

Constructing an input–output table of China for detailed agricultural policy analysis

Xiaohe Liu, Institute of Agricultural Economics, Chinese Academy of Agricultural Sciences

Xu Jian, Chinese Academy of Sciences

Ping Liu, Beijing Chiefinvestment Co. Ltd

Benjamin Buetre, ABARE

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Given the sheer size of Chinese agriculture, developments in the sector have major impacts both in China and in the rest of the world, with potentially large impacts on global agricultural markets. Following the entry of China into the World Trade Organisation 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 trade reforms is imperative.

A general equilibrium (GE) approach is frequently chosen for this type of assessment. The accuracy of the results from such an approach 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, an initial alternative IO table of China is constructed, with representations of important agricultural sectors using information from various statistical publications. The IO table is then evaluated 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 sectors in the IO table can bias the results.

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Introduction

The use of computable general equilibrium (CGE) models to analyse policy issues has been gaining popularity among policy analysts. CGE models have been at the forefront in the analysis of important issues among analysts in government and in 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.

When using CGE approaches to analyse China, problems arise because of insufficient representation of industries in published IO tables. For the agriculture 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 that 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 and McDougall 2005; referred to in this paper as the ‘GTAP database’ unless otherwise indicated) — that has a detailed agriculture sector, the costs and sales data in the database vary substantially from those 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 labor for the fast growing manufacturing and services industries. Also, the Chinese agriculture sector is very large relative to that in other countries. As such, developments in Chinese agriculture have major impacts domestically and in the rest of the world — with the potential for the impacts on global agricultural markets to be large. 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 to their agriculture sectors (WTO 2001). In addition, several countries are advancing proposals for additional and/or revised special treatment in the present WTO negotiations on agriculture. Some of these proposals call for trade liberalisation by developed countries while reserving the right of devel-

oping countries to provide substantial protection — and, in some cases, even to increase it (Roberts, Buetre and Jotzo 2002).

In this paper, an initial alternative IO table for China is developed for 2001, with representations of important agricultural sectors. Local knowledge of production and sales structure is used along with 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 the GTAP database.

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. A comparison of the new alternative IO table and GTAP IO is discussed later.

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 for which information is available or sectors for which transactions can be readily deduced from available statistics. This procedure is similar to the methods used by Gilchrist and St Louis (1999).

This resulted in an initial sector dimension of thirty (aggregated using the GTAP sectoral classification available in Huff, McDougall and Walmsley 2000), with only five agricultural sectors (including forestry and fisheries). Using the GTAP sectoral classification, the agricultural sectors were disaggregated into fourteen 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 nonagricultural sectors (table 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:

- obtaining the sectoral value of output, value added, consumption, investment, exports and imports for 2001 for a thirty sector IO table
- creating the thirty sector IO table of China for 2001
- disaggregating the agricultural sectors into fourteen sectors and establishing their input structures.

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	Nonmetallic minerals
6	Cane and beet sugar	26	Iron, steel and nonferrous 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		

Value of output, value added and final demand

The information on values of outputs for the initial thirty 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 *Statistical Yearbook of China 2002* 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 seventeen sector 2000 Chinese IO table were used to calculate the final demand expenditures for values of outputs for the seventeen sector aggregation of 2001 data. The estimates of final demand expenditures are in turn

disaggregated into the thirty sectors using information from the more disaggregated 1997 IO table. The shares of subsectors (identified in the thirty sector aggregation) in the sector that belongs to the seventeen sector aggregation are used to split the seventeen sector data set on final demand.

Intermediate input use

The remaining transactions to be estimated for the thirty 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 thirty 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 to the estimated 2001 values of output aggregated into seventeen 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 because of the replacement of transactions, a residual allocation system (RAS) was used to balance the IO table. Checks for anomalous transactions (Buetre et al. 2003) were made whenever a mechanical process of adjustment was used.

The last step is to disaggregate the seventeen sector intermediate input transactions for 2001 into the thirty 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 thirty 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 thirty 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 fourteen 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 fibres
8. Crops not included elsewhere

Livestock and livestock products into:

9. Bovine cattle, sheep and goats, horses
10. Animal products not included elsewhere
11. Raw milk
12. Wool, silkworm 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 area 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 were not available, the outputs were estimated as a residual or difference between the sum of outputs where data are available and the total output of the aggregate sector.

The estimates of sectors ‘Raw milk’ and ‘Wool, silkworm 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 product 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 develop-

ment 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, fertiliser, 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 agricultural product 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 Committee 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, silkworm cocoons' was based on the item 'silkworm cocoons' and the wool component of the 'sheep' item from *The Compilation of National Cost-Benefit Information of Agriculture* (National Development and Plan Committee 2002).

Calculating the agricultural value added

The agriculture 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 agricultural product 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, Rodriguez and Pant (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 ongoing to establish the demand for agricultural inputs by nonagricultural industries and on the final use of the detailed agricultural sectors.

Comparing the GTAP and new Chinese IO tables

In this section, the macroeconomic variables, such as gross domestic product, aggregate household consumption, government consumption, investment and net trade, and the sectoral variables, such as values of output, household consumption, value added and industry's use of own output from the two data sets, are compared. If there are significant differences between the two data sets, their use in the model would yield different results.

Macroeconomic variables

In table 2, 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. Household consumption, which is the highest component of GDP is a little higher in the new China IO table than the IMF estimate. On the other hand, the estimate of household consumption in the GTAP database is almost US\$100 billion less than the IMF figure.

In both databases, estimates of net trade are larger than the IMF data. One factor that led to the 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 macroeconomic variables, thereby further improving the accuracy of the new IO table.

Output

The Chinese IO table in the GTAP database has by far the most disaggregated agricultural sectors for China. In total, the 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 producers of 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. [In GTAP

2 Macroeconomic estimates

	GTAP database	New China IO	IMF (2004)
	US\$m	US\$m	US\$m
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 ^a	26 641
Gross domestic product	1 121 476	1 259 259	1 191 499

^a Includes inventory.

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)]. These disaggregated data in GTAP provide substantial information by which sectoral analysis can be undertaken for China at a level of detail that cannot 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, the analysis reported here indicates that agricultural sectors in the GTAP IO table differ dramatically from the apparent structure of agriculture in China (table 3).

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 overestimated 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 overestimated sectors such as fruits and vegetables and livestock, supply to the various users and demand for inputs by these sectors are larger than they should be. The opposite is true for sectors that are underestimated, such as grains and other crops. In percentage terms, the largest discrepancy occurs in the output of other crops, where the GTAP output

3 Value of output in agriculture, forestry and fisheries in China

	GTAP	Chinese	Difference	
	database	statistics	US\$m	%
	US\$m	US\$m	US\$m	
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

Sources: State Statistical Bureau of China (2002a,b).

4 Comparison of output estimates

	New China IO	GTAP database	Absolute difference	Difference ratio ^a
	US\$m	US\$m	US\$m	
1 Paddy rice	25 151	19 520	5 631	0.29
2 Wheat	13 232	9 879	3 353	0.34
3 Grains	18 103	10 139	7 964	0.79
4 Fruits and vegetables	70 411	124 651	54 240	0.77
5 Oilseeds	11 250	8 005	3 245	0.41
6 Cane and beet sugar	2 573	1 196	1 376	1.15
7 Plant based fibres	6 323	6 923	600	0.09
8 Other crops	27 629	2 603	25 026	9.62
9 Live cattle	10 776	8 175	2 601	0.32
10 Other animals	79 672	88 280	8 609	0.11
11 Raw milk	2 624	2 896	272	0.10
12 Wool	3 101	3 616	515	0.17
13 Forestry	11 338	17 719	6 381	0.56
14 Fishery	33 998	28 049	5 948	0.21
15 Coal	29 133	11 330	17 803	1.57
16 Oil and gas	33 202	19 789	13 413	0.68
17 Minerals	35 199	46 455	11 256	0.32
18 All processed food	195 458	173 942	21 517	0.12
19 Textile	125 922	154 765	28 844	0.23
20 Wearing apparel and leather	103 912	121 420	17 508	0.17
21 Lumber	27 717	38 379	10 662	0.38
22 Paper products	62 944	57 353	5 591	0.10
23 Petroleum, coal products	99 487	37 096	62 391	1.68
24 Chemical, rubber, plastic products	281 406	221 032	60374	0.27
25 Mineral products	82 624	143 939	61 315	0.74
26 Ferrous and other metals	140 019	143 127	3 108	0.02
27 Metal products	78 679	80530	1 851	0.02
28 Motor vehicles and other transport	120 985	83 643	37 342	0.45
29 Electronic equipment	179 707	124 907	54 800	0.44
30 Machinery and equipment	282 227	273 747	8 480	0.03
31 Manufactures	38 446	90 577	52 132	1.36
32 Electricity and gas distribution	109 720	35 990	73 730	2.05
33 Water	8 387	5 645	2 742	0.49
34 Construction	319 087	279 507	39 580	0.14
35 Trade	220 243	197 724	22 519	0.11
36 Transport and communication	139 905	109 514	30 391	0.28
37 Financial services and insurance	65 960	53 513	12 447	0.23
38 Other business and recreation	173 985	77 814	96 172	1.24
39 Public admin and dwelling	200 548	192 818	7 730	0.04
Total	3 471 082	3 106 208	364 874	0.12

^a Difference ratio = absolute difference/MIN(New China IO, GTAP database). If two data entries are close together, the absolute difference and difference ratio will be close to zero.

estimate is 91 per cent lower. Other products that are underestimated in GTAP are paddy rice, cane and beet sugar, wheat, cattle and fisheries.

For nonagricultural products, substantial discrepancies are observable on energy production and distribution, minerals, and business and recreation sectors. A complete comparison of values of output is given in table 4.

Household consumption

The higher estimate of aggregate household consumption in the new Chinese IO table is reflected in larger sectoral consumption estimates in the new Chinese IO table (table 5). All but seven of the 39 sectoral consumption estimates in the new Chinese IO table are larger than the GTAP data set. Interestingly, the largest divergence in estimates of household consumption occurs in the agricultural sectors, especially in the consumption of paddy rice, wheat, grains, fruits and vegetables, oilseeds, plant based fibres, other crops, live cattle, other animals, raw milk and wool. This large consumption of products in the new IO table generally reflects the larger production of agricultural products in the new Chinese IO table than in GTAP data set. However, the large consumption sales share for

5 Comparison of household consumption, selected products

	New China IO	GTAP database	Absolute difference	Household sales share	
				New China IO	GTAP
				%	%
	US\$m	US\$m	US\$m		
Household consumption					
1 Paddy rice	17 036	1 369	15 667	67.7	7
2 Wheat	10 915	287	10 628	82.5	2.9
3 Grains	6 688	319	6 368	36.9	3.1
4 Fruits and vegetables	16 098	63 213	47 116	22.9	50.7
5 Oilseeds	2 747	314	2 433	24.4	3.9
6 Cane and beet sugar	68	363	295	2.6	30.3
7 Plant based fibres	2 086	20	2 066	33	0.3
8 Other crops	7 433	10	7 423	26.9	0.4
9 Live cattle	27 306	642	26 664	253.4	7.9
10 Other animals	7 587	51 323	43 737	9.5	58.1
11 Raw milk	6 649	365	6 284	253.4	12.6
12 Wool	7 858	12	7 845	253.4	0.3
18 All processed food	114 265	98 171	16 094	58.5	56.4
21 Lumber	7 395	3 352	4 044	26.7	8.7
22 Paper products	5 042	1 351	3 691	8	2.4
23 Petroleum, coal products	1 590	5 647	4 057	1.6	15.2
29 Electronic equipment	15 328	7 670	7 658	8.5	6.1
30 Machinery and equipment	21 206	13 062	8 144	7.5	4.8
32 Electricity and gas distribution	10 892	4 023	6 869	9.9	11.2
38 Other business and recreation	45 658	12 241	33 417	26.2	15.7
Total	570 955	463 177	107 778		

6 Comparison of value added, selected sectors

	New China IO	GTAP database	Absolute difference	Difference ratio ^a
	US\$m	US\$m	US\$m	
2 Wheat	2 901	4 287	1 386	0.48
3 Grains	9 283	4 248	5 035	1.19
4 Fruits and vegetables	52 493	83 548	31 055	0.59
8 Other crops	21 013	2 140	18 872	8.82
9 Live cattle	7 920	4 873	3 047	0.63
15 Coal	13 233	6 227	7 006	1.12
16 Oil and gas	23 441	15 366	8 075	0.53
23 Petroleum, coal products	18 220	7 453	10 767	1.44
25 Mineral products	24 853	48 250	23 397	0.94
31 Manufactures	17 774	35 183	17 409	0.98
32 Electricity and gas distribution	56 062	10 664	45 398	4.26
38 Other business and recreation	76 045	31 332	44 713	1.43
Total	1 259 259	1 121 476	137 783	0.12

^a Difference ratio = absolute difference/MIN(New China IO, GTAP database). If two data entries are close together, the absolute difference and difference ratio will be close to zero.

agricultural products need further investigation. Also, such shares are likely to change when inventories are reallocated.

Value added

The pattern of differences in estimates of value of production in the two data sets are also reflected in the value added (table 6). Industries in the new Chinese IO table whose outputs are larger than those in the GTAP data set have correspondingly larger value added. Examples of these are the grains, other crops sector and electricity and gas distribution sectors. This is expected as more primary inputs are needed to produce an additional output.

The above comparison indicates that there are substantial differences in estimates of value of outputs from the two data sets. These differences in output are reflected in final demand as well as in value added. Additionally, industry transactions also differ between the two data sets. Such differences are notable in the values of multipliers which are discussed for selected products in the next section.

An assessment of the new Chinese IO table

It is noted in table 3 that estimates presented here for agricultural outputs in China for 2001 differ 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 the GTAP database. In this section, an assessment is made of whether the differences in the IO transactions would lead to differences in estimates from a simple IO impact analysis.

Impact analysis using the IO table

To evaluate the effects of the revised transactions and output data, the new China IO tables and the IO table from the 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 could 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 would have required more information that is not readily available at this stage of development and would also have involved 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 by 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.

To assess whether the differences in transactions between IO from the 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:

- an increase in final demand for other crops
- an increase in final demand for grains
- a simultaneous increase in final demand for all agricultural products.

An increase in final demand for other crops

As illustrated in table 7, a US\$1 billion increase in final demand for other crops increases output of this sector by a factor of 1.005 in the GTAP database and 1.008 in the new China

IO table, resulting in an increase in value of output of US\$1005 million and US\$1008 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\$1500 million under GTAP and US\$1647 million in the new IO, table 7). However, because of the significant differences in estimates of initial production in the two datasets (US\$2603 million in GTAP and US\$27 629 million in the new IO table, table 3), the estimated percentage increases in the value of output are significantly different, with output increasing by 39 per cent in GTAP IO and by only 4 per cent in the new China IO table.

Box 1: Technical details of an input-output model

The sales of i in the IO table can be represented as $\sum_j X_{ij} + F_i = X_i$, 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 $\sum_j a_{ij}X_j + F_i = X_i$ which, in matrix notation, is equal to:

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

where: \mathbf{A} = matrix of coefficients showing the shares of input X_{ij} to the total output X_j
 \mathbf{X} = the vector of sector gross output
 \mathbf{F} = the column vector of total final demands.

Rearranging (1), yields

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

where \mathbf{I} = an identity matrix

Total differentiation of (2), gives

$$(3) \quad d\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1}d\mathbf{F}$$

The matrix $(\mathbf{I} - \mathbf{A})^{-1}$ 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 \mathbf{X} given exogenous changes in \mathbf{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 $(\mathbf{I} - \mathbf{A})^{-1}$ matrix, 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 $(\mathbf{I} - \mathbf{A})^{-1}$ 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.

7 Impact of a US\$1 billion increase in final demand for other crops

		GTAP database	New China IO
Other crops base value of output	US\$m	2 603	27 629
Own use multiplier		1.005	1.008
Change in value of output	US\$m	1 005	1 008
Change in value of output	%	38.62	3.65
Other crops sector multiplier		1.50	1.65
Total impact	US\$m	1 501	1 647

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 were applied using the two databases, the economic impact would be markedly different.

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 affect 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 8. The differences in the own use multiplier leads to different estimates of changes in the value of output of grains. These increases are US\$1471 million in GTAP and US\$1135 million in the new IO table.

In table 8 the larger total impact in the GTAP database is further magnified by the larger multiplier, which indicates broader linkages in the GTAP database than in the new IO table.

8 Impact of a US\$1 billion increase in final demand for grains

		GTAP database	New China IO
Base value of output	US\$m	10 139	18 103
Own use multiplier		1.47	1.14
Change in value of output	US\$m	1 471	1 135
Change in value of output	%	14.51	6.27
Grains sector multiplier		2.58	1.65
Total impact	US\$m	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 fertilisers than in the GTAP database (table 9). Chemicals and fertilisers 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 the chemicals and fertilisers 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 fertilisers 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 fertilisers industry increasing production by US\$4.4 billion in the new IO. This increase is over US\$1.2 billion more than the increase in output when using the GTAP database.

This means that the ability of the chemicals and fertiliser industry to constrain agricultural output will be larger in the new IO table. If the two databases were used in models where input use constraints were imposed, and involving other sectors that were major users of outputs of chemicals and fertilisers, the impact on agriculture would potentially be 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

9 Impact of a simultaneous US\$1 billion increase in final demand for all agricultural products on the fertiliser and chemical industry

	GTAP database		New IO table	
	Change in value of output	Backward link with chemical and fertiliser industry	Change in value of output	Backward link with chemical and fertiliser industry
	US\$m	US\$m	US\$m	US\$m
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 fertiliser	3 146	1.69	4 371	1.68
Total impact	25 580		27 953	

using the two IO tables, with higher impacts expected when using the new IO table. Oil prices are likely to have an impact on chemicals and fertiliser prices because of the large cost share of oil in the production of chemicals and fertilisers in the two data sets.

The application of IO analysis so far gives insights into the differing results that could be obtained from CGE analysis from using 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.

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 following 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 modeling 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 affect the 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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