Developing an input-output table of China for detailed agricultural policy analysis

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China is a large country with a rapidly growing economy. Although the share of the agricultural sector in the Chinese economy is declining, agriculture remains an important sector, employing hundreds of millions of people.

Given the sheer size of Chinese agriculture, developments in domestic agriculture have major impacts both in China and also in the rest of the world, with potential for large impacts on global agricultural markets. With the entry of China into the WTO in 2001, and the pursuit of regional and bilateral trade deals both by China and trading partners, the ability to provide an accurate assessment of the potential impact of reforms is imperative.

Due to the key role of agriculture and its linkages with the rest of the Chinese economy, a general equilibrium (GE) approach is frequently chosen for this type of assessment. While this approach is appropriate, the accuracy of the results relies on the validity of the underlying data – especially the input-output (IO) tables. Inaccuracies and misrepresentation in the input-output table can bias the results and lead to misleading or incorrect policy conclusions. For China, the lack of a detailed representation of important agricultural sectors in published input-output tables prevents a more targeted and relevant analysis of agricultural policy change.

In this paper, we build an initial alternate IO table of China with representations of important agricultural sectors using information from various statistical publications. We then evaluate the IO table by comparing results from a simple economic impact analysis using the new data set and another Chinese IO table from a commonly used global GE database. This evaluation shows that discrepancies in representation of agricultural sector in the IO table can bias the results.

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1 Introduction

The use of computable general equilibrium (CGE) models to analyse policy issues have been gaining popularity among policy analysts. CGE models have been at the forefront in the analysis of important issues among analysts in government, at the research, educational and business institutions. The attraction of this type of model is its ability to recognise the interdependence of industries and other agents of the economy, and for a global model, the linkages between countries through trade and investment.

One particular challenge, however, is that CGE models are very intensive in data use. A CGE model requires a wide range of consistent and accurate data on all relevant transactions of all agents, including behavioural parameters of the producers and households. When the model is a global one, the construction of the model database becomes even more challenging. The assembly of a global database for a global CGE model is dependent on information supplied by various national and international agencies, which gather data for different reasons, using different data collection schemes such as a census, statistical sampling and subjective estimates by experts. These national or international data may already contain sampling and non-sampling errors. In addition, data based on expert opinion will be influenced by the knowledge base of the expert and reflect the experts personal views in some instances.

In addition, the process of assembling a global CGE database may itself introduce additional errors as this exercise involves combining data from various sources, which in some cases are inconsistent, and filling in any missing information by some alternative sources or techniques. The process may require the use of a balancing technique to meet the basic consistency requirements of an equilibrium database, such as the satisfaction of zero profit conditions by all production sectors in all regions and the condition that the global exports and imports of every commodity should be balanced. Since adjusting a cell entry in an input-output table would affect other entries, the balancing procedure could lead to a description of an industry that may not coincide with the one represented by the original data set or with the real industry structure.

When using CGE approaches to analyse China, problems arise because of insufficient representation of industries in published IO tables. For the agricultural sector, the Chinese IO tables do not provide sufficient details for agricultural policy analysis. This compelled CGE database developers to disaggregate the sector into a level of detail that would facilitate policy analysis. Undertaking such disaggregation processes without sufficient underlying data may provide an inaccurate representation of key agricultural activities.

The lack of a detailed representation of important agricultural sectors in published input-output tables prevents a more targeted and relevant analysis of agricultural policy change. For China, there are only three agricultural products (agriculture, food and fibre) in its most recent IO table. In this representation, agriculture is combined with other large sectors such as forestry and fishing whose production technologies are different from agriculture. Although there is an existing global CGE database for China – *the Global Trade Analysis Project (GTAP) database version 6 pre-release 5* (Dimaranan et al. 2005, referred to in this paper as “GTAP database” unless otherwise indicated) - that has a detailed agricultural sector, the costs and sales data in the database vary substantially from that indicated by other data sources.

A detailed policy analysis of agriculture in China is important because agriculture remains an important sector in China even if its share in the economy is declining. The sector employs hundreds of millions of people and provides labour for the fast growing manufacturing and services industries. Also, the Chinese agricultural sector is very large relative to that in other countries. As such, developments in domestic agriculture have major impacts in China and also in the rest of the world, with potential for large impacts on global agricultural markets. With the entry of China into the WTO in 2001, and the pursuit of regional and bilateral trade deals both by China and its trading partners, the ability to provide an accurate assessment of the potential impact of reforms is imperative.

The distortions in agricultural markets are expected to remain a major subject of research because countries still provide substantial support for agricultural sectors (WTO 2001). In addition, several countries are advancing proposals for additional and/or revised special treatment in the present WTO negotiations in agriculture. Some of these proposals call for trade liberalisation by developed countries while reserving the right of developing countries to provide substantial protection – and, in some cases, even to increase it (Roberts et al. 2002).

In this paper, we build an alternate IO table for 2001 with representations of important agricultural sectors for China. We use local knowledge of production and sales structure and other published data to construct the relationships between inputs and outputs in agriculture and the flows to and from agriculture with other industries. The ultimate objective is to improve the representation of Chinese agriculture in GTAP database.

2 The Inadequacy of Chinese IO tables

There are a number of IO tables for China that can be used for policy analysis. Most of these are published by the State Statistical Bureau of China (SSBC), while others are derived from these IO publications. Most of these IO tables do not support detailed agricultural policy analysis. One IO table, from the GTAP database, has detailed agricultural sectors but its accuracy needs improvement.

The Original Chinese IO tables

China publishes detailed IO tables every 5 years starting in 1987, with the latest publication covering 1997. These tables, which provide details on at least 100 sectors, are supported by large-scale surveys (Zhi Wang et al 2002). In between these publications, other IO tables are also published but they are more aggregated. For example, the latest IO table which covers the year 2000 has only 17 sectors.

The 1997 IO table has 124 sectors. Of these, three sectors cover primary agriculture while five others relate to food processing including fish and seafood. The rest are manufacturing and services sectors. While the 2000 table is the latest, it is less attractive for analysts and policy makers because the sectoral representation is very limited. This makes the 1997 IO table the basis for developing CGE IO relationships for China. For example, the contributed IO table to the GTAP database 5 is based on the 1997 IO table. It has also been used in developing the new GTAP database which has a base year of 2001.

This highly aggregated representation, poses difficulties in representing both agricultural and non-agricultural sectors in models that can be used for policy analysis. The interest on detailed agricultural policy analysis is driven by the fact that, globally agricultural markets are generally more distorted compared with non-agricultural markets. Within agriculture, distortions differ among specific products. In addition, China’s interest on agriculture becomes more important following its entry into the WTO in 2001. Given its commitments under the WTO, it is important for China and for other countries that detailed agricultural sectors are accurately represented in tools used for policy analysis.

IDE tables

The Institute for Developing Economies (IDE) in Japan updated the 1987 tables to produce a 89 sector IO table for China-Japan for 1990. This table is already dated and there are only 11 agricultural and food processing sectors. Most of the agricultural sectors in this table are not compatible with the classification in other databases such as those in GTAP.

GTAP IO tables

The Chinese IO table in the GTAP database has by far the most disaggregated agricultural sectors for China. In total, GTAP database relating to China is smaller, with only 57 sectors compared with 124 sectors in the 1997 Chinese IO. Twenty of the sectors in GTAP represent food and agriculture. Out of the twenty sectors, twelve are producing primary products while eight are processing sectors. This level of disaggregation of agriculture is greater than the detail in the 1997 and 2000 IO tables of China[1]. This disaggregated data in GTAP provides substantial information by which sectoral analysis can be undertaken for China at a level of detail that can not be achieved using the original Chinese IO tables. The disaggregation of Chinese IO table to the current level of representation allowed China to be integrated into the GTAP database and into a global analytical framework designed to assess implications of policy changes that have global dimensions such as those in the WTO negotiations. However, our analysis indicates that agricultural sectors in the GTAP IO table differ dramatically from the apparent structure of agriculture in China (Table 1).

Table 1. Value of output in agriculture, forestry and fisheries, US$M

	GTAP database	**Chinese[a] Statistics**	Difference	**%**
1 Paddy rice	19,520	25,151	-5,631	-22
2 Wheat	9,879	13,232	-3,353	-25
3 Other grains	10,139	18,103	-7,964	-44
4 Fruits and vegetables	124,651	70,411	54,240	77
5 Oilseeds	8,005	11,250	-3,245	-29
6 Cane and beet sugar	1,196	2,573	-1,377	-54
7 Plant based fibres	6,923	6,323	600	9
8 Other crops	2,603	27,629	-25,026	-91
9 Live cattle	8,175	10,776	-2,601	-24
10 Pigs and poultry & other animal products	88,280	79,672	8,608	11
11 Raw milk	2,896	2,624	272	10
12 Wool	3,616	3,101	515	17
13 Forestry	17,719	11,338	6,381	56
14 Fisheries	28,049	33,998	-5,949	-17
Gross Output Value of Farming, Forestry, Animal Husbandry and Fishery	331,651	316,181	15,470	5

[a]Sources: State Statistical Bureau of China 2000a, 2000b.

[1] In GTAP database 5, the IO table for China contributed to GTAP is composed of 42 sectors with only two primary agricultural sectors (crops and livestock). The agricultural sectors were disaggregated using an agricultural IO (McDougall 2002).

Eleven out of thirteen sectors in GTAP China IO database are either over US$1 billion larger or smaller than the output estimates from published statistics in China. The highest discrepancy is in the output of fruits and vegetables, where GTAP output is US$54 billion larger than published Chinese data. Pigs, poultry and other animal products sector production in GTAP is also over estimated by about US$8 billion. Similarly, forestry output in GTAP is 56 per cent larger than the data from Chinese statistics.

This means that for over-estimated sectors such as fruits and vegetables and livestock, the supply to the various users and the demand for inputs by these sectors are larger than they should be. The opposite is true for those sectors that are under-estimated such as grains and other crops.

In percentage terms, the largest discrepancy occurs in the output of other crops, where the GTAP output estimate is 91 per cent lower. Other products that are under-estimated in GTAP are paddy rice, cane and beet sugar, wheat, cattle and fisheries.

Inter and intra-industry transactions in GTAP database

The concept of interdependence of industries is embodied in the inter-industry transactions. This interdependence is the principle behind general equilibrium models using input-output tables for their data requirements. The larger the shares of transactions, the larger the magnitude of interdependence among industries will be. It is therefore important that such relationships are accurately represented. While it is very difficult to establish the intermediate input demand or the sales of products to various industries, it is possible to detect whether a transaction is accurate or not. There are products that are primarily produced to become inputs into the processing sector but there are other products that can be sold almost to all industries. For example, it is typical for a very large share of cotton sales flow to textile milling industries and almost none to other industries, but the sale of chemical products typically flows to almost all industries. Such specific use of inputs into industries is apparent when products are identified at a much higher level of disaggregation. With product-specific data, the transactions in an IO table can be evaluated even in the absence of sufficient statistics. For example, paddy rice is typically not an input into textile industries but when paddy rice is aggregated into a broad crop sector which includes cotton, then the combined crops sector would include some value of sales to textile industries. If such aggregated data is used to develop a disaggregated IO relationship, it would be possible to incorrectly represent sales from paddy rice to textiles industries. Such incorrect sales of paddy rice can be easily detected by examining the inter-industry transactions.

Based on the above principles, the observations in Table 2 highlight some of the possible problems in the inter-industry transactions for Chinese agriculture in the GTAP database. It is evident from Table 2 that primary agricultural products in the GTAP database are distributed in larger proportions to the industries that are lesser users of the products. For example, in the GTAP China IO table, the leather industry is the major user of raw milk output instead of the dairy processing industry. In addition, the grains, cattle and cane and beet sugar industries are the main users of their own outputs. In most countries, the dominant buyers of these primary products are the food processing industries. These are incorrect interdependence of industries. Such distortions in the inter-industry transactions can lead to inconsistent or even misleading analytical results (Buetre et al. 2003, Mercenier et al.1999).

Table 2. Sales of primary agricultural products for intermediate input use in China in GTAP database,(%)

Primary commodity (1)	*Main industry user (2)*	*Share of industry user (3)*	*Main use in other countries in GTAP database (4)*
Wheat	Other animals	73	In 56 of 87 countries the main use of wheat is for Other food products manufacture
Grains	Grains	36	In 48 of 87 countries main use is for OFD manufacture
Oilseeds	Other animals	69	The major user of oilseeds is vegetable processing industry in most countries
Cane and beet sugar	Cane and beet sugar	23	The main user of cane and beet sugar is the sugar processing industry
Cattle	Cattle	18	60 of 87 countries have cattle meat industry the dominant buyer of cattle
Raw milk	Leather industry	25	In 59 out of 87 countries, raw milk is mainly used by dairy processing industry

Source: GTAP database 6 pre-release 5

3 Constructing the IO table

Although the ultimate objective is to construct an IO table for China with exactly the same dimension, sectoral classification and base year as the GTAP database, the approach taken here is to construct the IO table starting with sectors whose information are available or sectors whose transactions can be readily deduced from available statistics. This procedure is similar to the methods used by Gilchist et al. 1999.

This resulted in an initial sector dimension of 30 (aggregated using GTAP sectoral classification available in Huff et al. 2000) with only five agricultural sectors (including forestry and fisheries). Using the GTAP sectoral classification the agricultural sectors were disaggregated into 14 sectors resulting in a total of 39 sectors with all the agricultural sectors matching the detailed agricultural sectors in the GTAP classification. Most of the 39 sectors in the new Chinese IO table are the same as the GTAP sectors except for the processed food sector and a few aggregated non-agricultural sectors (Appendix 1). This new IO table will be processed further so it can be integrated into a database for a general equilibrium model such as GTAP or GTEM.

The process of constructing the 39-sector Chinese IO table for 2001 involved three major steps such as:

1. Obtaining sectoral value of output, value added, consumption, investment, exports and imports for 2001 for a 30 sector IO table.
2. Creating the 30-sector IO table of China for 2001.
3. Disaggregating the agricultural sectors into 14 sectors and establishing their input structures.

Value of output, value added and final demand

The information on values of outputs for the initial 30 sector IO table was obtained from various issues of the Statistical Yearbook of China (State Statistical Bureau of China 2002c). The sectoral representation in the statistical yearbook does not match exactly the sectoral requirements of the GTAP database, especially for the agricultural sectors which are highly aggregated in the Statistical Yearbook. The disaggregation of these sectors is discussed later. For sectors whose outputs are not available, such as services, the value of outputs were estimated using the value added in 2001 from the China Statistical Yearbook 2002 (State Statistical Bureau of China 2002c) and the latest value added coefficients from the Input-output tables of China.

In estimating the value added in each sector, the general approach was to use the value added estimates from the Statistical Yearbook. When value added estimates are not available but the values of outputs are available, the latest available value added coefficients from the 1992, 1997 and 2000 input-output tables of China are used to estimate value added for sectors in 2001.

To calculate the final demand, including household consumption expenditure, government consumption expenditure, gross capital formation and changes in inventories and trade, the final demand coefficients from the 17 sector 2000 Chinese IO table were used to calculate the final demand expenditures for values of outputs for the 17-sector aggregation of 2001 data. The estimates of final demand expenditures are in turn disaggregated into the 30 sectors using information from the more disaggregated 1997 IO table. The shares of sub-sectors (identified in the 30-sector aggregation) in the sector that belongs to the 17 sector aggregation are used to split the 17 sector data set on final demand.

Intermediate input use

The remaining transactions to be estimated for the 30-sector 2001 IO table are the intermediate use flows. The data used to estimate these transactions are the 1997 and the 2000 IO table and the estimates of outputs for the 30 sectors in 2001.

To establish the intermediate input transactions, the first step undertaken is to take into account of the most recent known industrial structure in China. That structure is in the form of intermediate input coefficients embodied in the latest IO table which is for 2000. These coefficients were applied on the estimated 2001 values of output aggregated into 17 sectors to establish the intermediate input transactions for 2001. When there is an available individual transaction for 2001 from published statistics, the calculated transaction is replaced. When imbalances occurred due to the replacement of transactions, a residual allocation system (RAS) was used to balance the IO. Checks for anomalous transactions (Buetre et al. 2003) were made whenever a mechanical process of adjustment is used.

The last step is to disaggregate the 17-sector intermediate input transactions for 2001 into the 30-sector classification using the intermediate input coefficients from the 1997 IO table. The same approach in splitting final demand is applied. As in the first step, known intermediate transactions for 2001 for the 30-sector classification are incorporated when they are available. When imbalances occur, the RAS method is used to balance the system. This is followed by a check for any anomalous transaction. The values of output, value added and final demand for 2001 serve as the “control” in constructing the tables. This completes the 30-sector IO table for China.

Disaggregating the agricultural sectors

The new IO table contains the sectoral aggregation for agriculture from the 1997 IO table. These include crop cultivation, forestry, livestock and livestock products, fishery, and other agricultural products. These aggregate sectors are disaggregated into the 14 agricultural sectors (including forestry and fishing) of the GTAP sectoral classification.

The fishery and forestry sectors in the Chinese IO tables have their corresponding sectors in the GTAP database, so only crop cultivation, livestock and livestock products and other agricultural products have been disaggregated to the GTAP sectors as follows:

The crop cultivation and other agricultural products were disaggregated into:

1. Paddy rice
2. Wheat
3. Cereal grains nec
4. Vegetables, fruits
5. Oilseeds
6. Sugar cane, sugar beet
7. Plant-based fibers
8. Crops not included anywhere

Livestock and livestock products into:

9. Bovine cattle, sheep and goats, horses
10. Animal products nec
11. Raw milk
12. Wool, silk-worm cocoons

For crops, the disaggregation required information on outputs for the above sectors. Estimates of output were calculated using the data on physical output and acreage planted data from *Agriculture Yearbook of China* (Ministry of Agriculture 2002) and the *Statistical Yearbook of China* (State Statistical Bureau of China 2000c) and the data on estimates of total value of output per unit area from the *Rural Statistical Yearbook of China 2002* (State Statistical Bureau of China 2000a). For sectors where data is not available, the outputs were estimated as a residual or difference between the sum of outputs where data is available and the total output of the aggregate sector.

The estimates of sectors "*Raw milk*" and "*Wool, silk-worm cocoons*" were taken from *Agriculture Yearbook of China* (Ministry of Agriculture 2002), while the value of output of "*Bovine cattle, sheep, goats and horses*" was taken from *Rural Statistical Yearbook of China 2002* (State Statistical Bureau of China 2000a). The output of "*Animal products*" is calculated as the residual between total livestock output and the sum of the other three sectors.

Estimating the input structure of the agricultural sectors

The compilation of agricultural products cost and income data for 2002 from the *Rural Statistical Yearbook of China 2002* provides information on the cost structure of the following sectors: paddy rice; wheat; maize; grain sorghum; soybeans; vegetables; groundnuts; rape seeds; cotton; ramee; jute; sugar cane; sugar beet; silkworm; live swine; bovine animals; goats; and sheep. This information was used to establish the cost structure of the GTAP agricultural sectors. For sectors such as –"*Crops nec*" and "*Vegetables and fruits*", their cost structures were derived from the *IO table of China 1987* (State Statistical Bureau of China 2000). Vegetables and fruits represent a priority area for future database development given the importance of this sector to Chinese agriculture and the dramatic growth and change in fruit and vegetable production that has occurred in China in recent years.

The intermediate cost items for the crops sector are seeds, manure, fertilizer, pesticide use, other material inputs and fees for agricultural services, power, irrigation charges, expenditure on machinery and beasts of burden. For livestock, the intermediate input cost structure identifies the following cost items: stock, feedstuffs, water related fees, fees for electricity, coal, medical and epidemic prevention costs, insurance, and other direct costs.

In some instances, the GTAP sectoral classification does not match the sectors in the compilation of the agriculture products costs and income 2002 while in other cases, the cost structure for other component sectors are not available. In these instances, the available cost structure of the dominant activity in the aggregated sector is used. For example, for "*Animal products*", the cost structure of live swine is used because live swine is the largest production item in this aggregated sector (National Development and Plan Commitee 2002). In some instances, the input structure requires the addition of a component of a specific sector to another sector. For example, the input structure of the sector *Wool, silk-worm cocoons* was based on the item "*silk-worm cocoons*" and the wool component of the "sheep" item from *The Compilation of National Cost-Benefit Information of Agriculture* (National Development and Plan Commitee 2002).

Calculating the agricultural value added

The agricultural sector value added is calculated as the difference between the sectoral output and the total intermediate input cost. The value added is disaggregated into depreciation of fixed capital, compensation of employees, net taxes subsidies on production and operating surplus. These costs are available from the compilation of the agriculture product's cost and income from the *Rural Statistical Yearbook* of China (State Statistical Bureau of China 2002a) except for compensation to employees which is determined as the difference between total value added and the sum of the other value added cost items.

In assembling the dataset, checks for anomalous transactions as suggested in Buetre et al. 2003 are undertaken whenever a mechanical process is used to adjust the data.

To increase the accuracy of the representation of agricultural sectors, additional work is on-going to establish the demand for agricultural inputs by non-agricultural industries and on the final use of the detailed agricultural sectors.

4 An assessment of the new Chinese IO Table

It is noted in Table 1 above that our estimates of agricultural outputs in China for 2001 vary substantially from GTAP estimates. The new IO table for China incorporates the estimates of outputs as discussed in the previous section. The new IO table derives its structure from published statistics and previous IO tables. Some of these structures, particularly in agriculture, are different from those in GTAP database. In this section, the new IO table is evaluated relative to the GTAP database.

This assessment is composed of two parts. One is the comparison of sectoral output and macroeconomic estimates and the other is the comparison of results from IO analysis using the two databases. The IO analysis involves the use of the two IO tables to determine impacts from a change in final demand for output of selected sectors. The objective is to assess whether the differences in the IO transactions would lead to differences in estimates of effects of change in demand.

Macroeconomic and sectoral estimates

The sectoral comparison is focused on the detailed agricultural sectors found in Table 1 above which provides an indication in the differences in estimates from the two databases. The macroeconomic estimates are in Table 3 below.

Table 3 Macroeconomic estimates, US$ million

	GTAP database	New China IO	IMF (2004)
Household consumption	463,177	570,955	554,840
Government consumption	145,917	157,359	157,416
Investment	408,353	444,605	444,773
Net trade	104,030	86,341*	26,641
Gross domestic product	1,121,476	1,259,259	1,191,499

*includes inventory

In table 3 above, the estimates of final demand and GDP in the new China IO table are either closer to or almost identical to the IMF data than the estimates from the GTAP database. Deviation of net trade in the new China IO table is attributable to the changes in inventory. This transaction will be subsequently reallocated because the model for which the data will be used has no inventory feature. Such an adjustment is expected to further improve estimates of trade and gross domestic product, thereby further improving the accuracy of the new IO table.

Impact analysis using the IO table

To evaluate the effects of the revised transactions and output data, the new China IO and the IO table from GTAP database were used for an impact analysis. To make the results comparable, the sectors in the GTAP database were aggregated to exactly the same sectors as the new Chinese IO tables.

While a more sophisticated test can be implemented to compare the two IO tables, such as the use of general equilibrium models, the simpler approach of using the IO table for an impact analysis is used. The use of a general equilibrium model will require more information that is not readily available at this stage of development and will also involve the construction of a model.

The impact analysis undertaken (see Box 1 for technical details) involves a change in one or more elements of final demand. More specifically, a hypothetical increase of US$1 billion is applied to the final demand for selected sectors. This increase in demand could come from increased export demand which might be initiated by agricultural trade reform or even preferential arrangements. The objective is to determine how the sectors would adjust given the increase in final demand. The impact on other sectors depends on how the sectors are linked to each other. The links are represented by the value of sales or purchases of an industry from other sources including itself. The more a sector is linked with other sectors, the larger would be the overall impact. If these relationships differ between the GTAP IO and the new IO table, the impact of the additional final demand will also differ.

Box 1.Technical details of an input-output model

The impact analysis is undertaken by using the IO multipliers derived by first transforming the transactions table into a direct coefficient table[1]:

$$\mathbf{AX + F = X} \qquad (1)$$

Arranging (1), yields

[1] The sales of i in the IO table can be represented as $\Sigma_j X_{ij} + F_i = X_i$, where X_{ij} are the transactions on intermediate input from i to j, F_i the final demand for i and X_i the total supply of i. The ratio of intermediate input i in j to total input is given by $a_{ij} = X_{ij}/X_j$, so that $a_{ij}X_j = X_{ij}$. This gives the equation $\Sigma_j a_{ij} X_j + F_i = X_i$ which, in matrix notation, is equal to **AX + F = X.**

Box 1. continued

$$\mathbf{X = (I\text{-}A)^{-1}F} \qquad (2)$$

where: **A** = matrix of coefficients showing the shares of input X_{ij} to the total output X_j

X=the column vector of sector gross output

F=the column vector of total final demands

I=an identity matrix

Total differentiation of (2), gives

$$\mathbf{dX = (I\text{-}A)^{-1}dF} \qquad (3)$$

The matrix $\mathbf{(I\text{-}A)^{-1}}$ is the table of multipliers or total requirements matrix. It is also known as the Leontief inverse matrix. Each element in this matrix reveals the linkage between industries in the economy.

Equation (3) provides a framework to measure the effect on **X** given exogenous changes in **F** and on calculating the total impact of the change in final demand on the economy. By summing the elements of a column in the $\mathbf{(I\text{-}A)^{-1}}$, the total multiplier can be estimated for the column that represents a sector. The total multiplier indicates the magnitude of the increase in aggregate output that is necessary to meet the increase in demand for output initiated by the increase in final demand. The increase in aggregate output represents the increase in total outputs of all sectors initiated by the initial increase in final demand.

An element of $\mathbf{(I\text{-}A)^{-1}}$ shows by how much a sector would increase its purchases of products from the sectors supplying the inputs it needs in order to increase an output that will satisfy the increase in demand.

To assess whether the differences in transactions between IO from GTAP database and the new China IO would have an impact on the results of an IO analysis described in Box 1, three experiments involving a US$ 1 billion increase in final demand for selected sectors were undertaken, as follows:

1. an increase in final demand for other crops;
2. an increase in final demand for grains; and
3. a simultaneous increase in final demand for all agricultural products.

An increase in final demand for other crops

As illustrated in Table 4, a US$1 billion increase in final demand for other crops increases output of this sector by a factor of 1.005 in GTAP database and 1.008 in the new China IO table resulting in an increase in value of output of US$ 1,005 million and US$ 1,008 million, respectively. This is only the impact of the increased demand on the specified sector.

With similar sector multipliers for other crops (1.5 for GTAP and 1.65 for the new China IO table), the total impact of the increase in final demand is similar in the two IO tables (US$ 1,500 million under GTAP and US$ 1,647 million in the new IO, Table 4). However, because of the significant differences in estimates of initial production in the two datasets (US$ 2,603 million in GTAP and US$ 27,629 million in the new IO table, Table 1), the estimated percentage increases in the value of output are significantly different with output increasing by 39 per cent in the GTAP IO by only 4 per cent in the new China IO table. This finding indicates that inaccuracies in the estimates of the sizes of industries in databases could result in significant differences in estimates of impacts from exogenous changes in economic variables. Such inaccuracies would be evident especially when using the database in a model where variables are in percentage changes. For example, for the other crops sector to attain a similar output increase of 39 per cent in the new China IO table, it would need to expand its output by US$10,775 million. This indicates that if similar percentage increases in output are applied using the two databases, the economic impact will be markedly different.

Table 4. Impact of a US$ 1 billion increase in final demand for other crops

	GTAP database	New China IO
Change in value of output (US$ million)	1,005	1,008
Own use multiplier	1.005	1.008
Change in value of output (%)	***38.62***	***3.65***
Other crops sector multiplier	1.50	1.65
Total impact (US$ million)	1,501	1,647

An increase in final demand for grains

This experiment is designed to evaluate how a difference in the direct requirements for inputs coming from the same sector will impact the estimates of an IO analysis. In the GTAP database, there is a large increase in sales of grains for its own use. This is evident in the own use multiplier in Table 5 below. The differences in the own use multiplier leads to different estimates of changes in the value of output of grains. These increases are US$ 1,471 million in GTAP and US$ 1,135 million in the new IO table.

In table 5 below the larger total impact in GTAP database is further magnified by the larger multiplier which indicates broader linkages in GTAP database than in the new IO table.

Table 5. Impact of a US$ 1 billion increase in final demand for grains

	GTAP database	New IO table
Change in value of output (US$ million)	1,471	1,135
Own use multiplier	1.47	1.14
Change in value of output (%)	14.51	6.27
Grains sector multiplier	2.58	1.65
Total impact (US$ million)	2,575	1,647

A simultaneous increase in final demand for all agricultural products

A notable characteristic of the agricultural sectors in the new IO table is the higher proportion of purchases of chemicals and fertilizers than in the GTAP database (Table 6). Chemicals and fertilizers are the second most important intermediate input into the production of all agricultural sectors in the two data sets. A question that might be asked is how much of the chemicals and fertilizers industry output should expand to meet the requirements of the agricultural sectors given a simultaneous US$1 billion increase in demand for all agricultural products.

The results of this experiment show that because of the higher cost shares of the chemicals and fertilizers in the agricultural sectors in the new IO table, the multipliers representing this linkage are higher than in the GTAP data set. This results in the chemicals and fertilizers industry increasing production by US$4.4 billion in the new IO. This increase is over US$1 billion more than the increase in output when using the GTAP database.

This means that the ability of the chemicals and fertilizer industry to constrain agricultural output will be larger in the new IO table. If the two data bases were used in models where input use constraints are imposed, and involving other sectors that are major users of outputs of chemicals and fertilizers, the impact on agriculture will be potentially different because of the differing requirements for these products by the agricultural sectors in the two data sets. For example, any CGE analysis of the recent rise in oil prices would likely result in substantially different impacts on agricultural production in China using the two IO tables with higher impacts expected when using the new IO table. Oil prices are likely to impact chemicals and fertilizer prices because of the large cost share of oil in the production of chemicals and fertilizers in the two data sets.

Table 6. Impact of a simultaneous US$ 1 billion increase in final demand for all agricultural products on the fertiliser and chemical industries

	GTAP database		New IO table	
	Change in value of output (US$ million)	Backward link with chemical and fertilizer industry	Change in value of output (US$ million)	Backward link with chemical and fertilizer industry
1 Paddy rice	1,420	0.26	1,165	0.42
2 Wheat	1,461	0.48	1,400	0.67
3 Grains	1,712	0.36	1,847	0.45
4 Vegetables and fruits	1,449	0.25	1,088	0.21
5 Oilseeds	1,385	0.26	1,363	0.42
6 Cane and beet sugar	1,216	0.33	1,435	0.68
7 Plant based fibres	1,022	0.55	1,130	0.49
8 Other crops	1,023	0.15	1,178	0.16
9 Cattle	1,228	0.08	1,154	0.07
10 Other animals	1,222	0.13	1,123	0.15
11 Raw milk	1,011	0.12	1,026	0.18
12 Wool	1,017	0.15	1,014	0.46
Chemical and fertilizer	3,146	1.69	4,371	1.68
Total impact	25,580		27,953	

The application of IO analysis so far gives insights into the differing results that could be obtained from CGE analysis from utilising the revised IO table. However, the impact analysis approach of assessing the differences in the IO tables has some limitations such as the assumption of constant coefficients and the lack of capacity constraints. Further evaluation using a global general equilibrium framework will be implemented when the data set is integrated into a global GE database.

5 Concluding remarks

There is an increasing need for agricultural trade policy analysis involving China because of its strong economic growth, large agricultural sector and its potential impact on world agricultural markets due to its entry into the WTO and its likely involvement in trade and other preferential arrangements. The tools that are commonly used for this type of analysis are CGE models, which recognise the interdependence of industries, the link between countries and the competition for factor inputs. The accuracy of results using such models relies on the validity of the underlying data, especially the IO tables.

When using CGE models for international agricultural policy analysis involving China, a limitation is the lack of detailed representation of agricultural sectors in basic IO tables of China. In this paper, a new IO table containing detailed agricultural sectors is constructed with the overall objective of integrating the new data set into a global trade modelling framework. The motivation for this work is to improve the accuracy of the representation of the Chinese agricultural sectors in the currently available database for global CGE models. Various data sets and techniques are employed in undertaking this activity to ensure that the basic structure of the detailed agricultural sectors is represented accurately.

The representation of agricultural sectors in the new IO table for China differed from the equivalent aggregation of the GTAP database. A simple IO analytical framework was used to evaluate whether the differences would impact on results of an economic analysis involving changes in final demand. The results of this evaluation indicate that the discrepancies in sizes and structure of agricultural sectors can lead to large differences in sectoral and macroeconomic impacts.

Improvements to the new Chinese IO table for 2001 are continuing. Emphasis will be made on the representation of detailed food processing sectors. Along with providing information on demand for imports, the disaggregation of food into sectors that are compatible with the GTAP classification is one of the important steps that will be undertaken. The objective is to improve the representation of China in the GTAP database.

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Appendix 1. Sectors in the New 2001 Chinese IO table

1 Paddy rice	21 Lumber
2 Wheat	22 Paper products
3 Grains	23 Petroleum and coal
4 Vegetables and fruits	24 Chemicals, rubber and plastic
5 Oilseeds	25 Non-metallic minerals
6 Cane and beet sugar	26 Iron, steel and non-ferrous metals
7 Plant based fibres	27 Fabricated metal products
8 Other crops	28 Motor vehicles and transport equipment
9 Cattle	29 Electronics
10 Other animal products	30 Other machinery and equipment
11 Raw milk	31 Other manufacturing
12 Wool	32 Electricity and gas distribution
13 Forestry	33 Water
14 Fishery	34 Construction
15 Coal	35 Trade
16 Oil and gas	36 Transportation and communication
17 Other minerals	37 Financial services
18 Food processing	38 Other business services and recreation
19 Textile	39 Government services and dwelling
20 Wearing apparel and leather	