in Millions of U.S. Dollars

Country Name	China actual exports to partners	China direct exports to Partners	Hong Kong total exports to partner	Hong Kong domestic export to partner	China re- exports to partner via Hong kong	Hong Kong re-export markup	Partners total imports from Hong Kong	Partners actual imports from China	Partner imports of Hong Kong domestic products	Partner direct import from China	Re-exports as percent of partner total exports to China	Statisti cal	Hong Kong re- export markup rate	Partners balance of trade with China after adjustment		Partner reported balance of trade with China	Partners balance of trade with Hong Kong after adjustment	Hong Kong reported balance of trade with partners	Partner reported balance of trade with Hong Kong	cif/fob ratio, China to partner	Ü
Variable in the model	•		•	•	RX0(s,CH)	•			•	DM0(CH,r)	(RX0(CH,r) RXM0(CH, r))/TX0(CH	-	RXM0(C	TX0(CH,r)- TX0(r,CH)	TX0(CH,r)		TX0(HK,r)- TX0(r,HK)	TX0(HK,r)- TM0(r,HK)	TX0(r,HK)- TM0(HK,r)	·	cif(HK,r)
Initial Estimates	-(- //	-(- , ,	, ,,	, ,	, ,	-(- ,,	-(,,	-(- //	-(// (-	.,	(- , ,	-(,- ,	-(,- ,	-(- //	-(, ,	-(, ,	-(- (- //	, ,,
United States	148,395	125,118		17,680		11,743	- , -	208,153	9,141	182,798	15.8		33.0	,	,	,	8,745	-, -	-28,110	1.056	1.064
Canada Mexico	10,060 5.658	8,161 4.973	3,132 938			819 110		18,526 14.003	552 406	16,484 13,273	19.0 12.1	35.9 57.1	29.7 13.6	4,514 4,923		-13,460 -13,529	568 15		-2,157 -955	1.072 1.060	1.052 1.048
Australia & New Zealand	11.814	9,916			2,847	910	,	15,244	1,037	13,208	16.1	13.3	32.0	,	,	-7,835	-298	1,418		1.069	1.049
Japan	81,678	73,222		4,141	11,977	3,348	11,373	93,589	1,322	84,605	10.4	3.5	28.0	-6,444	-21,036	-22,981	-7,923			1.065	1.041
Korea Rep	29,199	27,810	-,	2,287	2,832	, -	-,	29,585	3,268	28,135				-,	- ,	20,173	-8,694	-7,244	, -	1.068	1.025
Taiwan China	15,351	13,489		2,215		598		16,625	2,072	14,679		1.0		-31,093		17,373	-13,793	,	9,738	1.053	1.029
India Russia	6,610 9,371	5,925 9,103		389 113		118 88	-, -	6,687 4,734	1,683 10	5,973 4,450	10.3 2.9					-1,403 3,635	-1,636 14	,	,	1.060 1.078	1.019 1.041
Brazil	4,338	3,675						4,049	369	3,348			13.5			1,388	-263		-711	1.061	1.041
South Africa	3,423	2,952				101		3,578	419	3,072						-2,524	-150		-779	1.069	1.048
EU 15	119,561	99,815		12,642		8,805		154,305	12,793	133,311	16.5		30.5			-98,759	-570	,		1.060	1.045
European FT	3,065	2,534	1,537	808		590		4,679	890	4,114	17.4			-687		-1,431	-1,588	-2,140		1.066	1.038
EU 10 Rest of Europe	8,357 3,545	7,325 3,410	1,600 199	516 47	,	454 37	2,155 241	12,505 3,533	1,029 83	11,418 3,390	12.3 3.8		30.3 21.0	-,	-, -	-11,099 -2,630	301 -80	1,142 142	,	1.053 1.072	1.037 1.044
ASEAN	48,621	41,793		5,793		3,652		44,369	11,437		14.0		34.5			-5,402	-16,887	-16,515		1.054	1.039
Rest of Asia	9,880	9,126				354	3,188	5,918	1,505	5,093	7.7	-47.2	31.5	6,892		-3,374	300			1.073	1.072
Rest of Latin America	9,336	8,036				212		8,620	322	7,223			13.8			-703	127	787	-1,630	1.066	1.055
Midest and North Africa	16,602	15,342				353	,	15,259	1,551	13,912			21.5	-,		-4,816	-1,264			1.072	1.034
Rest of Africa Other reporting countries	5,208 4,115	4,943 3,517	389 806	90 159		64 113	566 1,193	2,597 3,940	247 497	2,308 3,282	5.1 14.6		19.1 15.6	2,353 2,077		178 -1,996	65 53			1.073 1.081	1.066 1.075
No reporting partner countries	12,364	11,256		404		235		1,179		3,202	9.0		17.2			-1,179	-7,287	535		1.073	1.075
Partner Total	566,552	491,440				34,233		671,679	88,310	591,213						-324,470	-50,243		-84,217	1.186	1.711
Hong Kong, China	34,433	100,215		ū		-		12,650	0	82,410						21,980	0	0	2.,000	1.017	an
China	0	0	. 0,000	13,312		0	,	0	11,539	0	0.0		0.0		0	0	-21,121	-3,422		na	1.015
World Total Adjusted Estimates	600,985	591,656	223,975	64,931	110,863	34,233	264,315	684,329	99,849	673,623	12.5	6.1	30.9	177,285	-2,276	-302,490	-71,364	-13,419	-40,257	1.139	1.538
United States	179,178	154,628	37,707	10,190	35,587	10,444	40,971	188,361	11,708	161,619	13.8	0.0	29.4	137,570	80,396	-174,095	2,144	29,467	-28,104	1.056	1.064
Canada	13,695	11,625	2,837	637		646		14,618	692	12,395	15.2					-13,460	64		-2,154	1.072	1.052
Mexico	8,543	7,834	1,011	268	808	86	1,070	8,974	293	8,219	8.3	0.0	10.6	7,096	2,831	-13,529	208			1.060	1.048
Australia & New Zealand	13,407	11,466	3,423	1,030		867	3,609	14,296	1,100	12,215						-7,835	-408	,		1.069	1.049
Japan Kasas Bas	86,217	77,259	11,912	1,769		2,839	, -	91,755	1,924	82,239	10.4			-4,883		-22,981	-10,690	-, -	695	1.065	1.041
Korea Rep Taiwan China	28,024 15.878	26,546 13.943		2,361 2,198	2,832 2,486	1,333 525		29,912 16.688	2,414 2,273	28,369 14.668	5.3 12.2			-38,437 -54,248		20,173 17,373	-4,196 -9.457	-7,244 -13,723		1.068 1.053	1.025 1.029
India	6.940	6,227	2.589	862	,			7,356	884	6.613				189	- ,	-1,403	-1,173	-, -	- ,	1.060	1.019
Russia	5,741	5,450	376			65		6,237	42	5,928	5.1	0.0	18.0	-3,688		3,635	-63	,		1.078	1.041
Brazil	4,101	3,415					,	4,336	280	3,611	16.7			,	-,	1,388	-72		-709	1.061	1.041
South Africa	3,694	3,203		192		81		3,931	212	3,403						-2,524	-90			1.069	1.048
EU 15 European FT	136,433 3,521	116,038 2,956		10,761 626	28,914 1,131	8,145 555	,	144,438 3,744	11,446 648	122,760 3,144	15.0 16.1			71,165 -620	,	-98,759 -1,431	-1,538 -1,778		-22,490 752	1.060 1.066	1.045 1.038
EU 10	9,946	8,861	1,729				1,439	10,433	629	9,291	10.1			8,273		-11,099	423			1.053	1.037
Rest of Europe	2,906	2,767	205	50				3,111	54	2,963	4.8					-2,630	-406	,	,	1.072	1.044
ASEAN	46,453	39,217	17,943	7,546	10,587	3,239	18,739	48,854	7,927	41,191	15.6	0.0	30.6	-23,286	-20,659	-5,402	-13,048	-16,514	858	1.054	1.039
Rest of Asia	7,883	7,110					2,706	8,453	1,027	7,607	9.9			5,523		-3,374	529	,	,	1.073	1.072
Rest of Latin America	8,707	7,369	1,630	220		171		9,249	255	7,811	15.4			-1,069		-703	25		,	1.066	1.055
Midest and North Africa Rest of Africa	15,875 3,693	14,561 3,416	2,556 420	815 111		298 51		16,988 3,954	860 125	15,585 3,652	8.3 7.5					-4,816 178	-680 13			1.072 1.073	1.034 1.066
Other reporting countries	4,139	3,512				84		4,458	305	3,769	15.2					-1,996	211	534		1.073	1.075
No reporting partner countries	6,742	5,571	2,905			170		7,183	895	5,936						-1,179	-330			1.073	1.035
Partner Total	611,714	532,973				30,536	147,388	647,328	45,993	562,991	13.1		27.5	124,774	-24,249	-324,470	-40,312		-84,079	1.059	1.063
Hong Kong, China	19,758	98,499	0	0				20,173	0	100,494	0.0					21,986	0	0	,	1.017	na
China World Total	0 631,472	0 631,472	00,000	16,896 59,473		0 30,536	0.,000	0 667,502	17,133 63,126	663,485	0.0 12.5				-2,263	-302,484	-2,862 -43,174		21,986 -40,108	na 1.058	1.015 1.055

Table 8. Initial and Adjusted Estimates of Bilateral Trade Between China, Hong Kong and their Partner Countries, Westbound Flows, 2004, in Millions of U.S. Dollars

															Partners		
			Partner	Partner	Partner re-		Hong	China	Hong Kong	China	Re-exports as		Hong	Partners	balance of		fob/cif
	Partner	Partner	total	exports	exports to	Hong	Kong total	actual	retained	direct	percent of		Kong re-	balance of	trade with	cif/fob	ratio,
	actual	direct	exports to	remain in	China via	Kong re-	imports	imports	imports	import	partner total	Statistical	export	trade with	Hong Kong	ratio,	partner to
	exports to	exports to	Hong	Hong	Hong	export	from	from	from	from	exports to	discrepan	markup	China after	after	partner to	Hong
Country Name	China	China	Kong	Kong	kong	markup	partners	partners	partner	partner	China	cies	rate	adjustment	adjustment	China	Kong
											(RX0(r,CH)-		RXM0(C				
											RXM0(r,CH))/		H,r)/RX0	TX0(CH,r)-	TX0(HK,r)-		
Variable in the model	TX0(s,CH)	DX0(s,CH)	TX0(s,Hk)	DX0(s,Hk)	RX0(s,CH)	RXM0(s,C	TM0(s,HK	TM0(s,CH) DM0(s,HK)	DM0(s,CH) TX0(r,CH)	SDX(s)	(CH,r)	TX0(r,CH)	TX0(r,HK)	cif(s,CH)	cif(s,HK)
Initial Estimates	, , ,	, , ,	,	, ,	, ,				, , , ,		,	` '				, ,	, ,
United States	39.049	34,058	15,509	8,935	5,795	674	14,457	44,722	7,710	39,510	12.9	5.4	11.6	-109,345	-8,745	1.027	1.023
Canada	5,546	- ,															
Mexico	734																
Australia & New Zealand	8,025					50						27.1					
Japan	88,122			12,064		2,459	32,925		,			0.3	11.9			1.045	
Korea Rep	55,894		18,127	10,981													
Taiwan China	46,444	33,997	29,728	16,007	14,773	1,828	20,022	64,778	5,74	51,642	27.5	5.7	12.4	31,093	13,793	1.053	1.043
India	5,813	5,285	3,649	2,025	621	66	3,782	7,701	2,110	7,128	9.4	12.0	10.7	-797	1,636	1.113	1.015
Russia	8,543	8,369	345	99	195	8	552	12,111	280	11,917	2.2	26.1	4.0	-828	-14	1.077	1.068
Brazil	5,758	5,437	773	392	352	13	894	8,704	489	8,357	7 5.8	24.8	3.8	1,420	263	3 1.150	1.058
South Africa	1,221	1,054	564	282	184	10	696	2,541	39	2,363	14.0	43.7	5.6	-2,202	150	1.076	1.053
EU 15	62,947	55,546	23,503	13,211	8,771	1,079	22,130	68,824	11,40	60,994	12.0	1.3	12.3	-56,614	570	1.036	1.040
European FT	3,752	3,249	3,585	2,396	586	64	3,677	4,569	2,44	4,037	7 13.7	8.1	11.0	687	1,588	1.037	1.034
EU 10	1,594	1,406	504	215	232	39	458	1,889	160	1,694	11.9	7.6	16.8	-6,763	-301	1.031	1.034
Rest of Europe	929	904	167	127	42	15	57	1,477	7 14	1,449	2.9	24.6	35.2	-2,616	80	1.084	1.054
ASEAN	48,746	38,967	35,109	22,680	11,904	1,700	32,318	62,452	19,382	2 52,111	20.6	7.1	14.3	125	16,887	1.059	1.040
Rest of Asia	2,988	2,544	1,066	437	502	24	1,058	3,305	382	2,815	15.7	0.7	4.8	-6,892	-300	1.063	1.065
Rest of Latin America	8,269	7,917	558	138			851	10,543	3 40	3 10,167	4.4	16.8	13.9	-1,067	-127	1.080	1.055
Midest and North Africa	10,947	10,442	2,673	1,782	596	66	1,997	15,895	1,078	3 15,351	4.8	20.8	11.1	-5,654	1,264	1.079	1.031
Rest of Africa	2,855	2,776	210			5	285	2,931	6			-0.7	5.9	-2,353	-65	1.052	1.139
Other reporting countries	2,039	1,944	265	105	111	10	274	7,827	7 10:	7,724	4.9	74.7	9.4	-2,077	-53	1.079	1.061
No reporting partner countries	173		, -			18	,		1,59							1.082	
Partner Total	410,388	347,209	181,251	101,863	74,329	8,652	154,984	515,696	72,44	449,000	16.0	5.4	11.6	-156,164	50,243	1.257	0.711
Hong Kong, China	13,312	78,989		-				,		78,235	0.0				(
China	0	0	,				82,410		,						,		
World Total	423,699	426,198	281,466	136,296	74,329	8,652	237,394	527,235	85,09	527,235	13.2	5.6	11.6	-177,285	71,364	1.244	0.624
Adjusted Estimates																	
United States	41,608	,			-,		-, -		- /	- ,				- ,			
Canada	6,106	5,625	1,103	573	585	78	1,180	6,738	62	6,222	2 8.2	0.0	13.3	-7,588	-64	1.089	1.054
Mexico																	

4.1 Adjusted trade flow and balance of trade between China and its major trading partners

Table 7 reports model adjusted aggregate bilateral trade flow and balance of trade between China, Hong Kong and their major trading partners along with official trade balance reported by both sides. For eastbound trade, Chinese total exports were adjusted upward by just 5%. However, the direction and magnitude of adjustment differs considerably by partners. China's reported exports to North American markets, Australia and New Zealand, the EU 15, and the EU 10 receive the largest upward adjustments ranging from 14% to 51%. Adjustments to China's exports to Russia, the Rest of Africa, the Rest of Asia, and the Rest of Europe have substantial downward adjustments of 39%, 29%, 20%, and 18%, respectively. This reflects the fact of a tendency by China's exporters to misidentify destinations by under-assigning exports for high-income markets but over-reporting exports to transition and less-developed economies. 13 Exports reported by China are reallocated to conform more closely to the partner reports while China's official reported exports to the world receive minimal adjustment. 14 For example, China's actual exports to the United States have an upward adjustment of 20%; for EU 15, it is 14.1%; for Japan, it is 5.6%; for Taiwan, it is 3.4 %; while for ASEAN, it is -4.5%, for Korea, it is -4%. These model-based adjustments can be viewed as corrective measures giving greater respect to the most reliable reporters in question. This also indicates that though there is still room for the model to further adjust Chinese exports to its major partners, relatively speaking, the quality of initial estimates is already much better than reported trade statistics as long as institutional factors that could distort official trade data are considered in the initial data adjustments.15

For westbound trade, the percentage adjustments made to China's imports are minor for high income partners of North America, the EU, and Japan. For the US exports to China, the model adjustment is only -5%; for Japan, 1%; and -2%, for the EU 15. China's total imports are left virtually unchanged with these minor adjustments to its leading suppliers. China is considered a relatively reliable reporter when it comes to identifying sources of imported goods. Thus, when discrepancies arise with other significant suppliers adjustments fall largely on China's partners having a lower reliability than the import reliability for China. For example, exports from ASEAN and Taiwan were adjusted upwards by more than 40% to conform closer to China's actual import records.

Modest adjustments to import and export flows of major trading partners can translate into noteworthy changes in the model adjusted trade balances. For example, the model

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¹³ Changes of this nature were been made to China's exports in previous versions of the GTAP database but without the guidance of a formal optimization model. Over the last decade China's total exports have come closer in line with the total partner's trade even as bilateral discrepancies have widened for some partners such as Mexico and Russia.

¹⁴ The model's objective of preservation of reliable reported trade comes into play as countries with weaker reporting records bear more of the adjustment. Both the initial bilateral discrepancy and country totals for merchandise trade govern the magnitude of the adjustment.

¹⁵ An area of research in trade data estimation our model does not specially address is for missing bilateral trade (missing trade by both reporters). However, the model allows for conversions of zero to nonzero flows as long as one side of the two trading parties report trade transaction had occurred. This step improved our estimation of re-export margins.

adjustment of China-ASEAN balance of trade is 135 times, for China-Japan trade balance it is 24%; for China-EU 15 trade balance it is 26%; and for the all-important China-US trade balance, there is additional 26% increase compared to the initial estimates. In short, because of large discrepancies to start with adjustments by the model makes a difference, sometimes a big difference in reconciling trade flows and in particular the trade balances between China and its major trading partners.

Nevertheless, most of the adjusted bilateral balance of trade lie reasonably between China's and its partner's officially reported data. The choice between China and its partner's trade is a compromise that hinges largely on individual country reporting quality. If the choice was made to completely disregard China' trade record it would result in extreme outcomes that may not be economically accurate for subsequent trade and policy analysis. For example, the model adjusted trade surplus for China is \$127.6 billion, which is significantly higher than China officially reported surplus¹⁶, but also significantly smaller than the \$302 billion that partners reported as a trade deficit with China. At the bilateral level, for instance, the model adjusted trade balance between China and Canada is \$7.6 billion in China's favor, which lies between the \$0.8 billion China reported trade surplus with Canada and \$13.5 billion Canada-reported trade deficit with China. Similarly, the model adjusted trade balance between China and the 15 members of European Union is \$71 billion dollars in China's favor, which also lies between the \$31 billion China reported trade surplus with EU 15 and EU 15-reported \$99 billion trade deficits with China (bottom section of table 7).

4.2 Adjusted Hong Kong re-export markup rates

An important output of the modeling approach is the adjustments to the Hong Kong reexport markup rates. For eastbound re-exports, the differences are bigger, while for westbound 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% to 27.5%, while for goods from rest of the world re-exported to China, the markup rate is decreased slightly from 11.6% to 10.2%. Because of some data issues are still unresolved in the model, the accuracy of these adjustments is subject to further investigation which will be elaborated upon in future work.

In terms of country breakdowns, the model adjusts the markup rates for all destination countries in eastbound trade downwards. Among them, the China-US markup rate is reduced from 33% to 29.4%. In comparison, for westbound trade, the adjustment are made in different directions, Some of China's top deficit countries/region, such as Japan, Korea, and ASEAN, -- experience significant decreases in the markup rates for their goods shipped to China via Hong Kong, while others countries, such as Mexico, EU 10, rest of

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¹⁶ The balance of trade data reported here are calculated from current model data base, which is different from the officially reported data because our model database excludes utility trade (such as electricity) and HS Chapter 98 and 99. There are also 36.9 billion Hong Kong re-exports of China originated products back to China did not count as China's imports as described in the text. Therefore, China's trade surplus in the model is lower than 32 billion, the official 2004 number reported by China.

Africa, other reporting countries and non-reporting partner countries, experience dramatic increase in the markup rates of their re-exports to China through Hong Kong.

To better understand our model results for eastbound trade, which experiences relatively significant adjustments, we seek to put the markup rates in perspective. Using the approach described in Section 3.2, we also calculate the markup rates for the past 11 years (1995-2005), and as shown in Figure 1, a pattern has been revealed: China-US markup rates are consistently higher than the China-world markup rates and both are gradually increasing over time. The relative size of the model adjusted China-US versus China world markup rates is consistent with the patterns and their sizes after the model adjustment still lie in their respective historical range.

Figure 1. Hong Kong markup rates for re-export Chinese goods to the US and to the rest of the world, $1995 \sim 2005$

The relatively significant adjustments of markup rates for Chinese goods may also have something to do with our model's treatment of the Hong Kong re-exports of Chinese goods back to China, totaling \$34.8 billion in Hong Kong trade statistics (or \$36.9 billion in Chinese Customs statistics). ¹⁷ In initializing our model, they are simply eliminated from the statistics of Hong Kong's re-exports, total exports and imports, but no similar adjustment has been made to China's direct exports to Hong Kong, because there is no such information available in Chinese official export data. As a result, adjustments have to be made to account for the absence of round-tripping trade flow, which may be in part lead to the adjustment of the re-export markup rates for the Chinese goods.

In terms of sectoral breakdown, in eastbound trade, significant upward adjustments occurs in the lightly traded primary sectors such as fishing, plant-based fibers, dairy products, processed rice and food products, vegetable oils, and ferrous metals, while negative adjustments are made for most manufacturing products. In westbound trade, there is a similar pattern, but the biggest rise in markup rates go to wearing apparel.

Table 9. Initial and Adjusted Estimates of Hong Kong's Re-export Rate by GTAP sectors, 2004, in percent

				Eastbour	nd Trade					West Bou	ınd Trade		
			al Estimate	s	Adju	sted Estim	ates	Init	ial Estimate	es	Adjι	ısted Estim	ates
		Hong Kong re-	· Hong		re-exports	Hong		Hong Kong	Hong		re-exports	Hong	
		exports as	Kong re-	Standard	as percent	Kong re-	Standard	re-exports	Kong re-	Standard	as percent	Kong re-	Standard
		percent of	exports	deviation	of China's	exports	deviation	as percent of	exports	deviation	of China's	exports	deviation
		China's total	markup	of markup	total	markup	of markup	China's total	markup	of markup	total	markup	of markup
GTAF	Sector name	exports	rate	rate	exports	rate	rate	imports	rate	rate	imports	rate	rate
1	Paddy rice,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Wheat,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Cereal grains nec,	0.0	61.5	18.9	0.0	68.5	33.6	0.1	10.0	0.0	0.0	0.0	
4	Vegetables fruit nuts,	0.3	24.4	16.9	0.4	23.7	17.2	24.5	1.6	0.8	24.2	2 0.6	5.9
5	Oil seeds,	0.1	32.7	15.3	0.1	11.4	16.5	0.1	4.6	1.1	0.1	0.0	0.0
6	Sugar cane and sugar beet,	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	Plant-based fibers,	0.9								10.1			
8	Crops nec,	2.4											
9	Bovine cattle sheep and goats horses,	0.0											
10	Animal products nec,	0.6											
12	Wool silk-worm cocoons,	10.0											
13	Forestry,	3.5											
14	Fishing,	2.6											
15	Coal,	0.0											
16	Oil,	0.0											
17	Gas,	0.0											
18	Minerals nec.	0.5											
19	Bovine cattle sheep and goat horse meat prods,	0.5											
20	Meat products nec,	0.3											
21	Vegetable oils and fats,	1.1	32.0										
22	Dairy products,	4.0					7.3						
23	Processed rice,	0.1	15.7	_									
24	Sugar,	0.1											
25	Food products nec,	1.3											
26	Beverages and tobacco products,	14.1	35.7										
27	Textiles,	11.2					12.9						
28		14.5							_				
29	Wearing apparel,	27.9											
30	Leather products, Wood products,	27.8 4.1	31.0										
	•	4.1 25.4											
31	Paper products publishing,		6.4										_
32	Petroleum, coal products,	0.1											
33	Chemical rubber plastic products,	6.0		_				14.9					_
34	Mineral products nec,	2.9											
35	Ferrous metals,	0.2											
36	Metals nec,	2.5						_					
37	Metal products,	8.4										_	
38	Motor vehicles and parts,	0.2						7.6					
39	Transport equipment nec,	1.6					14.2						
40	Electronic equipment,	15.9						30.1					
41	Machinery and equipment nec,	15.5							_				
42	Manufactures nec,	30.0											
	All sectors	13.3	30.9	6.8	12.9	27.5	7.0	15.8	11.6	4.5	13.5	10.2	8.8

Table 9 presents the initial and model adjusted Hong Kong re-exports as percentage of China's total exports. For eastbound trade, the model reduces the overall share of re-exports via Hong Kong in total Chinese exports by only 0.4% (from 13.3% to 12.9%). The sectors that are mostly affected are GTAP sector 42 (manufactures nec, -4.1%), sector 14 (fishery, -2.6%), sector 40 (electronic equipment, -2.4%) and sector 31 (paper products publishing, -2.0%). For westbound trade, the overall share of Chinese imports via Hong Kong in total Chinese imports declines by 2.3% (from 15.8% to 13.5%). Noteworthy impacts occur in four sectors: sector 28 (wearing apparel, -29.4%), sector 20 (meat products nec, 15.4%), sector 26 (beverages and tobacco products, 10.9%), and sector 40 (electronic equipment, -8.5%).

4.3 Hong Kong re-exports earnings and retained imports

Another key output used in the GTAP database is the estimates for retained imports and domestic exports for Hong Kong. The first panel of table 10 summarizes Hong Kong's earnings from its re-export of China-originated goods to other countries, from re-exports other countries' products to China, and from re-exports of commodities among other countries via Hong Kong by GTAP sectors. It shows that for all sectors combined, re-export earnings from Chinese goods are highest in absolute value and also have significant adjustment in terms of the percentage change (-10.8%), followed by earnings for re-exports of China-bound goods in terms of both value and percentage change (-12.5%). For all other goods, their earnings are far smaller in terms of value and percentage change (2.6%). Similar to discussions in section 4.2 on the round-tripping of re-exported Chinese goods, the same explanation may also apply to the dramatic adjustments in re-export earnings from goods related to China.

Across sectors, the percentage changes in re-export earnings from China-bound goods vary the most, followed by earnings from Chinese goods. Adjustments in earnings from all other goods have the minimal variations across sectors in percentage terms.

Nevertheless, both the initial and the adjusted estimates show that Hong Kong's re-export activities and their associated earnings are mainly concentrated on a few finished goods manufacturing sectors. In eastbound trade, these products are: (1) electronic equipment, (2) other machinery and equipment, (3) other manufactures, (4) wearing apparel, (5) leather and sporting goods, (6) textiles, and (7) chemical, rubber and plastic products. These seven GTAP sectors account for 93 percent Hong Kong's markup earnings from re-exporting China originated goods to the world in the initial estimates, and 92 percent in the model adjust estimates. Electronics equipment, other machinery and chemical, rubber, and plastic products are the three major products that Hong Kong re-exports for other countries to China. Earnings from these three GTAP sectors constitute more than three quarter of Hong Kong's markup earnings in westbound trade for both the initial and adjust estimates. Qualities of these products are usually more difficult to observe and more likely to require the service of intermediation to resolve information problems in trade (Feenstra and Hanson, 2004). Therefore, these estimates make good economic sense.

Table 10. Initial and Adjusted Estimates of Hong Kong's Re-export Earnings and Retained Imports, 2004, in million U.S. Dollars

Re-export for China Re-export to China Initial A

Excluding China

Including China

GTAP Sector name

The second panel of table 10 lists initial and adjusted estimates of Hong Kong's retained imports from all its trading partners excluding and including China by GTAP sectors. The initial estimates fall close to the estimates for 2004 published by Hong Kong Census and Statistics Department at the aggregate level when excluding imports from China (68.7 and 72.5 billion U.S dollars respectively), while the model-adjusted estimates are significantly larger. However, carefully comparing the initial and adjusted estimates, we find our current treatment of Hong Kong re-exports of China-originated products to China in the model is a major contributing factor to such results. Recall the discussions on our model's treatment of the \$34.8 billion round-tripping Chinese re-exports. It is very possible that the exporters misreported to Chinese Customs that such exports are bound for some other final destinations via Hong Kong for economic reasons, such as export rebates; but in fact these exports went back to China eventually as shown in both Hong Kong's re-exports and China's official imports statistics. Therefore, the model tends to over-estimate Hong Kong retained imports and introduces bias to its estimates of Hong Kong re-exports markup rates. For instance, the initial estimate of Hong Kong's retained imports for other machinery and equipments is just 7.8 billion, but after adjustment it jumps to 17.4 billion, while the corresponding Hong Kong re-exports from China back to China are 7.3 billion. Treating such round trip trade flows properly in the model will improve the accuracy of the final estimates.

4.4 Adjusted China's balance of trade at sector level

The first and second panels of table 11 presents initial and model adjusted net exports of China with all its trading partners, with and without Hong Kong, by GTAP sectors. There are several interesting features of the model adjusted estimates of China's net exports to the world. First, there is no sign change among China officially reported net exports between the initial and model adjusted estimates for all but three GTAP sectors (fishery, beverages and tobacco products and other transport equipment). Furthermore, when trade with Hong Kong is included, two of the three sectors are consistent to the net direction of the partner officially reported trade balances, the only exception is GTAP sector 14, fisheries, which is more problematic from an inherent data quality issue. 18 Finally, by adjusting Hong Kong's re-exports back to China's total export and imports, the adjusted net trade flows show China's current comparative advantages in the world market more clearly. For instance, the adjusted net exports are significantly larger than China officially reported in most labor intensive products such as leather and sporting goods, wood products, other manufactures and certain technology-capital intensive goods such as electronic equipments. All these imply that Hong Kong's re-export activities facilitate China to fully realize its comparative advantages and the model did a reasonable job in adjusting China's net trade flows.

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¹⁸ Products in this sector (raw fish and seafood) are sometimes traded offshore and often misclassified as processed products or assigned to unidentified partners leading to a high frequency of missing flows. This circumstance may lead to an invalid solution at the bound due to excessive missing bilateral trade values in

Table 11. Initial and Adjusted Estimates of China's Net Trade Flows, 2004, in million U.S. Dollars

			alance with A										
		Exc	luding Hong	Kong		Tra	ade Balance wit	th All Partne	ers	Trade Bala	ance with th	e United Sta	ates
		China			Partner	China			Partner	China			U.S.
		officially	Initial	Adjusted	offcially	officially	Initial	Adjusted	offcially	officially	Initial	Adjusted	officially
GTAI	P Sector name	reported	estimates	estimates	reported	reported	estimates	estimates	reported	reported	estimates	estimates	reported
1	Paddy rice,	47.5	47.6	3 45.9	-101.7	47.5	47.6	45.9	-101.7	0.0	0.0	0.0	0.0
2	Wheat,	-1,528.4	-952.1	-1,541.1	880.2	-1,528.4	-952.1	-1,541.1	880.2	-648.2	-495.1	1 -810.4	495.
3	Cereal grains nec,	69.0	199.3	118.6	-350.9	70.7	201.0	120.4	-352.8	0.1	-0.6	6 -0.2	9.2
4	Vegetables fruit nuts,	1,095.1	1,222.0										
5	Oil seeds,	-6,620.1	-4,665.6	-5,600.3	4,545.8	-6,623.1	-4,663.6	-5,596.7	4,542.6	-3,334.8	-2,314.9	-3,286.7	2,306.9
6	Sugar cane and sugar beet,	-0.4	0.0					-0.3					
7	Plant-based fibers,	-2,829.9	-2,057.0					-2,762.1	2,037.7	-1,766.1			
8	Crops nec,	898.0	920.4	477.9	-1,183.9	1,006.7	1,030.3	573.7	-1,301.1	45.9	46.3	3 21.1	-120.
9	Bovine cattle sheep and goats horses,	-184.3	-154.3		,		,		144.2				
10	Animal products nec,	-1,216.1	-955.0	-826.9	92.9	-1,725.1	-706.9	-520.8	-186.2	-380.0	-414.9	-375.7	
12	Wool silk-worm cocoons,	-976.0	-978.2					-941.0					
13	Forestry,	-2,816.1	-1,421.5										
14	Fishing,	729.5			-615.7								
15	Coal,	2,927.2			-4,155.3								
16	Oil,	-24,368.3						-17,763.5					
17	Gas,	-0.1	-140.5					120.0					
18	Minerals nec,	-18,063.6							8,308.6				
19	Bovine cattle sheep and goat horse meat prods	-441.3	,		275.7			-258.7	253.7				
20	Meat products nec,	923.1	901.9										
21	Vegetable oils and fats,	-3,775.6											
22	Dairy products,	-425.8	,		,			,					
23	Processed rice,	-73.5											
24	Sugar,	-276.0							82.8	_			
25	Food products nec.	6,575.6						7,261.1	-9,109.5				
26	Beverages and tobacco products,	27.5						512.4	,				
27	Textiles,	23,596.4	28,304.8		-26,059.3					_			
28	Wearing apparel,	40.695.1	47.645.2	,							,		,
29	Leather products,	17,201.4	24,896.2		-34,024.2			,		-,			,
30	Wood products,	11,559.4	12,772.9										
31	Paper products publishing,	-7,344.8	-4,006.7	,			,	-4,965.3			,	,	,
32	Petroleum, coal products,	-3,282.4	-2,674.7	,									,
33	Chemical rubber plastic products,	-44,194.3	,		,								
34	Mineral products nec,	5,686.2			-9,761.6			7,591.3		1,539.0			
35	Ferrous metals,	-11,957.5	,	,			,						
36	Metals nec.	-11,957.5	-8,361.7 -7,345.9	,			,	,	,				
37	Metal products,	12.367.4	15,022.7		-18,289.3		,	13,856.6					
		,	-4,333.7		,			-3,935.6					
38	Motor vehicles and parts,	-4,980.3			8,723.0								
39	Transport equipment nec,	2,205.4	2,069.0				,			, -		,	
40	Electronic equipment,	22,336.5	70,769.5		-135,930.9				-152,064.1	35,413.8			
41	Machinery and equipment nec,	-43,914.9	,	,			,	,	,			,	,
42	Manufactures nec,	17,698.2	27,317.8	,	,								-24,511.
	All sectors	-24,248.6	156,164.8	3 124,774.0	-324,469.7	-2,263.1	177,284.6	127,636.3	-393,562.8	80,395.7	109,345.1	1 137,570.3	-174,095

China's trade balance with the United States by GTAP sector is presented (second panel of table 11) as an example to illustrate the features of model adjusted bilateral net trade flows at sector level. It also shows that most model adjusted sector net trade flows lie between China and the U.S. officially reported statistics except few sectors, which are associated with either very small trade balance or China and US both reported surplus or deficit with each other. It is also interesting to note there are four GTAP sectors where the initial estimates of the sector balance of trade were adjusted out of the range reported by the two trading partners. Yet the model is able to correctly realign the final estimates back to (or closer to) an acceptable range (vegetable and fruits, other animal products, forestry, fishing). This further demonstrates some desirable attributes of the model not only as a tool for statistical reconciliation but preserving consisting in global trade flow data where economic soundness of data must be respected.

V. Concluding Remarks

This study constructed a mathematical programming model to estimate re-export markups and reconcile detailed bilateral trade statistics from China, Hong Kong and their trading partners. Five key steps are required to link the model with actual trade statistics. The model was applied to 2004 bilateral world trade data in GTAP sector classifications to produce Hong Kong re-exports adjusted trade flows to be contributed to the version 7 GTAP database. Preliminary results show that the model is able to eliminate statistical discrepancies efficiently and at the same time provides positive re-export markup estimates in both directions for all covered commodities. Hong Kong's re-export mark-up, each trading partner's exports and imports via Hong Kong as percent of the country's total exports to and import from China, and adjusted bilateral trade balances among China, Hong Kong and their partner countries by commodity are all part of the model solution.

In conclusion, the model provides a flexible tool to reconcile trade statistics from China, Hong Kong and their trading partners simultaneously. Advantages of the model are its flexibility in data requirements and its desirable theoretical and empirical properties. It can also be applied to reconcile direct and indirect trade for other regions of the world where re-export activities create major discrepancies. It not only provides a tool for the preparation of global trade data in future versions of GTAP database, but also contributes to the methodological development to estimate and reconcile discrepancies in international trade statistics when re-export activities diminish the ability of a country to identify its partner countries correctly.

However, there are several caveats that need mentioning. First, we keep re-export statistics reported by the Hong Kong Census and Statistics Department unchanged in the model during the adjustment process, because it is the most reliable source to provide both origins and destinations of re-exports through Hong Kong. In reality, such statistics also subject to errors as other reported trade statistics.

Second, the model assumes both China and Hong Kong correctly report their total exports to and imports from the world. Therefore, these totals enter the model as controlled constants. However, in the real world, the sum of partner countries reported trade with

China and Hong Kong in some sectors may well exceed what China and Hong Kong reported as illustrated by the huge negative discrepancies in derived trade statistics for the no reporting country block in our model. Therefore, there is an inconsistency at the global level which can not be eliminated by the current model alone. To solve this issue, a global commodity equilibrium adjustment model is needed. Such a model would treat each country as both supplies and demanders for each commodity and reconciles each countries' total exports and imports statistics using equation (17) as its constraint to solve a set of global consistent total exports and imports (no bilateral trade data needed) for each commodity and every country, which then can be used as input to our current model to solve the bilateral details.

Third, we made our estimates on bilateral transport margins primarily from trade-related shipping cost information from the United States and these estimates enter the model as constant parameters. The associated errors with these parameters may transmit through the model thus impact the accuracy of the re-export markup and bilateral trade flow estimates. Therefore, the numeric estimates reported in the paper should be interpreted with caution and sensitivity analysis should be conducted in future studies to check how changes in these fixed parameters of the model may impact results from its solutions.

Finally, the current model only reconciles one year's bilateral trade data, to be consistent with the 2004 base year of version 7 GTAP database. However, a three year average may be more desirable. This would smooth any unusual annual variation of the bilateral trade data, reducing time differences in record keeping which might cause discrepancies, and it would also provide more non-zero entries in the trade flow matrix. This would have a positive impact on the development of CGE-based trade policy analysis using future versions of GTAP database.

References

Antonello, Paola, 1990, "Simultaneous Balancing of Input-Output Tables at Current and Constant Prices with First Order Vector Autocorrelated Errors," *Economic Systems Research*, Vol. 2, No. 2, pp. 157-171

Bacharach, M, 1970, *Bi-proportional Scaling and Input-output Change*, Cambridge University Press, Cambridge

Bachem, Achim and Bernhard Korte (1981) Mathematical Programming and Estimation of Input-Output Matrices, Report WP78102, University of Bonn

Baras, JS and Panoutsopoulos, 1993, "World Trade Data Estimation: A Methodology Using Progressive Elimination and Constrained Quadratic Optimization," The World Bank (unpublished report), March.

Batten, F. David, 1982, "The Interregional Linkages between National and Regional Input-Output Models," *International Regional Science Review*, Vol. 7, pp. 53-67.

Bohatyretz, Sandra and Bruna Santarossa, 2005, "Merchandise Trade Reconciliation Study: Canada-China, 2002 and 2003," *Canadian Trade Review*, No 3, International Trade Division, Statistics Canada, Ottawa, http://www.statcan.ca/english/research/65-507-MIE2005003.htm

Brooke, Kendrick, Meeraus, and Raman, 2005, "GAMS -- User's Guide" GAMS Development Cooperation, Washington, DC.

Byron, Ray P. 1978. "The Estimation of Large Social Account Matrix," *Journal of Royal Statistical Society*, A, 141 (Part 3), 359-367.

Canning, Patrick and Zhi Wang, 2005, "A Flexible Mathematical Programming Model to Estimate Interregional Input-Output Accounts." *Journal of Regional Sciences* 45(3):539-563, August.

Deardorff, Alan V. 1998, "Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World?" In J. A. Frankel, ed., *The Regionalization of the World Economy*, pp. 7-22. Chicago: University of Chicago Press.

Jonathan, Eaton and Samuel Kortum, 2002, "Technology, Geography, and Trade," *Econometrica*, Vol. 70: 1741-1779, September.

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.

Feenstra, Robert C., James R. Markusen and Andrew K. Rose, 2001, "Using the Gravity Equation to Differentiate Among Alternative Theories of Trade," *Canadian Journal of Economics*, Vol. 34: 430-447, May.

Feenstra and Robert C. and Gordon H. Hanson, 2004, "Intermediaries in Entrepôt Trade: Hong Kong Re-Exports of Chinese Goods," *Journal of Economics and Management Strategy*, Vol. 13, No. 1, pp. 3-35.

Feenstra, Robert and Gordan Hanson, 2005, "Ownership and Control in Outsourcing to China: Estimating the Property-Rights Theory of the Firm," *Quarterly Journal of Economics*, p729-761, May

Ferrantino Michael J and Zhi Wang, 2007, "Accounting for Discrepancies in Bilateral Trade: The Case of China, Hong Kong, and the United States" ITC staff working paper, 07-04-A.

Fung, K C, 1996, "Accounting for Chinese Trade: Some National and Regional Considerations," *NBER Working Papers 5595*, National Bureau of Economic Research (NBER), Cambridge, MA

Fung, K C and Lawrence Lau, 1998, "The China-United States Bilateral Trade Balances: How Big Is It Really?" *Pacific Economic Review*, No. 3, October, pp. 33-47

Fung, K C and Lawrence Lau, 2001, "New Estimates of U.S.-China Bilateral Trade Balances," *Journal of the Japanese and International Economics*, Vol. 15, pp. 102-130

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

Florian, M, 1986, "Nonlinear Cost Network Models in Transportation Analysis," *Mathematical Programming Study*, Vol. 26, pp. 167-196

Friedlander, D, 1961, "A Technique for Estimating Contingency Table, Given the Marginal Totals and Some Supplementary Data," *Journal of the Royal Statistical Society*, A. Vol.124, Part 3, pp. 412-420

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

Harrigan, J. Frank and Iain Buchanan. 1984. "A Quadratic Programming Approach to Input-Output Estimation and Simulation," *Journal of Regional Science*, 24(3), 339-358.

Hong Kong Census and Statistical Department (HKCSD), *Hong Kong Monthly Digest of Statistics*, various issues, Hong Kong

Johnston, R.J., A.M. Hay, and P. J. Taylor, 1982, "Estimating the Sources of Spatial Change in Election Results: A Multipropotional Matrix Approach," *Environment and Planning*, A, Vol. 14 pp. 951-962

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

Kaneko, Yukio, 1988, "An Empirical Study on Non-survey Forecasting of the Input Coefficient Matrix in a Leontief Model," *Economic Modelling*, No.1, pp. 41-48

Klincewicz, J. G., 1989, "Implementing an Exact Newton Method for Separable Convex Transportation Problems," *Networks*, Vol.19, pp. 95-105

Lahr, Michael L, 2001, "A Strategy for Producing Hybrid Regional Input-output Tables," in Lahr, Michael and Erik Dietzenbacher (eds.), *Input-Output Analysis: Frontiers and Extensions*. Basingstoke, U.K: Palgrave, pp. 211-242.

Miller, R. E. and P.D. Bliar, 1985, *Input-Output Analysis: Foundations and Extensions*, Prentice Hall, Englewood Cliffs, New Jersey

Mohr, Malte, William H. Crown and Karen R Polenske, 1987, "A Linear Programming Approach to Solving Infeasible RAS Problems," *Journal of Regional Sciences*, 27(4), 587-603

Nagurney, A., Dae-Shik Kim and A.G. Robinson, 1990, "Serial and Parallel Equilibration of Large-Scale Constrained Matrix Problems with Application to the Social and Economic Sciences," *The International Journal of Supercomputer Applications*, Vol. 4, No. 1, pp. 49-71.

Plane, D.A., 1982, "An information theoretic approach to the estimation of migration flows," *Journal of Regional Science*, 22: 441-456.

Ploeg, van der C3oa82, "Reliability and the Adjustment of Sequences of Large Economic Accounting Matrices," *Journal of the Royal Statistical Society*, A. 1453o69-194

Ploeg, van der C3oa84, "General Least Squares Methods for Balancing Large Systems and Tables of National Accounts," *Review of Public Data Use*, 12, 17-33

Ploeg, van der C3oa88, "Balancing Large Systems of national Accounts," *Computer Science in Economics and Management* 1, 31-39

Robinson, Sherman, Andrea Cattaneo and Moataz El-Said, 2001, "Updating and Estimating a Social Accounting Matrix Using Cross Entropy Methods," *Economic System Research*, 13(1), 47-64

Schindler, W. John and Dustin Beckett, 2005, "Adjusting Chinese Bilateral Trade Data: How Big China's Trade Surplus?" *International Journal of Applied Economics*

Weale, Martin R, 1989, "Asymptotic Maximum-Likelihood Estimation of National Income and Expenditure," Cambridge, mimeo.

Yao, Shunli, 2000, *Three Essays on China's Foreign Trade*, unpublished PhD dissertation, University of California, Davis.

Zenios, Stavros A., Arne Drud and John M. Mulvey, 1989, "Balancing Large Social Accounting Matrices with Nonlinear Network Programming," *NETWORKS*, 19, 569-585.

Appendix Table A. Countries in the other reporting country block of the model

Country number	ISO3	Country name	Country number	ISO3	Country name
1	ABW	Aruba	33	KNA	St. Kitts and Nevis
2	AND	Andorra	34	LBY	Libya
3	ARM	Armenia	35	LCA	St. Lucia
4	AZE	Azerbaijan	36	LSO	Lesotho
5	BDI	Burundi	37	MDA	Moldova
6	BFA	Burkina Faso	38	MDV	Maldives
7	BHR	Bahrain	39	MKD	Macedonia, FYR
8	BIH	Bosnia and Herzegovina	40	MLI	Mali
9	BLR	Belarus	41	MNG	Mongolia
10	BLZ	Belize	42	MRT	Mauritania
11	BOL	Bolivia	43	MSR	Montserrat
12	BRB	Barbados	44	MUS	Mauritius
13	BRN	Brunei	45	NAM	Namibia
14	CAF	Central African Republic	46	NCL	New Caledonia
15	CIV	Cote d'Ivoire	47	NER	Niger
16	CMR	Cameroon	48	NIC	Nicaragua
17	COK	Cook Islands	49	NPL	Nepal
18	CPV	Cape V erde	50	OMN	Oman
19	DMA	Dominica	51	PNG	Papua New Guinea
20	ERI	Eritrea	52	PYF	French Polynesia
21	ETH	Ethiopia(excludes Eritrea)	53	QAT	Qatar
22	FJI	Fiji	54	RWA	Rwanda
23	GAB	Gabon	55	SEN	Senegal
24	GEO	Georgia	56	SLE	Sierra Leone
25	GIN	Guinea	57	SLV	El Salvador
26	GMB	Gambia, The	58	STP	Sao Tome and Principe
27	GRD	Grenada	59	SUR	Suriname
28	GRL	Greenland	60	SWZ	Swaziland
29	GUY	Guyana	61	SYC	Seychelles
30	HND	Honduras	62	TTO	Trinidad and Tobago
31	ISL	Iceland	63	VCT	St. Vincent and the Grenadines
32	JAM	Jamaica	64	WSM	Samoa

Country Name	China actual exports to partners	China direct exports to Partners	Hong Kong total o exports to partner	Hong Kong domestic export to partner	partner via	Hong Kong re-export markup	total imports from Hong	Partners actual imports from China	Partner imports of Hong Kong domestic products	g direct	China		nc re-export	China after	trade with	Partner reported f balance of trade with China	Partners balance of trade with Hong Kong after adjustment	trade with		cif/fob ratio, China to partner	cif/fob ratio, Hong Kong to partner
Variable in the model	TX(CH,r)	DX(CH,	r) TX(HK,r)	DX(HK,r)	RX(s,CH)	RXM(CH,r)	TM(HK,r)	TM(CH,r)	DM(HK,r)	DM(CH,r)	(RX(CH,r)- RXM(CH,r))/TX(CH,r)	SDX(r)		r TX(CH,r)-		- TX0(r,CH)) TM0(CH,r)			- TX0(r,HK)- TM0(HK,r)	cif(CH.r)	cif(HK,r)
United States	179,178	154,62	28 37,707	10,190	35,587	10,444	40,971	188,361	11,708	3 161,61	9 13.7	0	.0 29.	4 137,570	80,396	-174,095	2,144			1.056	
Canada	13,695	11,62	2,837	637	2,761	646	3,004	14,618	692	2 12,39	5 15.1	0	.0 23.	4 7,588	816	-13,460	64	1,927	-1,620	1.072	1.052
Mexico	8,543	7,83	34 1,011	268	808	86	1,070	8,974	293	8,21	8.3	0	.0 10.	6 7,096	2,831	-13,529	208	543	-625	1.060	1.048
Australia	11,732					760	3,198	12,504				0								1.068	
New Zealand	1,675					106	411	1,793				0									
Japan	86,217					2,839	12,479	91,755				0								1.065	
Korea Rep	28,024				2,832	1,333	5,953	29,912				0									
Taiwan China	15,878		-			525 974	6,516	16,688				0								1.053 1.040	
Singapore Macao	16,155 1,702					974 76	6,410 1,308	16,769 1,822		,		0		- , -						1.040	
Indonesia	4,957	4,28				171	1,194	5,315		,		0		,	,				, -		
Malaysia	9,915				1,625	593	2,745	10,425				0								1.055	
Philippines	3,953					548	2,884	4,169				0									
Thailand	7,472	6,39	9 3,074	1,474	1,838	750	3,202	7,892	1,539	6,75	3 14.4	0	.0 40.	8 -3,113	-5,757	7 -1,158	-743	-2,210	1,774	1.060	1.040
Vietnam	3,342	2,74	3 1,560	649	746	134	1,670	3,577	705	5 2,92	7 17.9	0	.0 18.	0 2,306	1,777	-1,602	363	3 771	-1,661	1.084	1.058
Cambodia	659	34	10 577	233	393	68	635	706	26	1 35	3 48.4	0	.0 17.	2 643	3 422	-402	228	3 443	-164	1.085	1.086
Bangladesh	2,288	1,98	543	3 203	418	102	590	2,447	225	5 2,10	3 13.5	0	.0 24.	5 2,219	1,825	-1,556	146	419	-682	1.073	1.074
India	6,940	6,22	2,589	862	813	90	2,641	7,356	884	4 6,61	3 10.3	0	.0 11.	1 189	-1,776	-1,403	-1,173	-1,686	233	1.060	1.019
Sri Lanka	940				355	136	647	1,014				0			668	-458				1.084	
Pakistan	1,758					14	153	1,874				0								1.068	
Austria	1,681	1,32				152	625	1,777				0									
Belgium	7,238		,		1,047	297	1,695	7,729		-,		0			, -	- ,					
Germany Denmark	35,100 2,405				-	1,779 208	8,013 806	36,882 2,581				0									
Spain	8,475					385	1,816	9,084				0									
Finland	2,928					318	871	3,043				0						,			
France	16,286					709	3,247	17,191				0								1.056	
United Kingdom	22,373					2,170	8,559	23,948				0									
Greece	1,569					44	274	1,694				0								1.080	
Ireland	3,180	2,96	507	268	328	108	531	3,293	3 28	1 3,06	6.8	0	.0 32.	9 2,035	946	-2,748	-408	-596	186	1.038	1.043
Italy	12,729	10,76	7 2,719	580	2,654	652	2,831	13,630	608	3 11,54	9 15.4	0	.0 24.	6 6,157	2,731	-9,246	-1,450	-336	875	1.071	1.042
Luxembourg	155	12	28 82	2 23	35	8	84	162	2 24	13	4 17.3	0	.0 23.	5 24	788	3 40) 8	3 45	-95	1.036	1.028
Netherlands	19,465					1,089	4,454	20,367				0									
Portugal	566					33		608				0									
Sweden	2,283				652	192	1,078	2,450				0								1.070	
Switzerland	2,008		-				1,076	2,128				0								1.060	
Norway	1,513						363	1,617				0									
Cyprus Czech Republic	201 2.558	17 2.38				4 77	44 298	217 2.667				0								1.077 1.046	
Estonia Estonia	2,330	,			64	19		2,007		, .		0		,							
Hungary	2,969				747	206	928	3,064				0									
Lithuania	311	29				5	27	332				0									
Latvia	110)2 26		26	8	27	118				0									
Malta	82		57 25			4	26	87				0									
Poland	2,876	2,68				64	290	3,064	7			0				3 -3,509					
Slovak Republic	368	33	32 49) 12	43	6	51	388	3 13	3 34	9.9	0	.0 14.	8 275	31	1 -719	-2	2 32	-61	1.059	1.046
Slovenia	186	15	i8 36	5 7	36	7	39	199)	3 16	3 15.2	0	.0 20.	5 144	165	5 -152	2	2 25	-23	1.070	1.055
Albania	64	- 6	3 '	1 0	1	0	1	69) () 6	8.0	0	.0 35.	0 61	57	7 -100	0) 1	-1	1.065	1.042
Bulgaria	407	37	' 4 50) 12	38	4	53	432	2 13	3 39	8.1	0	.0 11.	0 371	270	-427	' 8	38	-53	1.066	1.036

Country Name	China 6094, actual 28 exports to partners	direct 16 exports to		domestic	partner via	Hong Kong re-export markup	Partners total imports from Hong Kong	Partners actual imports from China	Partner imports of Hong Kong domestic products			Statistical	Hong Kong	China after	balance of trade with		trade with Hong Kong	trade with			cif/fob ratio, Hong Kong to partner
Croatia	443	422	39	15	5 30	8	41	472	16	3 449	4.8	0.0	27.2	415	323	-628	12	33	3 -50	1.069	1.052
Romania	873	843	46	13	3 37	6	48	936	14	1 903	3.5	0.0	16.8	723	730	-865	5	19	-20	1.074	1.038
Yugoslavia	281	272	12	;	3 12	3	13	301	3	3 292	3.1	0.0	25.6	261	150	-540) 1	10) -1	1.075	1.048
Ukraine	839	793	56		7 56	10	59	901	7	7 853	5.4	0.0	17.8	577	403	-69	-433	42	2 6	1.073	1.049
Russian Federation	5,741	5,450	376	40	0 361	65	392	6,237	42	5,928	5.1	0.0	18.0	-3,688	-3,009	3,635	-63	-124		1.078	1.041
Kazakhstan	997	991	6		1 10	5	6	1,081	1	1,075	0.5	0.0	0 48.2	-354	-74	1,006	5 1	7		1.078	1.082
Kyrgyz Republic	199	199	1	(0 0	C) 1	215		215	0.2	0.0	0 8.5	153	381	-41	0	-1		1.075	1.077
Argentina	1,235	1,103	172	2	7 151	16	181	1,301	30	1,161	10.7	0.0	0 10.9	-1,550	-2,407	1,229	-1	-50) -1	1.057	1.045
Brazil	4,101	3,415	978	252	2 778	82	1,035	4,336	280	3,611	16.7	0.0	0 10.6	-2,999	-5,030	1,388	-72	-61	-32	1.061	1.041
Chile	1,841	1,572	302	24	4 303	28	325	1,957	30	1,667	14.6	0.0	9.3	-1,503	-1,989	1,363	-28	122	-15	1.067	1.057
Colombia	950	874	94	15	5 86	9	100	1,010	17	929	7.9	0.0	10.8	807	453	-1,096	5	72	2 -8:	1.068	1.054
Ecuador	528	501	34		6 34	7	36	564	7	7 535	5.0	0.0	20.0	462	2 250	-654	-2	24	-2	1.072	1.064
Peru	628	581	65	15	5 55	6	70	668	17	617	7.5	0.0	0 11.7	-668	-1,108	468	-3	24	-4:	1.069	1.064
Paraguay	388	280	131	14	4 124	14	138	405	17	7 290	27.9	0.0	11.3	321	175	-442	. 7	112	-13	1.047	1.041
Venezuela	448	388	95	32	2 73	11	103	479	36	3 414	13.4	0.0	15.6	-381	-146	-199	30	61	-11:	1.071	1.065
Uruguay	199	180	27	(6 22	3	29	209	7	7 189	9.6	0.0	0 13.0	93	99	-61	-3	-5	5 -1:	1.056	1.051
Costa Rica	230	212	40	2	1 25	6	43	247	23	3 227	8.0	0.0	25.2	-653	-489	-107	-17	-246	6	1.079	1.069
Guatemala	517	429	125	34	4 110	21	137	556	39	459	17.0	0.0	18.7	495	349	-185	32	113	-15	1.079	1.078
Panama	1,301	810	538	23	3 548	49	570	1,378	29	854	37.7	0.0	0 8.9	1,289	2,171	-509	5	567	-53	1.068	1.051
Cuba	443	438	8	:	2 5	C) 8	475	. 2	2 470	1.1	0.0	7.9	220	135	-510	-1	-6	· -:	1.076	1.037
Algeria	991	985	24	19	9 7	2	26	1,064	20	1,059	0.5	0.0	24.8	742	711	-667	18		3 -3:	1.078	1.047
Egypt Arab Rep	1,154	1,061	136	34	4 112	17	147	1,235	38	3 1,134	8.1	0.0	15.5	1,008	1,151	-569	15	67	· -11	1.071	1.068
Iran Islamic Rep	1,926	1,894	78	3	7 36	4	84	2,035	41	2,001	1.6	0.0	11.8	-2,972	-2,021	-1,404	-45	-79) 20	1.065	1.044
Israel	1,547	1,197	1,134	48	5 495	134	1,160	1,661	497	7 1,289	22.6	0.0	27.1	537	558	-695	-606	-252	2 8	1.071	1.021
Jordan	682	536	197	4	5 185	37	217	730	52	2 570	21.4	0.0	19.7	649	534	-642	40	196	-20	1.081	1.078
Lebanon	597	572	42	10	0 38	12	45	642	. 11	615	4.3	0.0	30.7	583	3 471	-705	6	38	3 -30	1.077	1.059
Morocco	744	723	39	17	7 26	5	42	794	19	772	2.8	0.0	18.7	594	720	-695	-10	-84	3	1.071	1.064
Nigeria	1,108	1,032	140	48	8 99	21	150	1,184	53	3 1,101	6.9	0.0	21.5	924	1,253	-676	37	100	-19	1.066	1.061
Saudi Arabia	3,183	2,949	304	48	8 266	27	317	3,463	49	3,213	7.4	0.0	0 10.2	-3,822	-4,749	4,477	-118	-76	8:	1.089	1.046
Syrian Arab Republic	611	581	42		8 37	5	44	658	8	625	5.0	0.0	14.8	583	662	-434	6	41	-34	1.071	1.031
Tunisia	241	231	20	9	9 13	3	3 21	256	; 9	9 246	4.1	0.0	20.5	212	2 211	-266	7	7	-20	1.071	1.046
Turkey	3,825	3,461	535	102	2 422	52	561	4,046	112	3,660	9.5	0.0	12.3	3,442	2,205	-4,152	16	358	-420	1.062	1.042
Yemen	373	370	5	2	2 3	1	6	403	3	3 401	0.7	0.0	16.5	-906	-1,007	936	-7	-10) .	1.083	1.061
Benin	237	234	6		1 4	C) 6	257	' 1	1 254	1.3	0.0	0 12.0	129	466	33	0	6	S -	1.080	1.051
Ghana	497	482	26	9	9 18	3	3 28	533	10	516	3.0	0.0	16.3	446	430	-345	4	-86	3 4	1.077	1.071
Kenya	385	334	70	17	7 60	8	3 76	410	19	355	13.2	0.0	13.6	356	313	-176	8	17	-4	1.073	1.072
Mozambique	58	55	10		6 4	1	10	64	6	60	5.8	0.0	0 19.0	20) 31	-19	5	-8	3 -14	1.094	1.058
Malawi	21	20	3	:	2 2	1	3	23	. 2	2 22	4.8	0.0	39.9	20) 19	-25	5 1	2	2 -	1.077	1.064
Madagascar	315	236	87	:	2 91	10	96	337	' 4	1 250	25.2	0.0	0 11.3	301	134	-171	-2	69	5284 1	.089 1	.083

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Appendix Table C. Adjusted Estimates of Bilateral Trade Between China, Hong Kong and their Partner Countries, Westbound Flows, 2004, in Millions of U.S. Dollars

	Partner actual	Partner direct	Partner total		Partner re- exports to China via	Hong Kong re	Hong Kong total imports from	China actual imports from	Hong Kong retained imports from	China direct	Re-exports as percent of partner total		Hong Kong re	Partners balance of trade with China after	Partners balance of trade with Hong Kong after	cif/fob ratio, partner to	cif/fob ratio, partner to
Country Name	exports to China	exports to China		Hong Kong			partners	partners	partner	import from partner	China	discrepanci es	markup rate		adjustment		Hong Kong
	T)// O/I)	5.4. 64.1		5.//	D.// O.I.						(RX(r,CH)- RXM(r,CH))		RXM(CH,r)/	,	TX(HK,r)-	O.I.)	
Variable in the model United States	TX(s,CH) 41,608		(-, ,	DX(s,Hk) 8,046	RX(s,CH) 5,795	RXM(s,CH) 587	15,231		DM(s,HK) 8,415	(-,-,	TX(r,CH) 12.3	SDX(s)	RX(CH,r)	TX(r,CH) -137,570	TX(r,HK) -2,144	cif(s,CH) 1 1.027	cif(s,HK) 7 1.023
Canada	6,106								-						-		
Mexico	1,447						176							-			
Australia	8,562																
New Zealand	1,158													-			
Japan	91,099			12,459	20,625						20.5	0.0	8.5	4,883	10,690	1.045	1.040
Korea Rep	66,461	60,218	13,805	6,557	6,730	235	14,399	70,106	6,877	63,512	9.6	0.0	3.5	38,437	4,196	1.059	1.033
Taiwan China	70,126	57,608	25,431	11,655	14,773	1,759	26,615	73,013	12,313	59,812	18.3	0.0	11.9	54,248	9,457	7 1.053	1.043
Singapore	20,102	17,782	15,796	12,918	2,471	64	16,371	20,768	13,390	18,326	11.8	0.0	2.6	3,947	10,543	3 1.039	1.033
Macao	228	219	285	122	12	2	302	242	129	232	4.2	0.0	19.2	-1,473	-219	1.062	1.050
Indonesia	6,748	6,076					1,537	7,428	703	6,691	10.5	0.0	12.4	1,791	349	1.113	1.083
Malaysia	20,183								-	-							
Philippines	11,068													-			
Thailand	10,585																
Vietnam	1,036				111												
Cambodia	15					-											
Bangladesh	69													-			
India	6,751			2,035				-							-		
Sri Lanka	26																
Pakistan	639 1,457			171 337	428 134												
Austria Belgium	3,122																
Germany	28,130								-								
Denmark	1,364						-,		,					-,			
Spain	1,582							-									
Finland	2,907									-							
France	7,455									-	7.1						
United Kingdom	5,128							-	-						-		
Greece	83	77	57	48	11	5	60	87	50	81	7.0	0.0	46.2	-1,487	-20	1.057	1.043
Ireland	1,145	892	1,010	676	484	226	1,035	1,171	693	912	22.4	0.0	46.7	-2,035	408	3 1.025	1.021
Italy	6,572	5,201	3,616	2,030	1,537	93	3,869	6,811	2,200	5,334	21.5	0.0	6.1	-6,157	1,450	1.042	1.051
Luxembourg	131	130) 18	15	13	13	18	137	' 16	136	0.5	0.0	94.8	-24	8	3 1.044	1.033
Netherlands	3,039	2,753	1,316	978	301	4	1,375	3,147	1,025	2,844	9.6	0.0	1.5	-16,426	-622	2 1.038	1.038
Portugal	210	196	68	45	21	6	71	218	3 47	203	7.0	0.0	29.3	-356	12	2 1.055	1.042
Sweden	2,945									-							
Switzerland	3,135				516				-	-							
Norway	1,006																
Cyprus	2																
Czech Republic	429																
Estonia	30																
Hungary	424													-			
Lithuania	9																
Latvia	10			1	0												
Malta	132																
Poland	501 93													-			
Slovak Republic Slovenia	93 42					_	16 14										
Albania	42														. 2		

Country Name	Partner actual exports to China	exports to	Partner total	emain in	China via	Hong Kong re- export	from	actual imports from	Hong Kong retained imports from partner	China direct import from partner	Re-exports as percent of partner total exports to China		Hong Kong reexport	Partners balance of e-trade with China after adjustment	Partners balance of trade with Hong Kong after adjustment	cif/fob ratio, partner to China	cif/fob ratio, partner to Hong Kong
Bulgaria	35		6	4			6		4	37				,	,		<u> </u>
Croatia	28		3	2			3		3								
Romania	151	144	24	7			26	162	8								
Yugoslavia	19		4	2		13	4	20	3								
Ukraine	261	251	451	440			478	281	466								
Russian Federation	9,428		308	103			344	10,131	125	9,965							
Kazakhstan	1,351	1,351	0	0			0	1,425	0								
Kyrgyz Republic	46		0	0			0	49	0								
Argentina	2,786		158	28		-	170	3,240	36								
Brazil	7,099		695	324	352		756	8,231	363	7,885				-			
Chile	3,344		149	524 52			176	3,490	68		3.1			-			
Colombia	3,344 143		20	52 10			21	3,490 148	11	3,381 142							
Ecuador	4 206		9	8	_		9	71	9								
Peru	1,296		33 12	17			40	1,397 72	23 9		1.3 7.9						
Paraguay	67	62		8			15	936									
Venezuela	829		11				13		3		0.6						
Uruguay	106		20	9			21	111	10								
Costa Rica	883		183	38			191	887	43								
Guatemala	22		2	2		1	2	25	2								
Panama	12		19	18		-	21	13	19								
Cuba	223		11	3			11	232	4	232							
Algeria	248		1	1	0		1	261	1	261	0.0						
Egypt Arab Rep	146		27	19			28	171	19								
Iran Islamic Rep	4,898		114	83			121	5,176	88								
Israel	1,010		1,629	1,091	216		1,648	1,037	1,106								
Jordan	32		5	4		1	5	35	5								
Lebanon	14		8	4			8	15	4	12							
Morocco	149		116	27	82		119	157	29								
Nigeria	184	177	18	10			19	193	11	186							
Saudi Arabia	7,005		336	166			371	7,470	185								
Syrian Arab Republic	29		3	2			3	32	2		1.2						
Tunisia	29		5	2			6	33	2								
Turkey	382		130	87	47		143	427	97	383							
Yemen	1,279		12	9	_		13	1,343	10								
Benin	108	108	0	0			0	117	0		0.0	0.0	0.0	-129) (1.086	1.064
Ghana	52		87	5	-		110	58	5								
Kenya	29		30	9			33	30	11	9		0.0					3 1.074
Mozambique	38	34	5	1	7	3	7	43	2	38	11.0	0.0	36.6	3 -20			7 1.113
Malawi	1	1	1	1	0	0	1	1	1	1	0.0	0.0	100.0	-20) -1	1.103	1.064
Madagascar	14	11	8	4	4	. 1	8	16	4	12	26.3	0.0	13.9	-301	2	1.114	1.080
Sudan	2,176	2,176	18	18	5	5	20	2,285	20	2,285	0.0	0.0	100.0	1,664	11	1.045	1.078
Togo	85	85	2	1	1	0	2	93	2	93	0.3	0.0	62.8	3 -83	-5	1.104	1.057
Tanzania	93	87	21	5	16	9	23	97	7	90	7.6	0.0	54.7	7 -114	1	1.037	1.077
Uganda	57	57	37	35	17	17	39	61	37	61	0.1	0.0	99.6	3 -23	33	1.071	1.076
South Africa	1,674	1,534	536	282	183	37	576	1,819	312	1,669	8.6	0.0	20.1	-2,019	90	1.076	1.053
Zambia	76	76	10	1	1	1	10	77	1	77	0.0	0.0	100.0) 24	-4	1.020	1.017
Zimbabwe	139	139	9	6	3	2	10	149	6	149	0.3	0.0	79.2	2 86	3	1.071	1.048
Other reporting countries	2,721	2,683	156	57	111	71	167	2,932	62	2,891	1.5	0.0	63.7	7 -1,418	-211	1.079	1.061
No reporting partner countries	972	854	1,368	1,183	191	61	1,405	1,030	1,209	897	12.9	0.0	32.3	-5,770	330	1.082	1.041
Partner Total	486,940		163,146	82,889			171,195	510,607	87,931	442,837	13.7		10.2				
Hong Kong, China	16,896	83,653	0	0	0	0	0	17,133	0	84,903	0.0	0.0	0.0	-2,862	. (1.015	5 na
China	0		98,499	19,758	0		100,494	0	20,173								
World Total	503,836	506,363	261,645	102,647	74,322	7,566	271,688	527,740	108,104	527,740				-127,636			