Assessing Environmental Effects of China's WTO Accession

Shantong Li
Fan Zhai
Xiaowei Xuan
Department of Development Strategy & Regional Economy
Development Research Center of the State Council, P.R.China

1. Introduction

Since the beginning of economic reform and its opening to the outside world, China's economy has been growing at a rate of nearly 10 percent annually and its external trade has expanded by more than 15 percent a year. In 2001 China's trade volume reached $509.9 billion, ranking 6th in the world. China has emerged to become an important player in world trading system. Integration of China into WTO's global trading system would significantly expand world trade, and strengthen the multilateral trade system's integrity and credibility. Substantial trade liberalization is expected in China in the coming 5-10 years to fulfil its commitment and further reform its foreign trade regime.

Accompanying the rapid economic growth, however, the environmental quality has deteriorated. Furthermore, with the rapid expansion of foreign trade, trade and environment linkages have become an important part of policy agenda. It is increasingly recognized that the import of goods and services entails an implicit transfer of environmental effects to the exporting country. Given the relatively lagged technology level in developing countries, it is possible that they would be the net losers in the environmental transfer through international trade.

Undoubtedly, China's WTO membership will have important environmental implications. This paper aims at providing a comprehensive analysis of the impact of China's accession to the WTO, based on its final offer for WTO accession. We try to provide some empirical evidences for policy makers to evaluate the effects of China's WTO accession from both economic and environmental prospective. This analysis uses a 53-sector, 2-region recursive dynamic computable general equilibrium (CGE) model of China.

This paper is organized as follows: Section 2 of this paper outlines the basic structure of the CGE model for China and presents major assumptions. Section 3 describes the basic characteristics of the base year data, and highlights the economic structure and market openness in China. Section 4 describes the simulation scenarios and section 5 uses simulation results to assess the impact of China's WTO accession. Section 6 concludes by drawing policy implications.

2. Model Features

The two-region Chinese CGE model we employ in this study is an extension of the single region Chinese CGE model that had been used in China's WTO accession study (Development Research Center, 1998; Zhai and Li, 2000). The Chinese CGE models are closely related to the applied general equilibrium model already used extensively over the past two decades to analyze the impact of trade policy reform (see Derivis, de Melo and Robinson, 1982; de Melo, 1988; Shoven and Whalley, 1992; de Melo and Tarr, 1992; Hertel, 1997). The starting point for the structure of single region Chinese model is the prototype CGE model developed for the Trade and Environment Programme of the OECD Development Centre (Beghin, et al., 1994). But some significant modifications were done in this model to capture the major features of trade and tax system in current Chinese economy. A more complete description of the model is provided in the annex. This section summarizes the main features.

An important feature of the single region Chinese CGE model is the explicitly treatment of two separate foreign trading regimes. As pointed out by Naughton (1996), China had established two separate trading regimes by 1986-87. One is the export processing or export promotion regime, which is extremely open, most foreign-invested firms and parts of domestic firm participate it. The other is traditional, but increasing reformed, ordinary trade regime. Since 1990s export processing has grown rapidly, which accounts for more than half of all exports. Obviously, to analysis the external trade behavior and the impact of alternative changes of trade policy in such an economy, it is very important to have an explicitly treatment of its dualistic foreign trading regimes in the model.

In the extension from single region Chinese CGE model to multi region setting, two regions - Guangdong province and rest of China - are specified, each with a demand and production structure, and interregional trade in commodities and services. The interregional factor mobility and intergovernmental transfer are also introduced in the model. Guangdong province locates in southern China, neighboring Hong Kong and Marco. As the largest economy in China, it accounts for nearly 40 percent of national foreign trade. The development of Guangdong since 1978 and its economic structure could be a representation of China's coastal area. The regional disaggregation in our CGE model, which specify Guangdong and the rest of China as endogenous agents and allow for inter-regional and national-regional feedback, makes it possible to assess the impact on coastal and inland areas of trade or other policy reforms.

Production is modeled using nested constant elasticity of substitution (CES) functions, and constant-returns-to-scale is assumed. Household demand is modeled using the Extended Linear Expenditure System (ELES). The other final demand accounts assume a fixed-coefficient expenditure function. Trade is modeled using the Armington assumption for import demand, and a constant elasticity of transformation (CET) function for export supply. The small country assumption is assumed for import, hence world import prices are exogenous in foreign currency. Exports are demanded according to constant-elasticity demand curves, the price-elasticities of which are high but less than infinite.

All commodity and factor markets are assumed to clear through prices. For each labor skill type, labor is assumed to be perfectly mobile across sectors, and thus there is a single region-wide equilibrating wage rate for each labor type. Capital is assumed to be partial mobile, reflecting difference in the marketability of capital goods across sector.

The model assumes imperfect interregional factor mobility to reflect the policy and institution factors that limit regional factors movement, as well as the location preference of residents. The movement of capital is driven by the relative rental rates across region and the constant elasticity of transformation, and the movement of labor is determined by the relative real income across region and the constant elasticity of transformation. The real income of labor is defined as the wage plus per capita net intergovernmental transfer income.

Emissions are generated by the consumption of goods, both in production and in final demand. In certain sectors, there are an autonomous component of emissions which are directly linked to the level of output. We have mainly used the database for Trade and Environment Programme at OECD Development Center to calibrate sectoral emission factors (Dessus et. al., 1994), which is in turn based on the World Bank database of Martin et. al. (1991). Pollution is characterized by a vector of 14 measures of various water, air and soil pollution source (toxic pollutants in water, air and land (TOXAIR, TOXWAT, TOXSOL), bio-accumulative toxic metals in air, soil, and water (BIOAIR, BIOWAT, BIOSOL); air pollutants (SO_2, NO_2, CO, CO_2, volatile organic compounds (VOC), total suspended particulate (TSP)); and water pollution (biological oxygen demand (BOD), and total suspended solids (TSS)).

The current version of the China's CGE model has a simple recursive dynamic structure. Dynamic in the model originate from accumulation of productive factor and productivity changes. The base year of the data and the model is 1997. The model is solved for subsequent years in 1998, 2000, 2002, 2004, 2006, 2008 and 2010. The growth rate of population, labor forces, labor

productivity is exogenous. The growth of capital is endogenously determined by the saving/investment relation.

3. Economic Structure, Market Openness and Sectoral Pollution Pattern in China

Our CGE model for China is constructed according to two SAMs for the year of 1997. The section outlines the basic features of industrial structure and market openness of Chinese economy in 1997 based upon the SAMs.

Table 1 summarizes the sectoral structure and market openness of Chinese economy in the base year. For each of the 53 sectors, the base year data for shares of output, employment, imports, exports, trade dependence, and the share of ordinary trade are reported. Columns 10 and 11 give information about the degree of import protection. As may be seen in columns 1 through 4, the data are notably asymmetric among the shares of output, employment, and trade. For example, the crop sectors (sector 1-5) account for 40 percent of China's labor employment but only produce 6 percent of its output and account for 2 percent of China's total trade. While textile, apparel and leather industries employ 2.5 percent of China's labor force, but produce 7.7 percent of its total output and account for more than 26 percent of the country's total exports.

Export dependency is high for the apparel, leather, social articles, electronics and instruments sectors as more than 30 percent of their products depend on foreign markets. Textile is also the export-oriented sector in which almost 20 percent of the outputs are sold on international markets. The sectors with the largest shares in imports are machinery, electronics and chemicals as they account for more than 10 percent of China's total imports, respectively. The wool, instruments, electronics and special equipment and two raw materials sector (crude oils and ferrous ore mining) have higher market penetration ratio. The electronics and instruments sectors have both high export and import dependency, reflecting the fact that a large percentage of production in this sector represents processing and assembling products from abroad, i.e. processing trade.

The trade balances by industry in column 10 reflect China's comparative advantage. China is a net exporter of labor-intensive manufactures and a net importer of capital-intensive manufactures. The largest share of the trade surplus in China comes from apparel and textile. In agricultural sector, China is net importer of grain, but has trade surplus of other agricultural products.

Table 1 Economic Structure and Market Openness in China, 1997 (%)

	Output	Employment	Imports	Exports	Import/ Domestic Use	Export/ Outputs	Ordinary Exports/ Total Exports	Ordinary Imports/ Total Imports	Net Export (bn. Yuan)	Nominal Tariff Rate	Collect Tariff Rate
Rice	1.2	7.5	0.2	0.1	0.9	0.9	100	92	0.0	1.0	0.4
Wheat	0.7	4.1	0.9	0.0	7.9	0.0	-	78	-11.3	1.0	0.2
Corn	0.4	2.6	0.1	0.4	1.1	7.9	100	21	6.3	1.0	0.0
Cotton	0.3	2.0	0.6	0.0	10.7	0.0	100	17	-7.7	3.0	0.6
Other non-grain crops	3.8	23.8	0.5	1.1	0.8	2.3	100	25	12.8	4.4	5.7
Forestry	0.4	2.0	0.5	0.2	6.8	3.6	96	33	-2.6	28.6	8.3
Wool	0.0	0.0	0.3	0.0	56.0	8.9	100	6	-3.8	15.0	0.7
Other livestock	3.8	8.2	0.1	0.4	0.1	0.9	97	47	6.8	5.0	2.1
Fishing	1.1	3.2	0.0	0.2	0.2	1.2	92	77	2.5	0.8	0.5
Other agriculture	0.6	2.2	0.0	0.1	0.0	1.2	88	12	1.5	16.0	1.7
Coal mining	1.1	1.2	0.1	0.6	0.4	3.1	100	63	8.6	6.0	3.3
Crude oil and natural gas	0.8	0.2	3.6	1.5	24.6	14.4	100	71	-20.6	1.5	1.0
Ferrous ore mining	0.2	0.1	1.1	0.0	30.2	0.0	100	43	-14.4	0.0	0.0
Non-ferrous ore mining	0.4	0.2	0.5	0.1	6.5	1.1	92	37	-4.9	0.0	0.0
Other mining	0.9	0.8	0.8	0.6	5.5	4.3	79	36	-0.5	2.9	0.9
Vegetable Oil	0.6	0.1	1.2	0.3	12.3	4.3	19	46	-10.3	17.0	5.3
Grain mill and forage	1.6	0.2	1.1	0.3	4.0	1.6	76	94	-7.9	4.7	4.4
Sugar	0.2	0.1	0.2	0.1	6.0	3.3	12	36	-0.8	30.0	9.5
Processed food	2.6	0.6	1.0	3.3	2.5	9.7	72	18	42.4	23.2	3.7
Beverage	1.3	0.3	0.1	0.5	0.5	3.1	84	45	7.5	60.2	24.0
Tobacco	0.7	0.1	0.2	0.3	1.3	3.2	96	24	3.3	49.1	10.6
Textile	4.6	1.5	6.8	11.4	10.1	18.4	60	1	104.5	27.5	0.2
Apparel	1.9	0.6	0.7	9.9	3.6	37.0	45	2	156.2	41.8	0.7
Leather	1.1	0.3	1.8	5.0	13.2	32.6	29	1	61.4	35.5	0.3
Sawmills and furniture	1.1	0.4	0.9	2.1	5.6	13.1	61	20	22.8	14.4	2.5
Paper & printing	1.7	0.6	2.9	0.5	9.9	2.0	35	33	-29.2	11.0	3.1
Social article	1.1	0.3	1.0	6.0	9.0	40.0	32	28	87.6	3.1	1.0
Petroleum refining	1.6	0.2	3.1	1.2	11.8	5.7	69	62	-19.6	8.7	4.8
Chemicals	4.0	1.0	11.8	4.2	16.7	8.3	80	31	-77.8	10.8	3.0
Medicine	0.9	0.2	0.2	0.7	1.8	5.9	84	75	8.5	10.9	7.2
Chemical fibers	0.6	0.1	2.1	0.5	18.3	6.6	31	7	-17.4	15.5	1.0
Rubber and plastics	2.1	0.6	2.1	4.2	7.0	15.7	28	12	42.8	19.8	2.0

	Output	Employment	Imports	Exports	Import/ Domestic Use	Export/ Outputs	Ordinary Exports/ Total Exports	Ordinary Imports/ Total Imports	Net Export (bn. Yuan)	Nominal Tariff Rate	Collect Tariff Rate
Build materials	4.4	2.1	0.8	2.1	1.2	3.4	82	20	23.9	20.8	3.6
Primary iron and steel	2.7	0.7	3.8	1.8	8.6	5.5	21	28	-17.5	8.1	2.0
Non-ferrous metals	1.2	0.3	2.6	1.2	13.0	8.0	56	14	-13.1	7.1	0.9
Metal products	2.5	0.7	2.6	4.1	7.0	13.1	57	20	36.4	13.1	2.4
Machinery	2.5	1.0	5.6	1.8	13.3	5.9	61	35	-41.0	13.7	4.2
Special equipment	1.7	0.6	8.0	1.1	23.6	5.6	63	21	-82.9	14.1	2.6
Automobile	1.6	0.4	1.1	0.4	4.2	1.9	63	73	-7.6	50.7	32.6
Oth. Transport equipment	1.3	0.4	2.6	1.6	12.1	9.7	24	28	-5.8	5.6	1.3
Electric machinery	2.8	0.6	4.0	5.5	9.6	15.9	21	20	42.2	17.9	3.1
Electronics	2.5	0.4	13.2	11.5	34.7	36.3	9	20	25.2	11.8	2.1
Instruments	0.4	0.2	2.7	2.7	44.3	49.5	15	20	12.3	12.5	2.3
Other manufacturing	0.8	0.6	0.4	0.9	3.1	8.1	29	3	9.6	38.9	0.9
Utilities	2.2	0.5	0.0	0.2	0.0	0.9	100	-	3.8	0.0	0.0
Construction	8.7	5.8	0.4	0.1	0.3	0.1	100	100	-2.6	0.0	0.0
Transportation	2.5	3.1	0.7	2.8	1.8	9.4	100	100	38.9	0.0	0.0
Post and communication	1.0	0.3	0.2	0.7	1.3	5.7	100	100	8.7	0.0	0.1
Commerce	6.6	9.0	1.2	0.7	1.2	0.9	100	100	-4.2	0.0	0.0
Finance	1.8	0.5	0.4	0.1	1.2	0.5	100	100	-2.7	0.0	0.0
Social services	3.8	1.6	2.9	4.5	5.2	10.1	100	100	38.8	0.0	0.0
Education & health	3.3	4.0	0.2	0.3	0.4	0.7	100	100	1.7	0.0	1.7
Public administration	2.2	1.8	0.2	0.0	0.5	0.1	100	100	-1.5	0.0	0.0
Total/Average	100.0	100.0	100.0	100.0	6.4	7.7	51	32	409.5	11.2	2.5

Note: 1) Imports/Domestic use and Exports/output are at domestic price. The sectoral share of imports and exports are at world price.

2) The imports of rice, wheat, corn, cotton, grain mill & vegetable oil are average of 1993-97.

Source: Chinese Social Accounting Matrix, 1997, Development Research Center of the State Council

Processing trade is the most rapid expanding portion of China's foreign trade. It accounts for 50 percent China's total exports and 46 percent of China's total imports in 1997. It is more important for finished goods than primary and intermediates products. For instance, nearly 80 percent of China's primary iron and steel, electric machinery, electronics and instruments exports, and more than two thirds of China's leather, social articles and chemical fibers exports are processing exports. It also constitutes a significant portion of China's exports on apparel, paper and printing products. The high shares of processing exports in these sectors require a large volume of raw materials, components, and semi-processed products imported from abroad as their inputs. Column 8 in Table 1 shows that in the sectors of textiles, apparel, leather and other manufacturing, the ordinary imports were only about 5 percent of their total imports. Almost all those imports were used for the production of processing exports. Most imports on paper products, build materials, chemicals, basic metal and metal products, machinery and electronics are also used by foreign or joint-venture companies as intermediate inputs to produce processing exports.

Another notable feature of the base year data is the significant differences between China's nominal tariff rate and the actual collected rate. It is well known that China's tariff collection is significantly below its nominal tariff level because of a large volume of processed trade, extensive import duty exemptions and widespread smuggling activities (World Bank, 1994, Bach, *et al.*, 1996). The final two columns of Table 1 provide the nominal tariff rate and actual collected rate. It indicates the dramatic variation of the nominal/actual tariff rate ratio among sectors as this statistic ranges from 140 in textile and leather industries to less than 2 in medicine and automobile industries. In general, the more export-oriented sectors have the higher nominal/actual rate gaps because of the tariff exemptions applied to their imports of intermediate inputs and processed trade.

China's tariff structure is typical of that of developing countries, i.e. providing high protection for manufacturing sector, especially the capital-intensive manufacture and final consumption goods sectors. But in the aggregated level, China's actual tariff rate is moderate. Automobile subjects to the highest nominal tariff rate of 50% and its actual collection rate for ordinary import is 45%. The tariff rates in other manufactures, textile and apparel sector are also relatively high, but their effects are limited because the share of duty imports (ordinary imports) is very small.

Given the importance of Guangdong province in national economy and foreign trade, we distinguish Guangdong province and the rest of China in our two-region model and base year SAMs. Guangdong province, which has taken a leading position in the reform and opening of China since 1978, has achieved an extraordinary economic performance from 1978. Its average growth rate of GDP from 1978-1997 is 14.2 percent annually, 4.4 percentage point higher than the national average of 9.8 percent. The share of GDP in the national economy is raised from 5.1 percent in 1978 to 9.8 percent in 1997, compared with the population share of 5.7 percent. The value of GDP is 731.6 billion yuan in 1997 ranked the first in China.

Due to the location advantage and its broad connection of overseas Chinese in business field, Guangdong province enjoyed a very high growth rate of external trade. The average annual growth rate of foreign trade in Guangdong is 24.6 percent from 1978-1997. The share of Guangdong's foreign trade in China is nearly 40 percent in the year of 1997. It should be pointed out that a large share of export in Guangdong is processing trade. The share of processing trade in total export is raised from 0.83 percent in 1978 to more than 70% in 1997. Guangdong accounts for more than 50 percent of China's processing trade in the year of 1997.

Table 2 summarizes the economic structure of Guangdong in the base year. The first four columns report the sectoral composition of output, employment and foreign trade. Column 5-7 reports the trade dependence of Guangdong, both foreign and interregional. The share of ordinary trade and net export are reported in the last four columns. In comparison with national economy, Guangdong is more specialized in service sector and export-oriented labor-intensive manufacturing sector. Agriculture is not important in Guangdong in terms of output and employment relative to the national average, but there is still more than 40 percent of labor force employed in agricultural sector. Guangdong is an extremely open economy, 20 percent of its domestic uses are import and 25 percent of its products are exported to oversea market. The dependency of Guangdong's

economy on oversea market is higher than that on interregional domestic market. Only 17 percent of its domestic uses are from rest of China and 11 percent of its products are sold at the market of rest of China. At industry level, textile, apparel, leather, social articles, electronics and electric machinery are important export sectors, they together contribute 64 percent of Gaundong's exports. Electronics, chemicals and textiles sectors are three largest import sectors, they account for 41 percent of total imports. The electronics, instruments, special equipment and textiles sectors have both high export and import dependency. Guangdong depends on interregional import for most of energy goods and primary metal, as well as electric machine and electronics. The electric machine and electronics sectors are also the largest sector in terms of interregional exports. Exports to the rest of China are also important for most chemical industries in Guangdong.

The data for trade balance show that the largest share of foreign trade surplus in Guangdong comes from apparel, textile, leather, electric machine and electronics. The electric machine sector in Guangdong also has large surplus from interregional trade. Guangdong is net importer of energy, chemicals and primary metal.

Table 2 Economic Structure in Guangdong, 1997 (%)

	Output	Employment	Imports	Exports	Import/ Domestic Use	Export/ Outputs	Inter-regional Import/Domestic Use	Inter-regional Export/ Outputs	Ordinary Exports/ Total Exports	Ordinary Imports/ Total Imports	Net Export (bn. Yuan)	Net Inter-regional Export (bn. Yuan)
Rice	0.9	7.2	0.2	0.0	3.5	0.0	23.3	8.1	100	89	-0.9	-4.2
Wheat	0.0	0.0	0.2	0.0	92.2	0.0	2.1	8.1	-	17	-0.9	0.0
Corn	0.0	0.0	0.0	0.0	100.0	-	0.0	-	100	0	-0.2	0.0
Cotton	0.0	0.0	0.2	0.0	99.1	-	0.9	-	100	11	-0.8	0.0
Other non-grain crops	2.5	19.9	0.2	0.5	1.7	5.1	23.7	8.1	100	37	1.9	-10.8
Forestry	0.3	1.5	0.3	0.1	15.3	6.2	5.0	0.0	84	32	-0.7	-0.4
Wool	0.0	0.0	0.1	0.0	99.9	-	0.1	-	100	5	-0.6	0.0
Other livestock	1.9	4.1	0.0	0.3	0.3	4.2	4.7	0.3	92	56	1.9	-1.9
Fishing	1.4	7.0	0.0	0.2	0.6	2.8	3.8	12.5	79	63	0.8	2.9
Other agriculture	0.5	2.5	0.0	0.0	0.0	2.7	1.4	0.2	58	21	0.3	-0.1
Coal mining	0.0	0.2	0.0	0.0	0.6	4.4	94.9	2.8	100	55	-0.1	-15.1
Crude oil and natural gas	0.9	0.0	1.9	1.4	42.8	42.6	0.2	0.0	100	48	0.4	0.0
Ferrous ore mining	0.1	0.1	0.1	0.0	16.8	0.5	37.6	27.4	100	29	-0.4	-0.5
Non-ferrous ore mining	0.1	0.1	0.1	0.0	9.1	8.9	54.1	26.3	100	68	-0.1	-1.4
Other mining	0.6	0.3	0.8	0.3	17.4	12.4	27.2	0.2	39	19	-1.5	-5.5
Vegetable Oil	0.3	0.1	1.1	0.4	49.4	28.4	7.2	12.7	3	23	-2.8	0.2
Grain mill and forage	0.9	0.2	0.4	0.2	8.4	6.2	12.7	12.7	31	81	-0.5	-0.1
Sugar	0.3	0.1	0.1	0.1	11.8	8.6	32.2	45.7	8	1	0.0	1.1
Processed food	1.7	0.8	0.8	1.4	12.3	21.0	17.5	26.6	49	30	5.2	5.1
Beverage	1.0	0.3	0.1	0.5	1.9	12.6	26.9	34.6	84	75	2.8	3.1
Tobacco	0.3	0.1	0.1	0.1	5.7	10.1	43.9	14.9	100	22	0.1	-3.0
Textile	4.0	1.5	9.9	11.3	48.4	66.5	26.8	8.6	50	0	26.0	-16.5
Apparel	3.5	2.4	0.6	8.7	8.6	54.2	4.0	9.9	38	1	50.9	6.5
Leather	2.7	1.5	2.5	6.8	32.4	61.4	9.9	5.0	18	1	30.8	-0.4
Sawmills and furniture	1.4	0.5	1.6	2.4	16.8	41.6	47.4	10.9	40	13	8.1	-16.1
Paper & printing	1.8	0.8	4.6	0.8	35.2	10.8	15.2	18.7	19	9	-15.2	-1.2
Social articles	3.5	1.3	0.9	10.1	14.7	69.5	0.7	2.6	17	4	58.4	1.8
Petroleum refining	0.7	0.2	4.2	0.5	36.6	18.0	53.9	51.6	52	58	-15.4	-19.0
Chemicals	1.1	0.8	12.7	1.3	63.6	29.6	31.5	53.1	53	8	-47.7	-14.5
Medicine	0.7	0.3	0.1	0.2	5.6	5.8	32.7	52.9	87	71	0.4	4.9
Chemical fibers	0.7	0.2	1.1	0.3	27.6	10.1	30.0	43.5	24	3	-3.3	1.8

	Output	Employment	Imports	Exports	Import/ Domestic Use	Export/ Outputs	Inter-regional Import/Domestic Use	Inter-regional Export/ Outputs	Ordinary Exports/ Total Exports	Ordinary Imports/ Total Imports	Net Export (bn. Yuan)	Net Inter-regional Export (bn. Yuan)
Rubber and plastics	4.0	1.2	3.1	6.2	19.6	41.3	15.5	7.5	20	5	24.8	-4.2
Build materials	3.0	1.8	1.0	1.9	7.0	15.2	17.7	11.8	69	7	7.1	-3.6
Primary iron and steel	0.5	0.3	5.3	0.3	41.0	15.2	45.4	11.9	35	9	-21.6	-24.5
Non-ferrous metals	0.7	0.2	4.8	0.4	42.5	17.2	40.8	29.4	32	9	-18.3	-15.6
Metal products	3.4	1.0	2.9	4.2	22.1	32.9	8.4	13.6	34	3	13.4	5.3
Machinery	0.8	0.6	3.6	0.9	49.2	28.1	19.5	15.9	29	18	-10.7	-3.4
Special equipment	0.3	0.5	5.3	0.6	89.8	56.3	7.9	35.4	20	7	-19.3	0.6
Automobile	0.5	0.1	0.4	0.3	14.8	14.6	33.1	29.0	24	67	-0.1	-0.7
Oth. transport equipment	1.4	0.6	1.2	1.0	17.1	18.0	6.0	7.2	8	54	0.9	0.4
Electric machinery	5.9	1.7	5.3	9.2	34.4	41.7	35.3	42.5	13	8	33.4	31.7
Electronics	7.0	2.0	18.0	18.4	62.1	67.9	29.1	24.9	5	6	34.1	1.5
Instruments	1.1	0.4	1.5	3.8	84.3	84.9	3.9	11.1	7	8	16.6	2.3
Other manufacturing	1.2	0.9	0.5	1.3	8.4	26.3	19.4	7.6	12	1	5.7	-2.8
Utilities	2.8	0.5	0.0	0.6	0.0	6.1	2.3	3.6	100	-	3.8	0.9
Construction	7.0	8.1	0.0	0.0	0.0	0.0	0.0	0.0	100	100	0.0	0.0
Transportation	4.0	3.5	1.2	1.2	4.6	8.1	24.2	1.5	100	100	2.0	-25.7
Post and communication	1.5	0.5	0.0	0.2	0.0	3.2	0.0	0.0	100	100	1.0	0.0
Commerce	8.9	12.0	0.9	0.5	2.0	1.7	4.4	2.7	100	100	-0.6	-3.4
Finance	2.3	0.9	0.0	0.0	0.1	0.1	0.0	0.0	100	100	0.0	0.0
Social services	5.2	2.4	0.0	1.3	0.0	6.9	0.0	0.0	100	100	7.9	0.0
Education & health	2.8	5.0	0.0	0.0	0.0	0.0	0.0	0.0	100	100	0.0	0.0
Public administration	1.9	2.2	0.0	0.0	0.0	0.0	0.0	0.0	100	100	0.0	0.0
Total/Average	100.0	100.0	100.0	100.0	19.8	25.1	17.0	11.4	29	14	177.1	-124.5

Note: 1) Imports/Domestic use and Exports/output are at domestic price. The sectoral share of imports and exports are at world price.

2) The imports of rice, wheat, corn, cotton, grain mill & vegetable oil are average of 1993-97.

Source: Chinese Social Accounting Matrix, 1997, Development Research Center of the State Council

Table 3 Sector Effluent Intensities (kg / 10000 yuan)

	TOXAIR	TOXWAT	TOXSOL	BIOAIR*	BIOWAT*	BIOSOL*	SO_2	NO_2	CO	CO_2**	VOC	TSP	BOD	TSS
Rice	0.7	4.0	2.7	0.0	0.1	0.0	0.5	0.3	0.2	1.5	0.4	0.0	0.3	0.0
Wheat	0.7	4.0	2.7	0.0	0.1	0.0	0.5	0.3	0.2	1.5	0.4	0.0	0.3	0.0
Corn	0.7	4.0	2.7	0.0	0.1	0.0	0.5	0.3	0.2	1.5	0.4	0.0	0.3	0.0
Cotton	0.7	4.0	2.7	0.0	0.1	0.0	0.5	0.3	0.2	1.5	0.4	0.0	0.3	0.0
Other non-grain crops	0.7	4.0	2.7	0.0	0.1	0.0	0.5	0.3	0.2	1.5	0.4	0.0	0.3	0.0
Forestry	2.4	5.9	15.6	0.4	0.1	0.0	1.4	0.4	0.2	2.0	0.2	2.0	2.7	2.5
Wool	0.6	1.4	4.4	0.9	0.2	0.0	2.2	0.5	0.3	2.2	0.0	4.1	0.8	5.2
Other livestock	0.7	1.4	4.5	0.9	0.2	0.0	2.2	0.5	0.3	2.2	0.0	4.1	0.8	5.2
Fishing	2.2	4.9	14.3	0.6	0.1	0.0	3.0	1.4	0.8	6.0	0.2	2.7	2.4	3.3
Other agriculture	8.7	18.8	60.3	2.0	0.3	0.0	4.8	1.2	0.6	5.2	0.1	8.7	10.7	10.9
Coal mining	54.0	115.7	373.1	14.4	1.6	2.2	51.1	10.8	3.5	30.5	0.1	92.2	66.5	77.6
Crude oil and natural gas	1.3	3.3	7.6	2.8	0.3	0.6	13.9	5.2	1.1	26.0	0.2	15.2	1.2	15.2
Ferrous ore mining	5.3	12.0	55.6	115.5	4.1	3753.1	6.1	2.0	1.1	8.9	0.3	129.5	6.1	11.0
Non-ferrous ore mining	15.0	10.8	45.1	121.2	0.3	4471.6	6.4	1.7	0.9	7.6	0.2	131.7	5.4	13.9
Other mining	72.9	156.8	503.5	1.9	0.3	0.1	6.3	2.3	1.3	10.0	0.4	107.8	89.6	10.5
Vegetable Oil	0.9	2.1	5.8	0.8	0.1	0.0	3.1	4.1	0.2	2.0	0.0	9.7	1.0	4.5
Grain mill and forage	0.8	1.9	5.3	0.9	0.1	0.0	3.2	4.1	0.2	2.1	0.0	9.8	0.9	4.7
Sugar	1.7	3.5	10.9	7.3	0.8	0.1	17.5	7.0	1.8	15.3	0.1	38.0	1.9	40.0
Processed food	2.0	4.2	12.8	2.3	0.3	0.0	6.4	4.7	0.6	5.0	0.0	16.1	2.4	12.5
Beverage	0.3	0.7	1.2	3.1	0.3	0.3	8.0	5.1	0.8	6.5	2.3	19.4	0.2	16.7
Tobacco	0.1	0.5	0.5	0.7	0.1	0.1	2.7	3.9	0.2	1.5	0.0	9.1	0.1	3.8
Textile	0.1	0.5	0.4	1.9	0.2	0.0	9.0	9.9	0.5	4.0	0.0	11.2	0.0	10.2
Apparel	3.5	0.2	0.3	0.5	0.1	0.0	1.4	0.3	0.1	1.2	0.0	2.4	0.0	2.8
Leather	0.2	0.6	0.3	0.4	0.1	0.0	1.2	0.3	0.1	1.1	0.1	1.9	0.0	2.2
Sawmills and furniture	40.3	87.0	279.1	3.0	0.3	1.1	7.5	3.6	0.9	6.4	2.8	27.8	49.7	15.9
Paper & printing	5.3	12.3	34.5	3.9	0.4	0.6	26.3	10.9	1.0	8.7	0.2	21.0	6.1	21.3
Social articles	4.4	9.9	28.0	3.6	0.2	18.8	3.6	1.0	0.5	3.8	0.2	7.2	4.9	7.4
Petroleum refining	0.8	2.1	4.3	20.4	2.2	0.1	55.3	15.1	5.7	69.3	2.0	37.8	0.3	112.4
Chemicals	34.9	79.3	233.8	16.6	1.4	127.8	37.4	14.2	3.7	31.5	1.0	27.0	41.1	72.0
Medicine	0.8	3.0	3.5	1.0	0.1	0.2	9.2	7.6	0.3	2.2	0.2	6.5	0.5	33.8
Chemical fibers	1.3	9.4	3.1	2.9	0.3	0.1	13.9	8.9	0.9	7.7	0.9	9.8	0.0	16.1
Rubber and plastics	1.7	7.4	2.4	1.8	0.2	0.3	11.1	8.2	0.6	4.7	0.7	7.9	0.0	9.7
Build materials	84.3	180.9	582.1	21.6	2.2	25.8	66.6	29.7	5.4	73.7	0.3	155.3	103.6	114.2
Primary iron and steel	14.4	29.3	104.9	89.9	3.8	2526.2	48.9	10.6	4.4	37.0	0.4	60.8	16.2	79.2

	TOXAIR	TOXWAT	TOXSOL	BIOAIR*	BIOWAT*	BIOSOL*	SO_2	NO_2	CO	CO_2**	VOC	TSP	BOD	TSS
Non-ferrous metals	13.3	6.1	33.3	147.5	0.7	4812.6	27.5	5.2	1.6	13.5	0.2	45.6	2.9	30.7
Metal products	4.4	9.6	32.7	22.7	0.7	619.8	3.4	1.8	0.4	3.7	0.1	6.8	5.2	6.9
Machinery	2.6	4.8	15.2	10.6	0.4	230.9	6.6	1.8	0.8	6.7	0.5	14.6	2.5	13.7
Special equipment	1.1	2.3	6.5	5.7	0.4	92.2	5.6	1.6	0.7	5.6	0.1	12.8	1.0	11.4
Automobile	0.9	1.9	4.7	3.5	0.2	45.0	4.1	1.1	0.6	4.6	0.1	7.5	0.7	8.7
Oth. transport equipment	2.1	4.2	12.7	404.7	0.2	87.7	3.2	0.9	0.4	3.4	0.1	6.1	2.2	6.8
Electric machinery	1.5	3.1	7.5	16.3	0.3	314.9	2.5	0.8	0.3	2.7	0.2	4.0	0.9	4.3
Electronics	1.0	2.6	5.0	1.0	0.0	13.2	1.0	0.5	0.1	0.9	0.1	1.0	0.8	1.3
Instruments	1.2	3.0	6.0	1.9	0.1	22.6	2.0	0.6	0.3	2.1	0.1	4.1	1.0	3.6
Other manufacturing	0.9	2.2	4.5	6.5	0.7	9.9	13.6	2.9	1.5	12.7	0.4	27.3	0.7	32.7
Utilities	1.7	2.2	4.4	83.9	8.9	41.6	184.9	38.3	20.0	173.6	0.5	364.1	0.5	455.3
Construction	31.0	66.9	214.4	0.6	0.1	2.5	2.3	1.2	0.7	5.4	0.3	1.4	38.1	1.7
Transportation	3.9	9.1	24.1	2.7	0.7	0.1	12.1	47.7	3.0	23.3	0.9	17.9	3.8	14.7
Post and communication	0.1	0.2	0.2	0.0	1.0	0.0	0.4	0.2	0.1	1.1	0.1	0.0	0.0	0.0
Commerce	0.3	0.9	1.5	0.6	0.2	0.0	2.1	0.8	0.4	3.4	0.1	2.8	0.2	3.5
Finance	0.0	0.2	0.1	0.3	0.6	0.0	0.8	0.2	0.1	1.1	0.0	1.2	0.0	1.4
Social services	1.3	3.5	8.1	2.7	1.1	0.1	7.1	2.0	1.1	8.9	0.2	11.8	1.3	14.7
Education & health	1.1	2.5	6.9	5.0	1.6	19.4	10.0	2.1	1.1	9.5	0.1	19.5	1.2	24.4
Public administration	0.2	0.5	0.4	1.8	1.2	0.0	4.7	1.3	0.7	6.0	0.1	7.8	0.0	9.7

Source: Dessus et. al., 1994, Martin et. al. 1991, author's calculation

* Kg/ 10,000,000 Yuan ** Kg / 100 Yuan

Table 3 provides the sectoral effluent intensity for China. We should point out that they are calculated from the emssion coefficients of OECD database, not based on China's country-specific data, because this kind of emission data for China is not available currently. According to table 3, 13 of 53 sectors could be roughly classified as pollution-intensive, namely, coal mining, crude oil and natural gas, ferrous ore mining, non-ferrous ore mining, other mining, sawmills and furniture, paper and printing, petroleum refining, chemicals, build materials, primary iron and steel, non-ferrous metals, utilities. For example, the build materials industry has high effluent intensities for toxic pollutants and total suspend particulate, while utility sector has high pollution intensities for air pollution.

This SAM-based data analysis provides an overview of the characteristics of economy structure in China. It has important implications for the impact of trade liberalization and facilitates the understanding of simulation results reported later in this paper.

4. Base Case Projections and Simulations Design

The China's WTO accession includes a complex package of reform of trade and investment liberalization. Based on the final offer on market accession, this paper quantify the impact of the following four aspects: (1) tariff reduction on industrial products; (2) elimination of quotas on industrial products by 2005; (3) agricultural trade liberalization, i.e. tariff reduction for agricultural products, introduction of tariff rate quota system for agricultural goods; (4) the phase out of Multi-Fiber Arrangement (MFA) quota on textile and clothing under the WTO Agreement on Textiles and Clothing (ATC). Once China become member of WTO, China's exports in textile and apparel in North America and EU markets will be subjected to accelerate MFA quotas growth by 2004 similar with other developing countries, and the remaining export quota restrictions will be terminated in the year 2005. Therefore, the analysis at best captures only one part of the issue. It does not take into account other major aspects of WTO membership, such as reduction of barriers in service trade and foreign investment, protection of intellectual property rights, securing market access, enforcement of commitment, and cooperation in dispute settlement.

Since China's WTO accession schedule will be phased in over a transition period of 5-8 years, we utilized the recursive dynamic model to assess the impact of China's WTO membership. The dynamic model captures the changes of industrial structure, factor composition and comparative advantage of China in the next 10 years.

The base case projection for next 10 years is established first, which determines a reference growth trajectory, in absence of trade or other reforms. It assumes that China will continue its grain self-sufficient policy, and import quota of agricultural goods will grow at 3 percent annually from 2000-2010. Then we consider four scenarios in reference to the baseline scenario. The first scenario considers the tariff reduction and quotas elimination on industrial products that China offered for the WTO accession. The sectoral reduction rates of import tariff are aggregated from Harmonized Commodity Description and Coding System (HS) tariff schedules for the period of 2000-2008 in China-US agreement and weighted by 1997 ordinary trade data. In this scenario, the growth rate of import quota for petroleum refining and automobiles will also be accelerated in 2000-2005 and the quantitative restriction will be eliminated in 2005. The second scenario focuses on the agricultural trade liberalization. The tariff rate quota (TRQ) system will be introduced to replace the current quota system for rice, wheat, corn, cotton, wool, vegetable oil and sugar. Moreover, the tariff for other agricultural goods will also be reduced. The third scenario looks at the impact of MFA elimination. In this case, China faces accelerated quota growth rate for its textile and clothing export, and the quantitative restriction will be terminated in 2005. The last scenario combines all the three aspects of China's WTO accession. We want to see the whole effects of China's WTO accession. All the assumptions for baseline scenario and five policy scenarios are summarized in table 4.

Table 4 Summary of Simulations Design

Experiment	*Description*

E1 Base case:

- real GDP and agricultural output exogenous
- sectoral-specific TFP growth rate endogenous
- 3% growth rate of import quota for goods subjected to quantitative restriction (rice, wheat, corn, cotton, wool, vegetable oil, sugar, petroleum refining, automobiles)
- exogenous export quota growth for textile and apparel
  textile: 5.0% apparel: 6.2% (annual average)
- All tax rates are fixed at its base year level.
- Balance of payment gradually declines to 30% of its base year level in 2010.

E2 Tariff reduction and quotas elimination on industrial products

- an average 55% cut of 2000 tariff level from 2000-2008
- phased elimination of import quotas on petroleum refining and automobiles from 2000-2005

initial quota in 2000 - *petroleum refining*: 27.6 bn yuan *automobile*: 496.8 bn yuan
annual growth rate of quota from 2000-2005 - *petroleum refining*: 15% *automobile:* 15%

E3 Agricultural trade liberalization

- introduction of TRQ system

	initial quota in 2000	annual growth rate of quota
rice	0.857	18.9%
wheat	1.158	7.2%
corn	0.325	12.5%
cotton	1.046	4.7%
wool	0.635	4.5%
vegetable Oil	5.471	13.3%
sugar	0.387	5.0%

- Tariff cut for other agricultural goods

E4 Phase out of MFA

- acceleration of MFA quota growth rate from 2000-2004
- zero export tax of textile and apparel in 2005

E5 The whole WTO accession package

- E2, E3 and E4 combined

5. Major Simulation Results

1) Aggregate Effects

Table 5 reports the main efficiency and other macroeconomic indicators under the four scenarios of China's WTO accession. They are deviations from base case in the year of 2010. The results show that China will benefit from its WTO accession in terms of real GDP and social welfare. In 2010, China's real GDP will increase by 2.1 percent compared with base case. The welfare gains represented by Hicksian equivalent variations (EV), are smaller compare to GDP (1.89 percent of 2010 GDP), because of a 1.7 percent deterioration in terms of trade. Private consumption would increase by 2.06 percent, indicating the benefits to consumers from the trade liberalization. Investment increases by 2.09 percent. China's trade expansion is significant when it become a member of WTO. Exports and imports would increase by 25.4 percent and 23.8 percent respectively. The real exchange rate will depreciate slightly because of the import increase due to reduction of import protection.

Table 5 Major Macroeconomic Results under China's WTO Accession Scenarios, 2010
(percentage change relative to base case, except *Grain self-sufficiency Rate*)

	Whole WTO accession package (E5)	Tariff and NTBs reduction on industrial products (E2)	Agricultural trade liberalization (E3)	MFA elimination (E4)
EV (% of GDP)	1.89	0.33	0.88	0.41
GDP	2.07	0.36	0.86	0.51

Consumption	2.06	0.51	0.88	0.43
Investment	2.09	0.15	1.05	0.48
Exports	25.43	8.84	2.90	7.77
Imports	23.81	8.40	2.78	7.18
Government Revenue	0.78	-2.34	0.12	1.84
Urban Households Income	2.63	0.51	1.56	0.40
Rural Households Income	1.59	0.54	0.25	0.47
Terms of Trade	-1.68	-0.56	-0.17	-0.68
Real Exchange Rate	0.71	2.57	1.20	-1.88
Grain self-sufficiency Rate	0.887	0.968	0.898	0.966

Note: The results of E5 do not equal to the sum of E2, E3 and E4 due to the interactive effects.
Source: simulation results.

Many factors are interacting to determine these general equilibrium results. Generally, the large gains in GDP results from the enhanced efficiency of resource allocation through increased specialization according to comparative advantage. But the other two reasons also contribute to the GDP growth: (1) Removal of high protection rates induces real depreciation, enhancing international competitiveness of China's industries; (2) Elimination of the MFA further increases competitiveness of China's textile and apparel, leading to export expansion of these sectors[, while these sectors]which have comparative advantage in China.

A notable outcome is the significant expansion of foreign trade after China joins WTO. As we previously stressed, processing trade accounts for more than half of China's total trade. There are high import contents in its exports. Growth of exports will result in a corresponding growth of imports, increase the pressure of real depreciation, and contribute to further growth of exports. This factor partly contributed to the rapid increase of China's trade dependence in last 20 years, and explains the significant trade expansion effect of China's WTO accession.

Although China will benefit from its WTO accession, the overall gains are distributed unevenly. The results in Table (5) show the income of urban households and rural households increase by 2.6 and 1.6 percent respectively in 2010. The slow growth of import quota for food and agricultural products results in high domestic cost of agricultural production, thus keep their domestic pricesbecoming higher and higher than their world market prices year by year. The introduction of TRQ for agricultural goods after China joins WTO would sharply decrease the domestic price of agricultural products, and decrease the return of production factors in agriculture in turn. Obviously, rural households will loss during this process. The later is the liberalization in agriculture, the higher is the cost of protection, therefore the larger the welfare loss for rural households and the higher the political and budgetary cost for Chinese government.

There are great concerns about the harm of agricultural trade liberalization to China's food security. Our simulation results suggest that even the crops imports would increase significantly, near 200 percent relative to base case, China's grain self sufficiency rate will still be high at 89 percent in 2010. China's grain dependence on world market is still low when China opens its grain market. Moreover, given the fact of rapid increase in laid-off workers of state-owned enterprises and urban poverty, agricultural trade liberalization improve food security in the sense of the ability of urban poor to secure access to adequate food (Sen, 1981).

The decomposition of China's market accession package evaluated here helps understanding the roles of different trade reform measures. Given the scarcity of agricultural land and growing demand for food and agricultural products during China's industrialization and population growth in the next ten years, and the high import protection in its agricultural sector, it is not surprising that agricultural trade liberalization will bring significant welfare gains for China. As simulation results show, the elimination of import quota of food and agricultural products will raise China's real GDP by 166 billion yuan at 2010, which accounts for 41 percent the gains that China would

obtain from its WTO entry. However, agricultural trade liberalization induces adverse domestic terms of trade effect, urban households' income increases by 1.56 percent, while rural households' income increase only by 0.25 percent in the agricultural trade liberalization scenario.

Due to the low collection rates of tariff and relative opening policy adopted by processing trade, the gains from MFA quota elimination and reduction of tariff and non-tariff barriers in industrial goods are relatively small. Real GDP will increase by 97.9 billion yuan in the MFA elimination scenario, and 69.1 billion yuan in tariff reduction scenario, respectively. The welfare gains are smaller compared with real GDP due to adverse terms of trade effects. Their effects on income distribution are relatively neutral. The gains of urban households are slightly smaller than rural households in these two scenarios, because urban laborers are mainly employed in industrial sector, and most labor-intensive manufactures exports such as apparel and shoe (exports) are produced by village and town enterprises.

2) Sectoral Adjustments

While the aggregate results of the WTO accession scenarios show the overall welfare gains resulting from lower price distortions and expanding trade, they reveal only part of the story. Because economy-wide efficiency gains are also not distributed uniformly across sectors, and the adversely affected sectors are likely to strongly oppose trade reform, it is necessary to investigate the adjustment in sectoral output, employment and trade induced by China's WTO accession

Table 6 shows that change in gross output and trade vary significantly across sectors. The output of agricultural and food sectors subjected to import quota restriction would fall from 1.5 percent (corn) to 25.1 percent (vegetable oil). The imports increase of these sectors are dramatic, ranging from 18 percent (wool) to 969 percent (rice). A large portion of wool imports is not ordinary trade and not subjected to quota restriction, so the introduction of TRQ has relative small effect on imports of wool. Because the amount of grain imports is very small in base case, the sharp increase of imports would not affect domestic production significantly. Due to slow growth of quota for wheat and cotton, their quotas would bind and it results in the smaller increases of their imports compared with rice and corn. While the highly protected agricultural sectors are contracted, the production and exports of livestock products (excluding wool), which are more labor intensive and less land intensive than grain productions, would increase. However, their exports are quite marginal in absolute terms because of high domestic demand of those products.

The contraction of agricultural production will divert agricultural labor forces and capital to non-agricultural sectors. Given the large share of agricultural employment in China's today, the most important adjustment will be the relocation of agricultural labor. The simulation results on change of employment suggest that around 6.0 million agricultural laborers will be transferred to manufacturing and service sectors after China entering the WTO. Undoubtedly, it will bring adjustment costs and challenges to both the central and local government to make such relocation possible.

The elimination of MFA quota enhances China's export competitiveness in textile and clothing significantly. Exports of textile and apparels would increase by 180 percent and 206 percent respectively. The production of textile and apparel would increase by 43 percent and 70 percent respectively, thus create about 6.2 million new jobs in these two sectors.

Table 6 Changes of Sectoral Output, Employment and Trade after China's WTO Accession (E5)

	Output		Employment		Imports		Exports	
	Bn Yuan	%	10000 Person	%	Bn Yuan	%	Bn Yuan	%
Rice	-26.1	-8.7	-222.6	-8.4	32.6	969.3	0.0	7.2
Wheat	-9.4	-4.9	-73.2	-5.3	14.5	79.8	0.0	-
Corn	-1.9	-1.5	-22.1	-2.0	6.2	345.7	0.2	10.9
Cotton	12.7	11.5	101.3	10.8	19.3	169.6	0.0	21.0
Other non-grain crops	-34.8	-2.6	-410.9	-3.0	23.5	134.6	0.3	8.7

	Output		Employment		Imports		Exports	
	Bn Yuan	%	10000 Person	%	Bn Yuan	%	Bn Yuan	%
Forestry	-17.7	-11.2	-141.7	-11.3	15.6	32.6	-0.2	-7.5
Wool	-0.9	-13.7	-2.0	-14.1	2.0	18.1	0.0	2.3
Other livestock	70.6	3.5	137.2	3.0	0.0	-0.9	1.0	13.1
Fishing	12.3	1.8	28.6	1.6	0.2	9.0	-0.1	-0.6
Other agriculture	2.7	1.2	6.2	0.5	0.0	16.4	0.0	13.9
Coal mining	-3.3	-0.9	-12.4	-1.0	-0.2	-3.1	0.0	2.1
Crude oil and natural gas	-16.5	-7.1	-13.8	-6.9	3.7	1.8	-0.4	-1.6
Ferrous ore mining	-2.5	-3.8	-2.1	-2.9	-2.5	-4.3	0.0	-15.9
Non-ferrous ore mining	-6.8	-3.8	-4.3	-3.2	-0.9	-3.8	0.0	-4.4
Other mining	1.0	0.2	2.7	0.4	1.1	2.6	-0.2	-1.4
Vegetable Oil	-61.6	-25.1	-13.2	-19.5	66.6	187.9	5.7	29.6
Grain mill and forage	0.7	0.1	0.2	0.1	16.2	21.4	0.9	9.1
Sugar	-9.5	-13.6	-10.2	-13.4	7.2	154.9	-0.6	-8.6
Processed food	24.5	2.0	8.0	1.6	4.5	9.5	10.7	10.3
Beverage	-9.1	-1.5	-2.0	-0.7	16.8	239.2	0.3	2.7
Tobacco	-3.8	-1.2	-0.4	-0.9	9.3	81.1	0.3	5.0
Textile	873.9	43.2	355.5	30.2	340.0	144.8	581.5	179.5
Apparel	673.0	69.9	267.6	44.4	25.5	94.2	651.2	205.9
Leather	-16.9	-3.4	-7.0	-2.5	2.7	4.0	-15.2	-9.0
Sawmills and furniture	1.5	0.3	3.0	0.8	7.0	15.3	-1.5	-2.5
Paper & printing	-31.3	-3.9	-17.0	-3.0	25.6	16.7	-1.2	-7.1
Social articles	-20.7	-3.3	-5.0	-1.8	3.9	7.1	-23.4	-8.6
Petroleum refining	-29.0	-3.2	-9.7	-3.1	38.9	59.6	4.2	3.3
Chemicals	-46.8	-2.6	-16.4	-2.2	65.3	12.8	3.8	2.2
Medicine	2.0	0.4	1.3	0.6	3.4	32.4	1.2	3.8
Chemical fibers	47.9	16.4	12.2	13.5	81.4	112.3	1.8	4.5
Rubber and plastics	-45.1	-3.9	-18.2	-3.0	6.7	6.7	-13.4	-5.3
Build materials	6.8	0.3	3.3	0.2	4.2	9.8	-0.4	-0.6
Primary iron and steel	-67.5	-4.8	-32.3	-4.3	16.5	7.2	-0.8	-0.8
Non-ferrous metals	-20.6	-4.0	-7.3	-3.1	-3.3	-2.1	-0.7	-2.0
Metal products	-30.8	-2.6	-12.2	-2.0	15.7	9.3	-4.0	-2.9
Machinery	-69.0	-5.6	-38.5	-4.4	36.7	13.1	-3.6	-4.3
Special equipment	-22.2	-2.9	-12.6	-2.4	38.2	9.9	-0.9	-2.3
Automobile	-305.4	-34.2	-96.1	-28.9	154.2	679.7	-2.3	-13.5
Oth. Transport equipment	-1.5	-0.2	2.2	0.5	4.6	2.6	-4.5	-4.8
Electric machinery	-76.5	-4.5	-19.6	-3.1	35.8	14.9	-26.8	-7.3
Electronics	-164.3	-9.3	-39.1	-8.8	42.2	5.4	-60.1	-6.8
Instruments	-31.1	-12.7	-24.3	-11.7	15.7	11.8	-14.8	-10.5
Other manufacturing	-16.6	-3.8	-11.0	-2.2	3.8	21.0	-10.5	-16.3
Utilities	-0.5	0.0	-2.0	-0.5	0.0	-2.0	0.5	2.5
Construction	97.6	1.9	101.9	1.5	-0.4	-1.3	0.1	3.6
Transportation	16.5	1.1	25.7	0.8	2.0	5.7	3.5	2.2
Post and communication	8.4	1.2	3.2	1.0	-0.1	-1.7	1.3	1.7
Commerce	107.9	2.9	211.7	2.1	2.2	2.4	0.1	0.5
Finance	8.5	0.8	1.3	0.3	0.2	0.5	0.0	-1.1
Social services	39.3	1.7	20.9	1.3	-2.5	-1.5	5.2	2.6
Education & health	3.7	0.2	1.3	0.0	0.1	0.3	0.0	-0.7
Public administration	3.4	0.3	4.1	0.2	-0.1	-0.4	0.0	0.6

Source: simulation results.

Some food sectors would also increase their output and exports, which benefit from reduction of cost of imported agricultural intermediate inputs. However, those sectors with high protection,

such as automobile, petroleum refining and beverage, would experience a sharp increase in import. The lower import prices induce consumers to substitute imports for domestic products, resulting in dramatic decline in outputs.

The removal of tariff and non-tariff barriers is only one factor that contributes to the significant surge in imports after China joining the WTO, the export growth due to further realization of China's comparative advantage in labor-intensive products also contributes to the increase of imports. The expansion of labor-intensive production driven up the demand for capital and technology intensive equipment on one hand, and increase the demand for semi-processed products and intermediate inputs on the other hand. As we pointed out earlier, there is a large proportion of processing exports in China's total exports. This structural feature of China's foreign trade makes export growth particularly important in China's import growth. Its effects are shown clearly from the sharp increase of import of textile, apparel, chemical fibers sectors, since processing imports account for more than 90 percent of total imports in these industries.

All capital-intensive sectors, even those are not highly protected, such as machinery, electronics and instruments, would experience relatively large contract of production because of higher capital cost. The rapid expansion of labor-intensive sectors, especially textile and apparel, bid capital away from other manufacturing industries, and the large amount of labor released from previously highly protected agricultural sectors jointly push up the rental price of capital relative to labor.

3) Regional Effects

Due to different factor endowments, industrial structure and comparative advantage across provinces in China, the impacts of WTO accession on Chinese provincial economies would be different. The benefits of the trade liberalization would also be spread unevenly across regions. In general, the greater are the shares of a provincial output of industries which are relatively favored by China's WTO accession, the greater will be the benefits for the province. Conversely, the greater are the shares of a provincial output of industries which are relatively disadvantaged by China's WTO accession, the smaller will be the benefits for the province. Moreover, the more dependence of provinces on foreign trade are, the more the provinces would gain from China's WTO accession, especially for the provinces whose foreign trade mostly operated under ordinary trade regime.

The uneven distribution of benefits from China's WTO accession is confirmed in Table 7. The simulation results show that the real GDP of Guangdong will increase by 8.9 percent in 2010 relative to base case, while the real GDP in rest of China will only increase by 1.24 percent. The increase of GDP in Guangdong is around 187 billion yuan, accounts for 47 percent of national GDP gain.

If China joins WTO, the growth of investment in Guangdong is higher than that of private consumption, while in rest of China, the increase of investment due to China's WTO accession is almost zero. The different pattern of investment growth between Guangdong and rest of China are results from changes in domestic capital flows, which is driven by relative rental rate of capital among regions. The more rapid economic growth and expansion of export sectors in Guangdong after China joins WTO will raise the local return of production factors, drives more inflow of capital. On the contrary, the rest of China would experience more capital net outflow. As a result of increased capital outflow, the trade surplus of rest of China in 2010 will decline by 159 percent but its investment ratio to GDP will decline.

Expansion of foreign trade is significant for both economies. The increase of exports and imports in Guangdong are smaller than the rest of China. Two factors account for it. Firstly, the share of agricultural imports in total import in Guangdong is much smaller than national average. Agricultural trade liberalization under WTO accession framework will not result in dramatic increase of agricultural imports for Guangdong. Secondly, the export dependency of Guangdong is higher than rest of China. Even small expansion of export could induce a large increase of factor prices in Guangdong. Due to the imperfect factor mobility across regions, the relatively rapid

growth of factor costs would weaken the competitiveness of Guangdong's products, result in relatively small expansion of its exports.

The changes in interregional trade and trade surplus are driven by interregional capital flows. The increased capital inflow to Guangdong will reduce the export of Guangdong to rest of China, and increase its import from rest of China. The trade surplus of Guangdong will decline by 24 percent. Because of the high share of processing exports in total exports, the dependency of exports on intermediate inputs from interregional imports is small. As suggested by the simulation results, it is likely that expansion of foreign trade after China's WTO accession would not induce the large increase of interregional trade.

More rapid economic growth increases the demands of labor force. The rising wage in Guangdong will divert labor force from rest of China to Guangdong. Labor force and population of Guangdong will increase by 3.3 percent in 2010, due to migration from rest of China. The labor force in rest of China will decline by 0.23 percent.

Table 7 Major Macroeconomic Effects on Guangdong and Rest of China, 2010
(percentage change relative to base case)

	Whole WTO accession package (E5)	Tariff and NTBs reduction on industrial products (E2)	Agricultural trade liberalization (E3)	MFA elimination (E4)
Guangdong				
EV (% of GDP)	9.14	3.17	0.79	2.26
GDP	8.86	2.77	0.60	2.85
Consumption	8.23	3.47	1.04	1.94
Investment	14.06	4.21	0.66	3.44
Exports	19.01	7.45	2.12	4.86
Imports	16.64	7.75	1.79	3.14
Interregional Exports	-9.47	-4.19	-0.15	-2.87
Interregional Imports	3.33	-0.63	1.43	1.15
Trade Surplus	-23.83	-5.72	1.26	-3.83
GDP Deflator	-0.58	-2.04	-0.72	1.35
Per Capita Households Income				
Urban	2.76	1.12	1.37	0.13
Rural	4.45	2.22	0.40	0.69
Labor force	3.34	1.31	0.13	1.11
Rest of China				
EV (% of GDP)	1.00	-0.02	0.89	0.18
GDP	1.24	0.06	0.89	0.22
Consumption	1.41	0.20	0.87	0.27
Investment	0.67	-0.34	1.10	0.13
Exports	30.07	9.85	3.46	9.88
Imports	27.58	8.74	3.30	9.31
Interregional Exports	3.33	-0.63	1.43	1.15
Interregional Imports	-9.47	-4.19	-0.15	-2.87
Trade Surplus	-159.55	-38.35	8.43	-25.69
GDP Deflator	-1.18	-2.72	-1.21	1.77
Per Capita Households Income				
Urban	2.23	0.29	1.56	0.31
Rural	1.27	0.35	0.23	0.44
Labor force	-0.23	-0.09	-0.01	-0.07

Source: simulation results.

The different components of WTO accession package result in quite different regional impacts. Guangdong will get loss in agricultural trade liberalization solely scenario, because unlike rest of China, agricultural imports play an unimportant role in Guangdong. Guangdong would not benefit much from cheaper imports of agricultural goods and the shifts of agricultural labor forces to industry and service sector. Furthermore, due to more rapid growth in rest of China, more labor and capital will be diverted to it.

The aggregate effects on efficiency and welfare of rest of China in MFA quota elimination and trade liberalization on industrial product scenarios (E2 and E4) are limited. Although the increase of foreign trade in Guangdong is smaller than that in rest of China in these two cases, the Guangdong accounts for almost all benefits because Guangdong's share of foreign trade in China's total foreign trade is large, especially for the foreign trade in manufacturing sectors.

Table 8 provides the simulations results on sectoral production and employment for Guangdong and rest of China. The sectoral impacts on the two regions within China are quite similar to those on whole country. Because Guangdong's foreign trade ratio to GDP is higher than rest of China, the impacts on production of Guangdong are larger than rest of China for most sectors.

Table 8 Changes of Sectoral Output and Employment for Guangdong and Rest of China, (E5)

	Output				Employment			
	Guangdong		Rest of China		Guangdong		Rest of China	
	Bn Yuan	%	Bn Yuan	%	10000 Person	%	10000 Person	%
Rice	-7.5	-24.9	-18.6	-6.9	-38.7	-26.1	-183.9	-7.3
Wheat	0.0	-21.3	-9.3	-4.8	-0.1	-22.8	-73.1	-5.3
Corn	0.0	-	-1.9	-1.5	0.0	-	-22.1	-2.0
Cotton	0.0	-	12.7	11.5	0.0	-	101.3	10.8
Other non-grain crops	-4.3	-4.3	-30.5	-2.4	-30.8	-6.0	-380.1	-2.9
Forestry	-1.2	-10.5	-16.4	-11.3	-3.4	-10.9	-138.3	-11.3
Wool	0.0	-	-0.9	-13.7	0.0	-	-2.0	-14.1
Other livestock	9.5	8.7	61.1	3.2	10.1	7.0	127.1	2.9
Fishing	2.3	2.4	10.0	1.7	4.1	1.8	24.6	1.6
Other agriculture	0.6	2.7	2.2	1.1	1.3	1.4	4.9	0.4
Coal mining	-0.3	-22.3	-3.0	-0.8	-3.1	-22.4	-9.3	-0.8
Crude oil and natural gas	-2.4	-7.6	-14.1	-7.0	-0.2	-7.6	-13.6	-6.9
Ferrous ore mining	-0.4	-16.2	-2.2	-3.4	-0.3	-14.8	-1.9	-2.6
Non-ferrous ore mining	-1.2	-14.8	-5.6	-3.3	-1.1	-15.0	-3.1	-2.5
Other mining	0.1	0.4	0.9	0.2	0.0	-0.3	2.7	0.4
Vegetable Oil	-3.3	-16.3	-58.3	-25.9	-0.8	-24.0	-12.5	-19.3
Grain mill and forage	0.6	1.4	0.1	0.0	0.0	-0.6	0.3	0.2
Sugar	-2.0	-13.7	-7.4	-13.6	-1.2	-14.2	-9.0	-13.3
Processed food	-1.9	-2.2	26.4	2.3	-1.3	-3.7	9.3	2.1
Beverage	-8.2	-12.9	-1.0	-0.2	-2.1	-12.7	0.2	0.1
Tobacco	-1.7	-17.1	-2.1	-0.7	-0.3	-15.2	-0.1	-0.3
Textile	258.6	120.8	615.3	34.0	56.2	91.7	299.3	26.8
Apparel	192.4	102.8	480.6	61.9	100.6	82.2	166.9	34.8
Leather	-15.3	-11.7	-1.6	-0.4	-8.3	-11.3	1.3	0.6
Sawmills and furniture	-2.9	-4.0	4.4	0.9	-1.0	-4.4	3.9	1.1
Paper & printing	-10.1	-8.2	-21.2	-3.1	-4.2	-8.8	-12.8	-2.5
Social articles	-16.7	-7.0	-4.0	-1.0	-4.7	-6.2	-0.2	-0.1
Petroleum refining	-2.3	-2.7	-26.8	-3.3	-1.0	-3.1	-8.7	-3.1
Chemicals	0.1	0.2	-46.9	-2.7	-0.8	-2.2	-15.7	-2.2
Medicine	-1.2	-3.9	3.3	0.7	-0.5	-4.6	1.8	0.9
Chemical fibers	8.0	19.6	39.9	15.9	1.3	14.6	10.9	13.4
Rubber and plastics	-17.1	-5.8	-28.1	-3.3	-5.1	-6.6	-13.1	-2.5
Build materials	9.1	4.4	-2.3	-0.1	2.1	2.0	1.2	0.1

	Output				Employment			
	Guangdong		Rest of China		Guangdong		Rest of China	
	Bn Yuan	%	Bn Yuan	%	10000 Person	%	10000 Person	%
Primary iron and steel	-1.2	-4.9	-66.3	-4.8	-0.9	-5.7	-31.4	-4.3
Non-ferrous metals	-2.5	-9.9	-18.0	-3.7	-0.8	-9.7	-6.4	-2.9
Metal products	-7.8	-4.1	-23.0	-2.3	-2.4	-4.6	-9.8	-1.8
Machinery	-4.2	-11.4	-64.8	-5.4	-2.6	-10.6	-35.9	-4.2
Special equipment	-1.3	-8.2	-20.9	-2.8	-1.8	-8.0	-10.9	-2.2
Automobile	-14.6	-57.4	-290.8	-33.5	-3.2	-53.8	-92.9	-28.5
Oth. Transport equipment	-3.2	-4.3	1.6	0.3	-1.4	-4.7	3.6	0.9
Electric machinery	-49.1	-9.3	-27.4	-2.4	-11.8	-9.6	-7.8	-1.6
Electronics	-53.0	-8.3	-111.2	-9.9	-12.9	-8.2	-26.2	-9.2
Instruments	-9.0	-12.3	-22.0	-12.9	-2.7	-11.5	-21.6	-11.7
Other manufacturing	-9.1	-8.0	-7.5	-2.3	-5.1	-8.2	-5.9	-1.3
Utilities	8.7	4.4	-9.2	-0.9	0.1	0.4	-2.1	-0.5
Construction	67.9	13.3	29.7	0.7	60.0	10.8	41.9	0.7
Transportation	8.9	3.8	7.6	0.6	3.4	1.9	22.3	0.7
Post and communication	8.0	6.4	0.4	0.1	1.2	3.7	2.0	0.7
Commerce	56.5	9.6	51.4	1.6	55.8	7.3	155.9	1.7
Finance	10.4	6.1	-1.9	-0.2	1.7	3.6	-0.4	-0.1
Social services	23.2	5.8	16.1	0.8	4.7	3.4	16.2	1.1
Education & health	5.3	3.0	-1.6	-0.1	5.2	1.8	-3.9	-0.1
Public administration	3.2	2.7	0.2	0.0	1.8	1.3	2.3	0.1

Source: simulation results.

4) Environmental Effects

The significant changes in the composition of domestic production will influence the level and composition of emssion effluent. Table 9 reports the main results on emission level of 14 pollutants. Tariff reduction in industrial sectors(E2) and agricultural trade liberalization(E3) result in an increase in the emssion level of almost all pollutants, while MFA elimination(E4) results in a decrease of the emission level. The net effect of total WTO accession package(E5) on pollution is nearly neutral: emission for 6 pollutants (three toxic pollutants, NO_2, VOC, BOD) increase, while those decrease for other pollutants. The changes of emission level relative to base case are small, usually less than 1%, except BIOAIR, BIOSOL and NO_2.

Tariff reduction and elimination of NTBs for industrial goods under China's WTO accession framework lower the domestic prices of energy good. The simulation results shows that the consumer prices of coal, crude oil and petroleum will decline 2.4%, 2.5% and 3.6% respectively in 2010 if China reduce its tariff and NTBs on industrial products (corresponding to experiment 2). These price changes result in more uses of energy goods in China. The third column of table 9 shows that the emssion level will rise for most pollutants under the scenario for tariff and NTBs reduction for industrial products, and the percentage change in emssion levels exceeds the percentage change in real output, indicating higher emission intensities. But the emission of SO_2, CO_2, TSP and TSS will decline slightly, because the petroleum will be relatively cheap and it would substitute for the coal at some extent.

Agricultural trade liberalization also leads to high pollution level because it leads to increases in the real output and in the relative output share of industries. The emission levels of all pollutants increase by 1-2 percent in 2010 relative to base case under the agricultural trade liberalization scenario. While under the MFA elimination scenario, the emission levels of all pollutants decrease. The MFA elimination leads to an increase in the output shares of textile, clothing and chemical fibers sectors, while the output shares of dirty industries will decrease. So the overall industrial structure would be cleaner under this scenario.

Table 9 Emission level under China's WTO Accession Scenarios, 2010

(percentage change relative to base case)

	Whole WTO accession package (E5)	Tariff and NTBs reduction on industrial products (E2)	Agricultural trade liberalization (E3)	MFA elimination (E4)
TOXAIR	0.76	0.60	1.22	-0.67
TOXWAT	0.50	0.62	1.19	-0.94
TOXSOL	0.43	0.61	1.22	-0.97
BIOAIR	-1.89	1.41	1.54	-2.96
BIOWAT	-0.98	0.00	1.29	-1.35
BIOSOL	-3.96	0.74	1.94	-3.99
SO_2	-0.25	-0.40	1.36	-0.85
NO_2	2.57	0.49	1.17	-0.03
CO	-0.13	0.06	1.21	-0.85
CO_2	-0.31	-0.03	1.22	-0.88
VOC	0.43	0.71	0.99	-1.05
TSP	-0.49	-0.19	1.35	-1.04
BOD	0.47	0.61	1.22	-0.94
TSS	-0.96	-0.61	1.39	-1.02
Guangdong				
TOXAIR	6.56	4.47	0.99	-0.33
TOXWAT	5.76	4.63	1.01	-1.13
TOXSOL	6.00	4.56	1.00	-0.97
BIOAIR	-3.64	2.29	1.09	-4.56
BIOWAT	2.13	1.49	0.89	-0.53
BIOSOL	-6.63	0.74	0.81	-5.09
SO_2	4.58	2.26	0.97	-0.17
NO_2	12.33	3.15	0.73	2.13
CO	6.32	3.92	0.77	0.40
CO_2	5.36	3.64	0.80	0.01
VOC	2.86	4.80	0.78	-2.13
TSP	2.42	2.26	1.03	-1.19
BOD	6.08	4.57	1.00	-0.95
TSS	1.63	1.42	1.18	-0.83
Rest of China				
TOXAIR	-0.13	0.00	1.25	-0.72
TOXWAT	-0.31	0.00	1.22	-0.92
TOXSOL	-0.43	0.01	1.26	-0.97
BIOAIR	-1.72	1.32	1.58	-2.80
BIOWAT	-1.31	-0.15	1.33	-1.44
BIOSOL	-3.77	0.74	2.02	-3.91
SO_2	-0.72	-0.66	1.39	-0.91
NO_2	1.65	0.24	1.21	-0.23
CO	-0.87	-0.38	1.26	-0.99
CO_2	-0.94	-0.43	1.27	-0.98
VOC	0.05	0.07	1.03	-0.89
TSP	-0.77	-0.43	1.38	-1.03
BOD	-0.40	-0.01	1.25	-0.94
TSS	-1.19	-0.79	1.41	-1.03

Source: simulation results.

Let's analyze the change of different pollutions in detail:

I: Water pollution

There are three indexes of water pollution: TOXWAT(toxic pollutants in water), BIOWAT(Bio-accumulative toxic metals in water) and BOD(biological oxygen demand).

From the Table 9, in the whole WTO accession package E5), compare the base scenario, TOXWAT increase slightly (0.5%), BIOWAT decrease a little (0.98%), while BOD increase 0.47%.

The water pollutions of China are mainly from industrial waste water, urban living waste water and agriculture waste water. Many industries of heavy waster emission shrink after China's

accessing WTO, such as Coal mining output decrease 0.9%, Non-ferrous ore mining and ferrous ore mining output decrease 3.8% respectively, Chemicals output decrease 2.6%. It results in decrease of industrial waste water. In fact, the industrial waste water is decreasing in recent years. The WTO's accession will accelerate the decrease speed.

The impacts on agriculture sector of WTO's accession are much greater comparing to those of the heavy pollution industries. With the dramatic output decrease of rice, wheat, forestry and wool, the agricultural waste water will decrease greatly.

But the decrease of industrial and agricultural waste water doesn't hold the TOXWAT and BOD increase slightly. It indicates the living waste water increase greatly. In China, the treatment of living waster water will be most important in future.

In short, the water pollution doesn't change distinctly after China's accession to WTO. The industrial and agricultural waster water will decrease compare the base scenario, but the living waste water which increase rapidly will be the focus of treatment of water pollution. The whole pressure of water pollution will not be light after China's WTO accession.

II：Air pollution

Air pollution indexes change as follows: TOXAIR(toxic pollutants in air) increase 0.76%, BIOAIR(bio-accumulative toxic metals in air) decrease 1.89%. SO2 decrease 0.25%, NO2 increase 2.57%, CO decrease 0.13%, CO2 decrease 0.31%, VOC increase 0.43%, TSP decrease 0.49%, TSS decrease 0.96%.

The air pollution in China is closely related with energy consumption. Comparing to base scenario, the energy consumption decrease after China's WTO accession, such as coal consumption decrease 3.5 billion yuan and the oil consumption decrease 12.4 billion yuan. The decrease of energy consumption results in decrease of air pollution. It explains why the most air pollution indexes decrease.

The decrease of energy consumption is due to the structural effect, technology effect and product effect of WTO's accession (OECD, 1994). Because of the structural effect, the resource will flow from the energy intensive sector to labor intensive sector. The output of energy intensive industrial sectors (iron, steel and chemicals) decreases greatly. It results in the decrease of energy consumption. And the sector (textile, apparel) whose output increase rapidly are labor intensive sectors. The technology effect and the product effect will improve the efficiency of energy use.

NO2 increase 2.5% compare to the base scenario. NO2 pollutions are mainly from industrial process and transport emission. Increase of NO2 emissions attribute to the expansion of transport. China's WTO accession will increase the transport of goods and passengers, the rapid growth of transport will cause the increase of NO2 emission.

Above all, China's WTO accession will drive the resource from the energy intensive sector to labor intensive sector because China has comparative advantage on labor. Compare to the base scenario, the energy consumption decrease and it ease the pressure of air pollution. But the degree is very small, the indexes of air pollution decrease less than 1%. The situation of air pollution is still severe in future.

Although the overall effects of WTO accession on pollution emssion in China are small, its regional impacts are significant because of the uneven distribution of growth effects. Accompanying higher economic growth and large trade expansion in Guangdong after China joins WTO, its environmental quality will deteriorate much more than the rest of China. Emssion level of most pollutants in Guangdong will increase, except two bio-toxic pollutants. But the increase of emission level mainly comes from the increase of real output. The only exception is NO_2, whose emission level rises by a larger percentage (12.3 percent) than the increase in real GDP of Guangdong, because of the sharp expansion of real output shares for textile sector. For the rest of

China, the environmental effect of WTO accession is positive. The emssion level of most pollutants in rest of China will decrease relative to base case, after China joins WTO. As a whole, the WTO accession will bring China a cleaner production structures, even the emission level of some pollutants will increase slightly.

6. Conclusion and Policy Implications

This paper analyzes the impacts of China's WTO accession using a two-region Chinese CGE model. The results of simulation show that China would gain significantly in economic efficiency when China becomes a member of WTO. If China enters the WTO and fully implements its commitment on market access at 2010, its real GDP and welfare measured in Hicks equivalent variations (EV) would be increased by 400.9 billion yuan and 365.6 billion yuan (1997 price, or 2.1% and 1.9% of real GDP of 2010) respectively. The large gains in real GDP mainly results from the enhanced efficiency of resource allocation through increased specialization in accordance with China's comparative advantage, and elimination of the MFA strengthens competitiveness of China's textile and apparel, leading to export expansion of these products, also contributes to the real GDP growth. If the gains to TFP improvement and economic growth from trade liberalization are taken into account, China's efficiency gain will be even larger.

But the gains are not evenly distributed among either sectors or provinces. Accession to the WTO also implies a relatively dramatic economic structural adjustment. Output of highly protected agricultural and some of the capital intensive industrial sectors such as automobile, instruments, cotton, wheat, etc., would contract significantly, while the labor intensive sectors such as textile and clothing would be the main beneficiaries. In regional level, the coastal area will gain more from trade expansion and the increased export of labor intensive goods, but the provinces in inland area, especially the provinces which specialize on agricultural production, could experience loss.

Structural adjustment involves adjustment cost. Structural unemployment may rise following China's accession to the WTO. Millions of farmers would have to transfer to non-agricultural sector. Although expansion of the textile and service industries should open up a large number of positions for rural migrants, the transition could be painful in the short term. Undoubtedly, the role of government would be crucial in the process of structural adjustment.

The significant changes in the composition of domestic production will influence the level and composition of emssion effluent. But the effect of WTO accession on pollution is quite neutral. Our simulation results show that emission for 6 pollutants (three toxic pollutants, NO_2, VOC, BOD) increase, while [those decrease for other the other pollutants' emissions decrease. Because of the dominate effect of MFA elimination on sectoral adjustment, the overall industrial structure after China's WTO accession will be cleaner, rather than more pollution intensive.

These results have an important implication for China's WTO accession. Firstly, accession to the WTO is one challenge to China, but it also means a great opportunity. Shortage of arable land and capital and existence of large amount of unskilled labor force are the basic national condition of China. This situation can not be changed fundamentally within the near future. This basic national condition will be the major decisive factor in the identification and choice of China's development strategy. Joining WTO will integrate China into the world economy more deeply. China will be benefited from its participation of the international division. Therefore, China's WTO membership is consistent with its medium and long term development strategy.

Secondly, [the overall income distribution would deteriorate after China entering WTO in terms of either rural-urban or coastal-inland gap] the overall income distribution would widen the gap of either rural-urban or coastal-inland after China entering WTO. But the rise of rural-urban income disparity is due largely to the food self-sufficiency policy that would continue in the future, rather than to trade liberalization. Protection in agriculture can improve the farmer's income temporally, but not sustainable. The cost of agricultural protection will grow during China's industrialization. The later is the reform, the larger distortion and the more serious is the problem

on income distribution. The appropriate strategy for China's WTO accession is to open its agricultural and food market to exchange the developed countries to lift their limits on labor-intensive products from China, phase in cutting the protection of manufacturing sectors over a period of time, and create necessary economic and social conditions for the shift of agricultural labor force. It will benefit both the efficiency and equality in China.

The enlarged regional disparity between coastal and inland area induced by China's WTO accession is mainly due to low degree of domestic regional integration and the structural features of China's foreign trade. Because of high proportion of processing trade, the linkage between foreign trade and domestic economy is weak in China. Export sector in coastal area depends on labor migration from inland area more than intermediate inputs from inland area. Therefore, the export expansion in coastal area would not increase the demand of interregional import, but divert labor force from inland area to coastal area. Although imposing limitations on labor mobility within region would reduce the regional disparity probably induced by China's WTO accession, it would be harmful to economic efficiency. Instead of putting more distortion on factor market, the central government should improve the domestic regional integration in commodity market through infrastructure creation in transportation, communication, etc., and reduce the institutional separation between export sector and domestic economy. It will make the efficiency gains from trade liberalization to spread evenly across regions in China without hurting economy efficiency.

Thirdly, it is urgent for China to create a social security system that will facilitate a smooth transition of labor force. The State Council issued a series of directives in the 1990s that aim to establish a national-wide three-pillar social security system. However, the current social security system is far from ready for the structural change in employment that would be brought about by WTO accession. (World Bank, 1997b)

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Annex: The Two-region Recursive Dynamic Chinese CGE Model

(1) Model Dimension

Each region in the model have 53 industries, 5 production factors and 2 representative households by urban and rural. Among the factors, labor and capital are used by all sectors, while land is used only by agricultural activities. Labor is disaggregated into three types: agricultural labor, production workers, and professionals. Within 53 sectors, there is 10 agricultural sectors, 5 mining sectors, 29 manufacturing sectors, 1 utility sector and 8 services sectors. The detailed disaggregation of agricultural and food sector make it possible to explicitly model the quantitative restriction on agricultural commodities and food.

(2) Production and Factor Markets

The model assumes that there are two types of competitive firm - *ordinary firms* and *export processing firms* - that produces same product in same industry. The products of ordinary firms are assumed to be sold on the domestic market or to be exported to rest of the world by a constant elasticity of transformation (CET) function. While for the later-export processing firms, their products export only.

All sectors are assumed to operate under constant returns to scale and cost optimization. Production technology is represented by a nesting of constant elasticity of substitution (CES) functions. At the first level, output results from two composite goods: a composite of primary factors plus energy inputs, i.e., value-added plus the energy bundle, and aggregate non-energy intermediate input. At the second level, the split of non-energy intermediate aggregate into intermediate demand is assumed to follow the Leontief specification, i.e. there is no substitution among non-energy intermediate input. Value-added plus energy component is decomposed into aggregate labor and energy-capital bundle. Aggregate labor is further split into 3 types of labor force. And energy-capital bundles are decomposed into energy and capital-land bundles. Finally, the energy bundle is made up of 3 types of base fuel components, and capital-land is split into capital and land in agricultural sector.

The model distinguishes between *old* and *new* capital goods. This assumption of vintage capital allows the substitute elasticity in production function to differ according to the vintage of capital. The model also includes adjustment rigidities in capital market. It is assumed that new capital goods are homogeneous and old capital good supplied second-hand markets. The installed old capital in a sector can disinvest when this sector is in decline. The supply curve of old capital is a simple constant elasticity function of the relative rental rates. The higher the rental rate on old capital, the larger the supply of old capital. But the rental rate on old capital is not allowed to exceed the rental rate on new capital. Within sector, the capital is fully mobile among ordinary firms and export processing firm.

Each type of labor forces is assumed by be full mobile across sectors and across the two types of firms. The agricultural laborers work only in agricultural sectors and production workers work only in non-farm sectors. There is no substitution between agricultural laborer and production worker in production function. In China, although reform deepening, there are still large barriers for rural labor forces to migrate to urban. These barriers include household registration regime, discrimination in employment, education and social security, etc. This segmented labor market is modeled by incorporating partially mobility between agricultural laborer and production worker. We assumed agricultural laborer and production worker could be converted from one to another. A CET function is used here to capture this specification, i.e., this transfer is determined by the relative wage of agricultural labor and production worker, as well as the constant elasticity of transformation.

The model assumes imperfect interregional factor mobility. CET functions are utilized to describe the regional movement of labor and capital. The movement of capital is determined by the relative rental rates and the constant elasticity of transformation, and the movement of labor is determined by the relative real income and the constant elasticity of transformation. The real income of labor is defined as the wage plus per capita net intergovernmental transfer income, deflated by the regional consumer price indices.

(3) Interregional and Foreign Trade

The rest of the world supplies imports and demands exports. Given China's small trade share in the world, import prices are exogenous in foreign currency (an infinite price-elasticity). Exports are demanded according to constant-elasticity demand curves, the price-elasticities of which are high but less than infinite.

The ordinary firms allocate their output between export and domestic sales to maximize profits, subject to imperfect transformation between the two alternatives. All the output of export processing firms is sold to overseas market. We assume the export by ordinary firms and export processing firms are heterogeneous, a CES aggregation function with relative high substitute elasticities is employed to form the composite export. In other words, we assume the buyers of rest of the world choose a mix between the two types of export to minimize their cost.

The domestic sales of ordinary firms are further split into local sales and interregional exports using a nesting of CET functions. At the top level, regional supplier optimally allocate aggregate domestic sales across local market and the rest of China. At the second nest, aggregate interregional export is optimally allocated across each trading region within China as a function of relative prices.

Three types of import are differentiated in the model. The first one is ordinary trade import, which is operated under the ordinary trade regime, subjected to import tariff and nontariff barriers. The second one is duty-free import of raw materials and components into processing trade export. Most of these imports are used as intermediate input of export processing firms. But part of them is transferred to domestic market. The third one is duty-free import of investment goods for foreign invested enterprises and export processing enterprises.

Products are assumed to be differentiated by region of origin, i.e. the Armington assumption (Armington, 1969). A three-level nesting CES aggregation function is specified for each

Armington composite commodity. At the top level, agents choose an optimal combination of the aggregate domestic good and an import aggregate, which is determined by a set of relative prices and the degree of substitutability. At the second level of the nest, the import aggregate is further split into ordinary import, duty-free import of investment and the import of processing trade which is transferred into domestic market, again as a function of the relative import prices and the degree of substitution across different import types. Note that the import prices are specific by import type because of the duty-free for the last two types of import. At the same level of the nest, aggregate domestic good are split into local good and interregional import from rest of China. At the third level, the demand for the aggregate interregional import is optimally allocated across the trading regions within China.

We establish the difference between domestic price and world price in two part, i.e. the tariff rate and non-tariff barriers. NTB is modeled as the tariff equivalent, which create a pure rent to households. The quantitative restriction on agricultural products is modeled explicitly through a Leontief specification, where imports cannot exceed the quota allocation. The rates of agricultural quota rent are solved endogenously.

In the textile and apparel sectors, China faces the MFA quota in the markets of USA, Canada, EU and other countries. In our model, we treat this VER quota as an export tax equivalent that is added to the domestic export price. The quota premium are assumed to be obtained by households.

In the simulations, the MFA quotas are exogenous, with export tax rates adjusted endogenously.

(4) Income Distribution and Demands

Factor income is distributed to four major institutions: enterprises, households, the government and extra-budget public sector.

Household income derives from capital, labor and land income. Additionally, households receive distributed enterprise profits, transfers from the government and rest of the world. All kinds of import and export quota rent are also allocated to households. Assume the rural households earn all the land returns. Rural households earn their labor income from both agricultural labors and production workers, while urban households obtain their wages from both production and professional workers. When transformation between agricultural labor and production worker occurs, if some agricultural labors transferred to non-agricultural sector and became production workers, their wage would be allocated to rural households. Vice versa, if production workers transferred to agricultural sector and became agricultural labor, their wages are still distributed to urban and rural households according to the distribution share of production worker's wages.

Capital revenues are distributed among households and enterprises. Enterprise earnings equal a share of gross capital revenue minus corporate income taxes. A part of enterprise earnings is allocated to households as distributed profits based on fixed shares, which are the assumed shares of capital ownership by households. Another part of net company income is allocated to extra-budget public sectors as fee. Retained earnings, i.e. corporate savings for new investment and capital depreciation replacement, equals a residual of after-tax enterprise income minus the distributed profits and fee.

Household disposable income is allocated to goods, services, and savings. Households maximize utility using the extended linear expenditure system (ELES) which is an extension of the Stone-Geary demand system. Saving enters the utility function, which is evaluated using the consumer price index. Social consumption and investment final demand follow a fixed share expenditure function.

Stock change is assumed as a demand for domestic products. The intermediate inputs for ordinary firms are provided by the Armington composite goods. While the intermediate inputs for export processing firms are composed by composite goods and duty-free import of raw materials and components into processing trade export through a CES function. The intermediate inputs for ordinary firms, the domestic part of intermediate input for export processing firms, household

consumption, and other final demands constitute the total demand for the same Armington composite of domestic products and imported goods from the rest of the world.

(5) Central and Regional Governments, and Extra-budget Public Sector

An important difference in the model relative to other applied general equilibrium models is the separate treatment of central government and regional governments. The governments collect taxes from the producers, households and foreign sector, transfer money to the household sector, and purchases public goods. There are also transfers between central and regional governments. Central government derives revenues from direct corporate income taxes, import tariffs, and various types of indirect taxes. Regional government derives revenues from direct corporate income and households taxes, as well as various indirect taxes. Subsidies and export tax rebates enter as negative receipts. There are two types of indirect taxes in the model. The value-added tax, which is the most important part of indirect tax in China after 1994 tax reform, is treated as a tax levied on production factors. Its revenues equal total sector value-added multiplied by a tax rate. Three quarters of value-added tax is allocated to central government and the rest is allocated to regional government. The value-added tax is also levied on imports while firms obtain rebates when they export. The other indirect tax, including various agricultural taxes, and business taxes on construction and services, is treated as a production tax levied on sectoral outputs.

Extra-budget public sectors collect fees from enterprise and households. Their incomes are allocated to consumption and saving. The consumption of extra-budget public sectors and government spending compose a type of final demand, i.e. the social consumption.

(6) Macro Closure

Macro closure determines the manner in which the following three accounts are brought into balance: (i) the government budget; (ii) aggregate savings and investment; and (iii) the balance of payments. Real government spending is exogenous in the model. All tax rates and transfers are fixed, while real government savings is endogenous. The total value of investment expenditure must equals total resources allocated to the investment sector: retained corporate earnings, total household savings, government savings, extra-budget saving and foreign capital flows. In this model, the aggregate investment is the endogenous sum of the separate saving components. This specification corresponds to the “neoclassical” macroeconomic closure in CGE literature.

The value of imports, at world prices, must equal the value of exports at border prices, i.e., inclusive of export taxes and subsidies, plus the sum of net transfers and factor payments and net capital inflows. An exchange rate is specified to convert world prices, e.g., in dollars, into domestic prices. Either this exchange rate or total foreign capital inflow can be fixed while the other is allowed to adjust providing alternative closure rules. With foreign saving set exogenously, the equilibrium would be achieved through changing the relative price of tradables to nontradables, or the real exchange rate.

Since the purpose of this paper is to estimate the impact of trade liberalization, we keep the trade balance fixed at foreign currency term. Thus, any changes in real absorption do not result from changes from lending to, or borrowing from, overseas. This makes it easy to compare the efficiency impacts of different simulations.

(7) Recursive Dynamics

The current version of the China's CGE model has a simple recursive dynamic structure as agents are assumed to be myopic and to base their decision on static expectations about prices and quantities. Dynamic in the model originate from accumulation of productive factor and productivity changes. The base year of the data and the model is 1997. The model is solved for subsequent years in 1998, 2000, 2002, 2004, 2006, 2008 and 2010. The time periods are linked together through factor growth (labor/land) and accumulation (capital), and change in productivity.

The growth rates of population, labor forces, labor productivity are exogenous. The growth of capital is endogenously determined by the saving/investment relation. In the aggregate, the basic

capital accumulation function equates the current capital stock to the depreciated stock inherited from the previous period plus gross investment. At the sectoral level, the specific accumulation functions may differ because the demand for (old and new) capital can be less than the depreciated stock of old capital. We assume the producer decides the optimal way to divide production of total output across vintages. If sectoral demand exceeds what can be produced with the sectoral installed old capital, the producer will demand new capital. Otherwise, the producer will disinvest some the installed capital.

In defining the reference simulation, a single economy-wide Hicks neutral efficiency factor (TFP) and sector specific agricultural productivity are determined endogenously to get a pre-specified growth path of real GDP and agricultural output. When alternative scenarios are simulated, the TFP growth rate is exogenous, and the growth rate of real GDP is endogenous.

(8) Data

The model is calibrated to the 1997 two-region Chinese Social Accounting Matrices (SAM) developed from the 1997 national and Guangdong Input-Output tables. The SAM provides a consistent framework to organize the relevant flow of value statistics for China's economy to satisfy the requirements of a benchmark data set for CGE modeling. Some key parameters of the model – essentially substitution and income elasticities – were derived from a literature search. All other parameters – mainly shift and share parameters – are calibrated in the base year using the key parameters and the base data.