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DEVELOPMENT OF A CGE MODEL

Development Research Center
The State Council
People's Republic of China

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Contents

PART I

The Two-Region Recursive Dynamic Chinese CGE Model

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 later section. 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 is an autonomous component of emissions which is 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, and labor productivity are exogenous. The growth of capital is endogenously determined by the saving/investment relation.

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 creates 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 elasticity and income elasticity – 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.

PART II

China's WTO Accession and Implications for National and Provincial Economies *

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 1999 China's trade volume reached \$360.7 billion, ranking 9^{th} in the world, with export volume reaching \$195 billion. China has emerged to become an important player in world trading system. A World Trade Organization (WTO) without China as members will have difficulty in claiming to represent the global economy. Integration of China into WTO's global trading system would significantly expand world trade, and strength the multilateral trade system's integrity and credibility. After 14 years of negotiations, China has reached bilateral agreements on the terms of its entry to the WTO with most of the trade partners participating in accession negotiations. 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 variation in economic performance across provinces has widened, particularly since the late 1980s. After declining in the later 1970s and 1980s, the dispersion of provincial per capita income has increased steadily. Despite a tendency towards convergence among the coastal provinces and also among the inland provinces, there is strong tendency towards divergence between coastal and inland provinces since the late 1980s (World Bank, 1997a).

The divergence trend in provincial development is the result of profound structural change in the Chinese economy. Some empirical literature have addressed the issue on development of regional disparity and its determining factors in China (Jian, Saches and Warner, 1996; Chen and Fleisher, 1996; Naughton, 1999). However, it is not clearly revealed that how the trade expansion has affected regional disparity since economic reform and opening up in existing literatures. Undoubtedly, China's WTO membership will have important implication on provincial development in China. As China is a large and diverse country, the effects on regional growth have significant meaning for the political feasibility of any trade policy reform in China. While the overall welfare gains may arise from the WTO accession, the uneven distribution of the gain may result in strong opposition to trade liberalization. Therefore, to evaluate the regional effects of trade policy reform is important for successfully implementing this reform.

* The views expressed in the paper are those of the authors and should not be attributed to their affiliated institution.

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 the 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 part is organized as follows: Section 2 describes the basic characteristics of the base year data, and highlights the economic structure and market openness in China. Section 3 describes the simulation scenarios and section 4 uses simulation results to assess the impact of China's WTO accession. Section 5 concludes by drawing policy implications.

2. Economic Structure, Market Openness 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.

Table2.1 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 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 sectors in which almost 20 percent of the output 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.

Table 2.1 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

	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
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
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

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 2.1 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 split 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 as 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 accounted for more than 50 percent of China's processing trade in the year of 1997.

Table 2.2 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 use 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 use 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 2.2 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

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

3. 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 2.3.

Table 2.3 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, based on the nominal tariff schedule in China-US agreement - 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	10.428	14.5%
sugar	1.523	8.0%

Experiment	Description
	- Tariff cut for other agricultural goods, based on the nominal tariff schedule in China-US agreement-
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

4. Major Simulation Results

1) Aggregate Effects

Table 2.4 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 1.1 percent compared with base case. The welfare gains represented by Hicksian equivalent variations (EV), are smaller compare to GDP (0.86 percent of 2010 GDP), because of a 1.1 percent deterioration in terms of trade. Private consumption would increase 1.05 percent, indicating the benefits to consumers from the trade liberalization. Investment increases by 0.81 percent. China's trade expansion is significant when it become a member of WTO. Exports and imports would increase by 17.1 percent and 16.8 percent respectively. The real exchange rate will appreciate slightly because of the sharply increase of exports, especially for textile and clothing exports.

Table 2.4 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)	0.86	0.08	0.43	0.16
GDP	1.10	0.15	0.42	0.27
Consumption	1.05	0.19	0.47	0.21
Investment	0.81	-0.05	0.44	0.15
Exports	17.13	4.26	1.99	6.51
Imports	16.75	4.16	1.98	6.36
Government Revenue	0.96	-1.62	-0.10	1.88
Urban Households Income	1.47	0.14	0.96	0.18
Rural Households Income	0.71	0.26	0.03	0.24
Terms of Trade	-1.07	-0.31	-0.12	-0.45
Real Exchange Rate	-0.27	1.63	0.90	-2.01
Grain self-sufficiency Rate	0.905	0.967	0.912	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 other two reasons also contribute 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 have comparative advantage in China.

A notable outcome is the significant expansion of foreign trade after China joins WTO. The increase of exports and imports in 2010 is a compounded accelerating growth effect. If we compare the annual growth rate of exports between accession case and base case, the difference is 1.6 percentage point. 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 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 2.4 show that the income of urban households and rural households increase by 1.5 and 0.7 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 prices become 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 decreasing the return of production factors in agriculture in turn. Obviously, rural households will loss during this process. The later the liberalization in agriculture, the higher 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 on the harm of agricultural trade liberalization on China's food security. Our simulation results suggest that even the agricultural imports would increase significantly, near 200 percent relative to base case, China's grain self sufficiency rate will still be high at 90 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 of 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 gain for China. As simulation results show, the elimination of import quota of food and agricultural products will rise China's real GDP by 86 billion yuan at 2010, which accounts 40 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 0.96 percent, while rural households' income increase only by 0.03 percent in the agricultural trade liberalization scenario.

Due to the low collection rate of tariff and relative opening policy adopted to 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 54.8 billion yuan in the MFA elimination scenario, and 29.6 billion yuan in tariff reduction scenario, respectively. The welfare gains are smaller compared to 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 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 expanded 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 2.5 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 1.2 percent (wool) to 13.2 percent (vegetable oil). The increase of imports for these sectors are dramatic, ranging from 75 percent (wheat) to 590 percent (rice), except for wool, which increase by 5.8 percent only. A large portion of wool imports is not ordinary trade and not subjected to quota restriction, so the introduction of TRQ only has 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 3.1 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 100 percent and 114 percent respectively. The production of textile and apparel would increase by 23.4 percent and 38.6 percent respectively, thus create about 3.4 million new jobs in these two sectors.

Table 2.5 Changes of Sectoral Output, Employment and Trade after China's WTO Accession (E5)

	Output		Employment		Imports		Exports	
	Bn Yuan	%	10^4 Person	%	Bn Yuan	%	Bn Yuan	%
Rice	-13.1	-4.6	-122.7	-4.5	19.4	590.5	0.0	-0.4
Wheat	-8.9	-4.7	-82.2	-4.9	13.2	75.0	0.0	-
Corn	-2.5	-2.1	-33.4	-2.3	6.9	514.4	0.0	0.7
Cotton	-1.7	-1.5	-23.4	-1.8	20.3	178.1	0.0	0.0
Other non-grain crops	-4.2	-0.3	-78.6	-0.6	8.5	27.6	0.1	1.4
Forestry	-5.1	-3.3	-48.9	-3.4	6.1	9.1	-0.1	-5.0
Wool	-0.1	-1.2	-0.2	-1.4	0.5	5.8	0.0	1.5
Other livestock	37.7	1.9	59.5	1.6	0.0	1.6	0.4	3.7
Fishing	6.4	0.9	12.6	0.8	0.1	5.5	-0.2	-1.9
Other agriculture	1.7	0.8	3.9	0.3	0.0	11.7	0.0	3.6
Coal mining	-3.3	-0.9	-12.8	-0.9	0.0	-0.1	-0.1	-2.5
Crude oil and natural gas	-12.3	-4.3	-10.3	-4.1	-4.7	-3.2	-1.3	-4.3
Ferrous ore mining	-2.0	-2.2	-1.7	-1.8	-0.8	-2.0	0.0	-10.5
Non-ferrous ore mining	-3.8	-1.7	-2.4	-1.5	-0.2	-1.2	-0.1	-5.2
Other mining	0.2	0.0	0.5	0.1	0.1	0.3	-0.5	-3.6
Vegetable Oil	-30.3	-13.2	-6.4	-9.8	35.1	130.1	3.7	54.7
Grain mill and forage	9.3	1.4	1.8	1.2	0.1	0.2	0.2	2.5
Sugar	-5.6	-8.4	-5.9	-7.9	4.8	132.7	-0.2	-7.3
Processed food	14.0	1.1	4.4	0.9	1.0	2.9	4.8	5.4
Beverage	1.7	0.3	1.1	0.4	3.5	49.1	0.1	1.0
Tobacco	-0.1	0.0	0.0	0.0	2.5	29.2	0.0	-0.2
Textile	491.7	23.4	191.1	16.4	183.7	96.2	325.3	100.4
Apparel	378.9	38.6	151.6	25.4	12.9	64.1	359.5	114.3
Leather	-8.0	-1.7	-3.5	-1.3	0.2	0.4	-8.3	-6.7
Sawmills and furniture	1.5	0.2	2.2	0.6	2.0	5.7	-1.8	-3.2
Paper & printing	-3.8	-0.4	-1.2	-0.2	6.1	5.5	-0.6	-4.0
Social articles	-12.3	-2.1	-3.2	-1.2	1.8	5.0	-13.9	-6.9
Petroleum refining	-38.0	-4.3	-12.9	-4.2	40.1	62.7	-2.7	-3.3
Chemicals	-23.6	-1.2	-7.8	-1.0	33.6	8.9	-2.9	-1.8
Medicine	0.5	0.1	0.6	0.3	1.2	13.0	-0.1	-0.4
Chemical fibers	29.2	9.9	7.2	8.1	42.9	74.0	0.6	2.6
Rubber and plastics	-20.7	-1.8	-8.3	-1.4	3.4	5.0	-7.5	-4.6
Build materials	1.1	0.0	-1.0	0.0	0.8	2.5	-1.8	-2.3
Primary iron and steel	-31.9	-2.0	-15.9	-1.9	5.0	3.2	-1.7	-3.0
Non-ferrous metals	-10.4	-1.7	-3.6	-1.3	-0.6	-0.6	-1.2	-3.8
Metal products	-15.5	-1.2	-5.5	-0.8	5.1	4.7	-5.1	-3.9
Machinery	-34.8	-2.5	-17.6	-1.9	14.1	6.6	-4.2	-5.2
Special equipment	-13.9	-1.6	-7.5	-1.3	19.0	5.9	-1.8	-4.3
Automobile	-165.2	-17.3	-50.6	-15.0	82.5	375.4	-2.0	-12.3
Oth. Transport equipment	-3.6	-0.5	-0.4	-0.1	3.4	3.1	-2.8	-4.8
Electric machinery	-29.8	-1.8	-6.4	-1.0	9.5	6.0	-14.2	-6.1
Electronics	-58.1	-4.0	-12.7	-3.3	9.7	2.2	-24.9	-5.7
Instruments	-13.7	-6.3	-9.5	-4.5	5.7	6.0	-7.2	-8.3
Other manufacturing	-8.9	-1.9	-4.5	-0.9	1.7	12.0	-7.3	-12.0
Utilities	1.6	0.1	-1.1	-0.3	0.0	0.9	0.6	3.4
Construction	38.8	0.7	34.5	0.5	0.2	1.1	-0.1	-1.6
Transportation	8.1	0.5	5.5	0.2	1.4	5.2	-1.9	-1.1
Post and communication	2.4	0.3	0.9	0.3	0.1	1.5	-1.3	-2.0
Commerce	64.3	1.6	114.8	1.2	1.8	3.0	-0.3	-1.1
Finance	5.4	0.5	1.1	0.2	0.4	2.0	-0.1	-2.7
Social services	12.6	0.5	5.3	0.3	1.5	1.2	-3.5	-1.4
Education & health	1.5	0.1	0.9	0.0	0.3	1.8	-0.1	-2.4
Public administration	2.1	0.2	2.4	0.1	0.2	1.6	0.0	-1.8

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 industry, 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 electric machine, 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. Moreover, electronics and instruments sectors will experience more adverse impacts because of their high export orientation and the real appreciation.

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, 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 2.6. The simulation results show that the real GDP of Guangdong will increase by 5.7 percent in 2010 relative to base case, while the real GDP in rest of China will only increase by 0.56 percent. The increase of GDP in Guangdong is around 122 billion yuan, accounts for 55 percent of national GDP gain.

If China joins WTO, the growth of investment in Guangdong is higher than 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 increase by 14.3 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 19 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 2.3 percent in 2010, due to migration from rest of China. The labor force in rest of China will decline by 0.16 percent.

Table 2.6 Major Macroeconomic Effects on Guangdong and Rest of China, 2010

(% 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)	5.09	1.75	-0.02	1.46
GDP	5.71	1.76	-0.10	2.07
Consumption	4.81	1.94	0.21	1.28
Investment	7.95	2.45	-0.46	2.34
Exports	15.66	4.06	1.50	5.64
Imports	13.03	4.50	0.86	3.84
Interregional Exports	-4.13	-0.79	-0.36	-1.81
Interregional Imports	2.46	-0.06	0.89	0.85
Trade Surplus	-18.90	-4.97	3.04	-5.03
GDP Deflator	-0.28	-1.58	-0.55	1.42
Per Capita Households Income				
Urban	1.14	0.33	0.87	-0.12
Rural	2.20	1.18	-0.03	0.32
Labor force	2.32	0.86	-0.11	0.86
Rest of China				
EV (% of GDP)	0.36	-0.11	0.48	0.00
GDP	0.56	-0.04	0.48	0.06
Consumption	0.68	0.02	0.49	0.11
Investment	0.01	-0.33	0.55	-0.10
Exports	18.06	4.39	2.31	7.05
Imports	18.57	4.00	2.52	7.58
Interregional Exports	2.46	-0.06	0.89	0.85
Interregional Imports	-4.13	-0.79	-0.36	-1.81
Trade Surplus	14.31	3.76	-2.32	3.82
GDP Deflator	-0.07	-1.70	-0.91	1.89
Per Capita Households Income				
Urban	1.28	0.03	0.98	0.13
Rural	0.56	0.16	0.03	0.23
Labor force	-0.16	-0.06	0.01	-0.06

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 2.7 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 that 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 2.7 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	%	10^4Person	%	10000 Person	%
Rice	-4.2	-16.0	-8.9	-3.4	-27.4	-16.8	-95.3	-3.7
Wheat	0.0	-22.6	-8.8	-4.6	-0.2	-23.4	-82.0	-4.9
Corn	0.0	-	-2.5	-2.1	0.0	-	-33.4	-2.3
Cotton	0.0	-	-1.7	-1.5	0.0	-	-23.4	-1.8
Other non-grain crops	-1.0	-1.0	-3.2	-0.3	-10.4	-2.0	-68.2	-0.6
Forestry	-0.3	-2.4	-4.8	-3.4	-0.8	-2.7	-48.1	-3.4
Wool	0.0	-	-0.1	-1.2	0.0	-	-0.2	-1.4
Other livestock	5.6	5.1	32.0	1.7	4.8	4.2	54.7	1.5
Fishing	1.7	1.8	4.7	0.8	2.7	1.4	9.9	0.7
Other agriculture	0.4	1.9	1.3	0.6	1.0	1.2	2.9	0.3
Coal mining	-0.3	-12.5	-3.0	-0.8	-2.9	-12.5	-9.9	-0.7
Crude oil and natural gas	-1.9	-4.6	-10.5	-4.2	-0.1	-4.6	-10.1	-4.1
Ferrous ore mining	-0.3	-8.3	-1.7	-2.0	-0.2	-8.2	-1.5	-1.6
Non-ferrous ore mining	-0.8	-7.1	-3.0	-1.4	-0.8	-7.5	-1.6	-1.0
Other mining	0.5	1.4	-0.3	-0.1	0.2	0.9	0.4	0.0
Vegetable Oil	-2.1	-13.5	-28.2	-13.1	-0.5	-17.0	-5.9	-9.5
Grain mill and forage	1.9	4.5	7.4	1.2	0.2	2.8	1.7	1.1
Sugar	-1.3	-8.6	-4.3	-8.4	-0.8	-9.0	-5.1	-7.7
Processed food	0.1	0.1	14.0	1.2	-0.4	-1.0	4.8	1.1
Beverage	-2.7	-3.6	4.4	0.8	-0.8	-4.1	1.9	0.8
Tobacco	-0.8	-6.7	0.7	0.2	-0.1	-6.5	0.1	0.4
Textile	159.2	65.2	332.5	17.9	35.5	52.0	155.6	14.2
Apparel	114.0	58.7	264.9	33.7	60.9	48.0	90.7	19.3

	Output				Employment			
	Guangdong		Rest of China		Guangdong		Rest of China	
	Bn Yuan	%	Bn Yuan	%	10^4Person	%	10000 Person	%
Leather	-8.5	-7.1	0.5	0.1	-4.7	-6.9	1.3	0.7
Sawmills and furniture	-1.9	-2.3	3.3	0.6	-0.7	-2.6	2.8	0.8
Paper & printing	-3.1	-2.1	-0.7	-0.1	-1.6	-2.9	0.5	0.1
Social articles	-8.8	-4.5	-3.5	-0.9	-2.5	-3.9	-0.7	-0.3
Petroleum refining	-3.5	-4.7	-34.5	-4.2	-1.4	-4.8	-11.5	-4.1
Chemicals	0.2	0.3	-23.8	-1.3	-0.5	-1.4	-7.4	-1.0
Medicine	-0.6	-1.9	1.1	0.2	-0.3	-2.4	0.9	0.5
Chemical fibers	5.9	13.5	23.3	9.3	1.0	10.4	6.2	7.8
Rubber and plastics	-7.4	-2.7	-13.3	-1.5	-2.6	-3.7	-5.7	-1.1
Build materials	6.1	2.7	-5.0	-0.2	1.0	0.9	-2.0	-0.1
Primary iron and steel	-0.5	-1.4	-31.5	-2.0	-0.5	-2.4	-15.4	-1.9
Non-ferrous metals	-1.7	-5.4	-8.7	-1.5	-0.6	-5.8	-3.0	-1.1
Metal products	-4.2	-2.0	-11.3	-1.0	-1.4	-2.4	-4.1	-0.7
Machinery	-2.7	-5.8	-32.1	-2.3	-1.7	-5.7	-15.9	-1.7
Special equipment	-1.2	-6.5	-12.7	-1.5	-1.5	-6.4	-5.9	-1.1
Automobile	-10.9	-37.9	-154.3	-16.7	-2.4	-35.8	-48.3	-14.6
Oth. Transport equipment	-0.3	-0.4	-3.3	-0.5	-0.3	-0.9	-0.1	0.0
Electric machinery	-25.6	-5.0	-4.2	-0.4	-6.6	-5.5	0.2	0.0
Electronics	-20.9	-5.4	-37.2	-3.5	-5.2	-5.5	-7.6	-2.6
Instruments	-4.4	-8.9	-9.2	-5.5	-1.3	-8.3	-8.2	-4.2
Other manufacturing	-6.1	-4.7	-2.8	-0.8	-3.4	-4.8	-1.1	-0.2
Utilities	7.4	3.5	-5.8	-0.5	0.0	0.1	-1.2	-0.3
Construction	38.6	7.5	0.1	0.0	32.7	5.9	1.7	0.0
Transportation	7.9	3.0	0.1	0.0	3.5	1.7	1.9	0.1
Post and communication	5.4	4.3	-3.0	-0.5	0.9	2.7	0.1	0.0
Commerce	39.8	6.8	24.5	0.7	37.9	5.0	76.9	0.8
Finance	7.7	4.3	-2.4	-0.2	1.3	2.8	-0.2	-0.1
Social services	15.3	3.7	-2.8	-0.1	3.3	2.4	2.0	0.1
Education & health	3.5	2.0	-2.1	-0.1	3.5	1.2	-2.6	-0.1
Public administration	2.1	1.8	0.0	0.0	1.0	0.8	1.4	0.1

Source: simulation results.

Grain are the most seriously affected agricultural products in China from its entry to the WTO. The provinces which specialize on the production of these products would get loss from China's WTO accession, especially the farmers in these provinces. Table 2.8 presents the regional distribution of the production of rice, wheat and cotton, and the per capita output of these agricultural products for each province. The per capita output of agricultural products could be an index of the level of interregional exports. Generally, provinces with higher per capita output would be the net exporters to other provinces or the world market. If China becomes a member of WTO, the provinces with net outflows of these agricultural products would have negative impact, while the provinces with net inflows of these agricultural products would be benefited. Table 2.8 shows that the Hebei, Shandong and Henan are important wheat producers in China, the three provinces also have high per capita output of wheat, their wheat production would be adversely affected due to China's WTO accession. Some provinces in middle China which specialize on rice production, such as Hunan, Jiangxi and Hubei, could experience loss from the competition with foreign imports in coastal market. In the mean time, Xianjiang, Hubei, Henan and Jiangsu will also get slightly loss in the production of cotton, because they are important providers of cotton in China.

It should be pointed out that the crop sector of China would experience the decline of production as a whole after China's entering WTO, but the livestock sector would expand. Although the major grain producing provinces would get loss in the production of grain, they can be benefited from the expansion of livestock sector if they actively prompt the structural transfer from crop to livestock sector, because these provinces have relative cheaper labor force and feed supply.

Table 2.8 Regional Distribution of the Production of Rice, Wheat and Cotton

	Rice		Wheat		Cotton	
	Share of provincial output, %	Per capita output (kg/person)	Share of provincial output, %	Per capita output (kg/person)	Share of provincial output, %	Per capita output (kg/person)
Beijing	0.1	13	1.0	80	0.1	0.2
Tianjin	0.2	43	0.6	73	0.2	1.3
Hebei	0.5	14	10.4	165	7.8	5.8
Shanxi	0.0	1	2.6	88	1.9	3.0
Imongolia	0.2	17	2.6	115	0.0	0.0
Liaoning	1.4	65	0.6	16	0.5	0.6
Jilin	1.6	116	0.2	7	0.0	0.0
Helongjiang	2.5	127	2.7	73	0.0	0.0
Shanghai	0.9	122	0.2	18	0.1	0.3
Jiangsu	9.7	255	8.7	126	11.8	7.9
Zhejiang	6.6	278	0.5	12	1.3	1.4
Anhui	6.9	212	6.8	117	6.3	5.0
Fujian	3.9	229	0.2	6	0.0	0.0
Jiangxi	8.0	366	0.1	2	2.5	2.9
Shandong	0.5	10	20.2	237	9.9	5.4
Henan	1.6	33	17.2	193	16.2	8.5
Hubei	9.3	300	3.6	63	12.3	10.2
Hunan	13.2	384	0.3	4	4.7	3.5
Guangdong	7.9	215	0.1	1	0.0	0.0
Guangxi	6.8	277	0.0	1	0.0	0.0
Hainan	0.9	222	0.0	0	0.0	0.0
Sichuan	11.3	188	7.2	65	2.4	1.0
Guizhou	2.3	124	1.1	32	0.0	0.0
Yunnan	2.8	128	1.3	34	0.0	0.0
Tibet	0.0	2	0.2	106	0.0	0.0
Shaanxi	0.3	18	4.0	117	0.8	1.1
Gansu	0.0	2	2.5	104	0.5	0.9
Qinghai	0.0	0	0.7	144	0.0	0.0
Ningxia	0.2	90	0.7	135	0.0	0.0
Xinjiang	0.3	28	3.9	237	20.8	59.8
Total	100.0	155	100.0	85	100.0	4.0

Source: *Rural Statistical Yearbook of China, 1996,* SSB

Table 2.9 provides the trade dependence of each province and the provincial distribution of China's manufacturing products. As the important producers of labor intensive manufacturing products and the most export oriented provinces, Guandong, Fujian, Shanghai would be major beneficiaries from China's WTO accession and the possible further expansion of China's labor intensive sectors. Jiangsu is also an important producer of textile and clothing, but it is less export oriented, so its gain from China's WTO accession would be relative smaller than Guandong and Fujian.

Machinery, transportation equipment, electric machine and electronics are adversely affected sectors. Jiangshu and Shanghai could be affected because of their high shares in the production of these sectors. Furthermore, the machinery sector in Liaoning and Shandong, the automobile sector in Jilin and Hubei, would also be adversely affected. Guandong province accounts for a large share of electronic sector, but the negative impact for it would be small because the export orientation of its electronic sector.

Table 2.9 Trade Dependece and Regional Distribution of the Production of Manufacturing Products

	Trade Dependence (%)		Share of provincial value-added (%)			
	Export/GRP	Import/GRP	Textile, Clothing & Social Articles	Machinery	Transportation Equipment	Electric Machine & Electronic
Beijing	15.3	11.0	2.0	2.5	5.4	4.7
Tianjin	27.2	32.2	1.9	2.6	4.5	6.5
Hebei	8.9	2.7	4.2	4.0	2.6	2.2
Shanxi	8.8	1.6	0.6	1.6	0.9	0.4
Imongolia	7.4	6.3	0.8	0.4	0.3	0.2
Liaoning	24.7	8.2	1.8	7.8	4.2	5.0
Jilin	10.5	9.6	0.4	0.8	9.4	0.3
Helongjiang	8.7	5.5	0.5	2.1	2.2	1.0
Shanghai	39.3	25.4	8.0	9.8	14.9	11.2
Jiangsu	8.1	19.1	20.8	17.5	10.0	13.2
Zhejiang	20.0	7.3	11.7	7.4	4.1	6.4
Anhui	6.6	3.0	2.7	3.1	1.5	1.7
Fujian	36.0	20.9	5.0	1.5	0.8	2.7
Jiangxi	9.9	1.6	0.9	1.2	2.0	0.9
Shandong	16.6	5.3	8.7	9.8	5.5	5.1
Henan	5.1	2.4	3.8	5.6	2.8	2.5
Hubei	8.1	4.8	4.7	4.0	6.9	1.6
Hunan	8.0	3.1	1.0	2.5	2.7	1.4
Guangdong	86.4	59.2	14.8	4.0	6.6	22.9
Guangxi	11.7	5.0	0.9	2.4	2.0	0.8
Hainan	19.0	32.9	0.1	0.0	0.5	0.1
Sichuan	6.5	3.8	1.5	4.7	5.8	4.3
Guizhou	5.7	2.7	0.2	0.5	1.3	0.3
Yunnan	9.2	5.5	0.4	1.0	0.5	0.4

Tibet	4.5	5.2	0.0	0.0	0.0	0.0
Shaanxi	10.7	3.8	0.9	1.5	2.5	3.7
Gansu	5.9	2.3	0.5	0.6	0.2	0.4
Qinghai	7.0	1.2	0.0	0.2	0.0	0.0
Ningxia	11.8	1.9	0.0	0.4	0.0	0.1
Xinjiang	7.7	6.6	1.0	0.3	0.1	0.1

Source: 1) China Regional Economy: A Profile of 17 Years of Reform and Opening-up, SSB, 1996

2) The Data of the Third National Industrial Census of the People's Republic of China in 1995, SSB

5. Conclusion and Policy Implications

This part 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 223.2 billion yuan and 175.0 billion yuan (1997 price, or 1.1% and 0.9% 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, but 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.

These results have an important implication for China's WTO accession. First, 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.

Second, the overall income distribution would deteriorate after China entering WTO in terms of either rural-urban or coastal-inland gap. 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 sustainablely. The cost of agricultural protection will grow during China's industrialization. The later the reform, the larger distortion and the more serious 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.

Third, 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 nationalwide 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)

Forth, the domestic taxation policy should perform a stronger function on redistribution of income to reduce the impact of income inequality resulted from the accession to WTO. One of our previous studies has investigated the welfare and distributional effects of tariff reduction under alternative tax replacement assumptions (Wang and Zhai, 1998). This study suggested that imposing a progressive tax of households income seems to be an appropriate policy choice to replace the lost tariff revenue, it reduces the Gini coefficient and retains most of the efficiency gains.

PART III

Environmental Implications of China's WTO Accession

Accompanying the rapid economic growth of China, 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 relative lagged technology level in developing countries, it is possible that they would be the net losers in the environmental transfer through international trade.

The prevailing opinions believe trade will have different effects to environment by five ways (OECD, 1994):

- Scale effects- associated with the overall level of economic activity or the macro-economic effects resulting from the trade measure or agreement.
- Structural effects- associated with changes in the patterns of economic activity or the micro-economic effects resulting from the trade measure or agreement.
- Technology effects- associated with changes in the way products are made depending largely on the technology used.
- Product effects- associated with trade in specific products which can enhance or harm the environment.
- Regulatory effect- associated with the legal and policy effects of a trade measure or agreement on environmental regulations, standards and other measures.

These different types of effects can be both positive and negative for the environment. And the determinant factor is there good market and proper policy exists or not. Where market failures or government intervention failures exist, there would be overuse of natural resources and over emission of pollution. Trade liberalization would magnify the environmental exacerbation. But if there were good market and proper policy, free trade would bring the more environmentally beneficial product and technology, and accelerate the speed of environmental improvement. In other words, trade liberalization is just an amplifier; it can amplify the shortcomings of the market or government policy, and also can magnify the efforts to improve the environment.

Undoubtedly, China's WTO membership will have important environmental implications. This part aims at providing environmental 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 environmental prospective.

1. Environmental Situation in China

China has experienced an outstandingly rapid economic growth since 1978, while the environmental problems have become serious such as widespread water and air pollution, solid waste accumulation, high air pollution and water scarcity in urban areas etc.

(1) Water pollution

High growth rate of industry output, population and city development in China have been accompanied by a substantial increase in demand for water. Between 1980 and 1993 urban water consumption increased by 350 percent and the industrial consumption doubled. Water Resources are not distributed evenly in China, the south of China has plenty of water while the most of north China cities are lack of water .

Due to the extensive use of fertilizer and pesticide, the quality of surface water has been worsened greatly. The serious water pollution did harm to person's health and had negative impact on agriculture and industry output on one side, and it aggravated the hardness of shortage of water resource on other side. It is estimated that the annual economic loss from water pollution in China reaches 1.5-3 percent of GDP, having more significant impact than floods and drought (OECD, 2001).

The main causes of water pollution are industrial wastewater discharge, untreated municipal sewage discharge as well as non-point pollution from agriculture. The industrial wastewater is mainly from the sectors of paper amking, metallurgy, chemical and mining. In addition, the sectors of food process or agricultural products process (such as beverage and leather) around the water area near cities and counties are chief source of COD and BOD.

It is indicated that the extensive use of fertilizer and pesticide are important source of wastewater. The rapid expansion of the livestock-breeding sector brings forth dramatic growth of meet products, and it produce large waste of livestock-breeding field at the same time. The great volume of livestock ordure is main resource of BOD in water.

Table 3.1 Wastewater and COD emission in 1995 2001

Year	Wastewater 100 million tons			COD 10 thousand tons		
	Daily Life	Industrial	Total	Daily Life	Industrial	Total
1995	133.7	281.6	415.3	610.3	1622.9	2233.2
1997	189.0	227.0	416.0	684.0	1073.0	1757.0
1998	194.8	200.5	395.3	695.0	801.0	1496.0
1999	203.8	197.3	401.1	697.2	691.7	1388.9
2000	220.9	194.2	415.1	740.5	705.0	1445.5
2001	227.7	200.7	428.4	799.0	607.5	1406.5

Source China Environmental Report 2001 2000 1999 1998 1997

Table 3.1 shows that the industrial wastewater was decreasing in recent years, but while the living wastewater increased rapidly. Both 1999 and 2000, the volumes of wastewater discharged from daily life exceeded those of industrial wastewater. According to this trend, the control and treatment of wastewater discharged from daily life would be the key and the most difficult problems in water pollution control. But comparing to the treatment rate of industrial wastewater of 70%, the treatment rate of wastewater discharged from daily life was less than 20% (World Bank 1997). With the decrease of industrial wastewater and increase of wastewater discharged from daily life, both the total volume of wastewater and COD decrease at first and then increase in 1995~2001. The control of water pollution is still a severe task in the future.

(2) Air pollution

In China, air pollution is mainly from the burning of fossil fuels. Same as trend of the demanding of water, the demand of energy increase quickly followed with the high growth rate of economy. China's primary energy consumption mainly relies on coal. Coal occupies 75% of total primary energy consumption. In 1980, coal consumption was 0.6 billion tons, but it reached 1.25 billion tons in 2000. Air pollutants increase rapidly with the energy consumption growth. The concentration of TSP and SO_2 already exceed the standards of WHO by 2~5 times in some large City of China. The chronic respire disease became the chief caution of death in China, and the air pollution resulted in this type of disease (World Bank, 1997). In 1995, China emitted 23.70 million tons sulfur dioxide, was the largest emitter nation in the World. Due to the large volume of SO_2 emission, the area of acid rain occupied one-third of total country's area. The lost value caused by the emission of sulfur dioxide and acid rain were 110 billion yuan, approximately accounted for the 2% of the GDP in 1995 (Xie, 1998).

Automobile has become the important resource of air pollution. Car per capita in large city increased rapidly. The traffic jam and smog emitted by automobile has become more and more serious in large city. It would be deteriorated if without proper measure in the future.

Industrial energy use occupied the two-third of final use of energy. The coal consumption of industrial boiler and kiln accounts for the half of the total coal consumption. Among the industrial sectors, the non-metal material sector (cement, brick and tile), metal smelt sector (steel, aluminum and copper) and chemical sector (fertilizer, soda ash) occupied the 60% of the total industrial end use of coal. The electricity sector accounted for one-third of coal consumption. These sectors were key sectors in the control of the air pollution.

Table 3.2 Energy Consumption and Composition in 1995~2000

Year	Total Energy Consumption (10^4 tons of SCE)	As Percentage of Total Energy Consumption			
		Coal	Crude Oil	Natural Gas	Hydro-power
1995	131176	74.6	17.5	1.8	6.1
1996	138948	74.7	18.0	1.8	5.5
1997	138173	71.5	20.4	1.7	6.2
1998	132214	69.6	21.5	2.2	6.7
1999	130119	68.0	23.2	2.2	6.6
2000	130297	66.1	24.6	2.5	6.8
2001	132000	67.0	23.6	2.5	6.9

Source China Statistical Yearbook 2002

Table 3.3 Emissions of SO_2, Soot, Industrial Dust in 1995 2000

Year	SO_2 10^4 tons	Soot 10^4 tons	Industrial Dust (10^4 tons)
1995	2369.6	1743.6	1731.2
1997	2266	1573	1505
1998	2091	1455	1322
1999	1857.5	1159.0	1175
2000	1995.1	1165.4	1092.0
2001	1947.8	1059.1	990.6

Source China Environmental Report 2001 2000 1999 1998 1997

Table 3.3 indicated that the air pollution in China had decreased in recent years. Besides the data error, we can attribute this situation to the change of composition of energy consumption that caused the more use of clean energy (as Table 3.2), and the more strict policy such as establishment of the two-control zone of SO_2 and acid rain. But it is the most important that whether the decrease of air pollution would be continuing or whether the air pollution emission would be a steady level.

Because air pollution had direct linkage of energy consumption, the level of air pollution will be decided by the trend of energy consumption in the future. In recent years, the energy consumption can be decreased with the change of economic structure and improvement of efficiency of energy use in China. But if we considered the trend of economic growth in China in the long run, the pressure of air pollution control would still be very large. In large cities, this pressure would be more obvious with the rapidly increase of car.

(3) Solid Waste

The accumulation of solid waste occupied a large volume of lands. The toxic and hazardous pollutants caused by solid waste can affect the environment and human health, by contaminating the soil and groundwater, by leaching toxic substances such as heavy metals and metalloids, nitrogen compounds, chlorinated compounds and other organics.

The solid waste could be classified by industrial solid waste and municipal solid waste. The industrial solid waste includes slag in ore mining, waste residue in melting, coal ash and other different types of industrial solid waste.

Table 3.4 Production, Emissions of Industrial Solid Waste and hazard solid, Municipal solid waste cleanup 10^4 tons

Year	Production of Industrial Solid Waste	Emission of Industrial Solid Waste	Emission of hazard Solid	Municipal solid Waste cleanup
1995	64474	NA	NA	10748
1996	65898	NA	NA	10825
1997	105849	18412	1077	10982
1998	80068	7034	974	11302
1999	78442	3881	1016	11415
2000	82000	3186	830	11819
2001	88700	2893.8	NA	16457

NA Not available

Source China Environmental Report 2001 1997 China Environmental Statistical Report 1999 1995, China Statistical Yearbook 2001 1997

As table 3.4 shown, the production of industrial solid waste increases a little in last years, but the emission of the industrial solid waste decrease dramatically in 1997~1999. The emission of industrial solid waste in 1998 was only the 40% of the number in 1997. And the number in 1998 was only the 55% of those in 1998. Besides data error, we attributed this dramatic decrease of industrial solid waste emission to the increase of recycle rate and the composition change of industrial solid waste emission. It is increase rapidly that the share of industrial solid waste produced by industrial factory in county and above county area which have good recycle measures (In 1997, the share number is 8.4%, and increased to 32.7% in 2000).

(4) Sector environment pollution

The effluent distribution of industrial sectors is shown as Table 3.5. The different types of pollution aren't distributed evenly across the industrial sectors. The pollution is mainly from the energy and raw material sector such as electricity, mining, building material, iron-smelting, steel-smelting, nonferrous metal smelting and raw chemical materials. In the emission of industrial waste, the sector of electricity production and supply accounts for the large shares. The SO_2 and industrial soot produced by this sector occupied near 50% of total pollution respectively, and industrial waste gas of this sector occupied 33%. The mining sector produce the 63% of total solid waste, taking the most important place in the solid waste emission. The four sectors of paper, raw chemical material, ferrous-smelting and electricity emitted the 60% of total industrial wastewater.

Table 3.5 Effluent Distribution of Industrial Sector in 1997 (sectoral share,)

Sector	SO_2	Industrial Waste Gas	Industrial Soot	Solid Waste	Waste Water
Mining	2.87	3.12	3.82	63.41	6.65
Food, Beverage, Tobacco	3.41	2.46	3.90	2.27	7.85
Textile	2.38	1.33	2.09	0.50	5.14
Leather	0.17	0.12	0.21	0.11	0.43
Papermaking	2.70	1.79	3.57	1.10	13.74
Printing	0.00	0.11	0.08	0.32	0.14
Petroleum refining, Coking	1.35	2.53	1.10	2.34	3.00
Chemical industry	3.23	7.58	7.30	5.04	21.41
Pharmaceutical products	0.67	0.43	0.69	0.25	1.69
Chemical fibers	1.13	2.35	0.73	0.32	2.72
Rubber products	0.55	0.41	0.35	0.11	0.54

Plastic products		0.14	0.12	0.07	0.25
Nonmetal Mineral Products	9.23	16.88	14.24	3.48	2.78
Smelting and pressing of Ferrous	6.25	15.96	5.53	10.48	13.91
Nonferrous metal smelting	5.60	6.16	2.42	2.74	2.22
Metal products	0.24	0.31	0.49	0.25	0.53
Machinery Building	2.34	2.99	2.65	2.27	5.89
Electric Power and gas, water	56.22	33.53	49.69	2.42	11.10
Other Sector	1.68	1.79	1.04	2.52	0.00

Table 3.6 Effluent Intensities of Industrial Sector in 1997

Sector	SO_2 (Kg/10^4yuan)	Industrial Waste Gas M^3/yuan	Industrial Soot (kg/10^4 yuan)	Solid Waste (Kg/10^4 yuan)	Waste Water (Ton/10^4yuan)
Mining	6.17	0.59	4.65	5.88	2.04
Food, Beverage, Tobacco	3.47	0.22	2.25	0.21	1.14
Textile	3.60	0.18	1.79	0.08	1.11
Leather	1.08	0.07	0.74	0.18	0.38
Papermaking	15.54	0.91	11.66	0.11	11.27
Printing	0.00	0.13	0.66	1.39	0.29
Petroleum refining, Coking	6.10	1.01	2.81	0.76	1.94
Chemical industry	5.63	1.17	7.21	0.24	5.32
Pharmaceutical products	5.47	0.31	3.18	0.13	1.96
Chemical fibers	12.76	2.34	4.67	0.16	4.38
Rubber products	5.96	0.39	2.16	0.11	0.82
Plastic products	0.00	0.06	0.32	0.22	0.17
Nonmetal Mineral Products	14.72	2.37	12.87	0.09	0.63
Smelting and pressing of Ferrous	16.24	3.65	8.13	0.67	5.14
Nonferrous metal smelting	33.18	3.22	8.12	0.40	1.87
Metal products	0.69	0.08	0.78	0.18	0.21
Machinery Building	1.18	0.13	0.76	0.30	0.42
Electric Power and gas, water	178.17	9.36	89.21	0.02	5.00
Other Sector					

Source China Statistics Yearbook 1998 China Input-Output Table 1997

Table3.7 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

The situation of effluent intensity of industrial sector is similar to the effluent distribution as Table 3.6. A sector with large share of pollution almost has high effluent intensity. The electric power sector has SO_2 effluent coefficient of 178 (kg/10000 yuan), the number exceeds greatly than other sectors. This sector also have the higher coefficients in the other air pollution. Mining sector has the higher solid waste intensity (5.6 kg/10000 yuan). In the water pollution, the above four sector of papermaking, chemical industry, ferrous-smelting and electricity also have the wastewater intensities of 11.3 5.3 5.1 and 5.0 respectively, also higher than other sectors.

Table 3.7 provided effluent intensity of all the sectors. The data in the table 3.7 are mainly from 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)).

Comparing table 3.7 with table 3.6, the distribution of effluent intensity across the sector are similar. The sectors with higher effluent intensity of SO_2 in table 3.6 also have higher effluent intensity in table 3.7. These sectors include mining, papermaking, petroleum refining and coking, chemical industry, nonmetal mineral products, smelting and pressing of ferrous metal, nonferrous metal smelting, and electric power, etc. Especially, for the electric power sector, its SO_2 effluent coefficient is 178 (kg/10000 yuan) in table 3.6, and it is 184 (kg/10000 yuan), they are very close. Generally speaking, effluent coefficients in table 3.6 are lower than they are in table 3.7. Due to the lack of data of detail sectoral effluent intensity in China, we will use data of table 3.7 in CGE model.

2. Simulation Results of Environmental Effects

In part II we designed five policy scenarios based on the final offer on WTO accession, and described simulation results of aggregate effects, sectoral adjustments, and regional effects. Based on that five policy scenarios and results we continue to report environmental effects of WTO accession.

The significant changes in the composition of domestic production will influence the level and composition of emission effluent. Table 3.8 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 emission 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 8 shows that the emission level will rise for most pollutants under the scenario for tariff and NTBs reduction for industrial products, and the percentage change in emission levels exceeds the percentage change in real output, indicating higher emission intensities. But the emission of SO2, CO2, 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 3.8 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

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 3.8, 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 wastewater, urban living wastewater and agriculture wastewater. 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 wastewater. In fact, the industrial wastewater 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 wastewater will decrease greatly.

But the decrease of industrial and agricultural wastewater doesn't hold the TOXWAT and BOD increase slightly. It indicates the living wastewater 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.

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 increases rapidly is labor-intensive sectors. The technology effect and the product effect will improve the efficiency of energy use.

NO_2 increase 2.5% compare to the base scenario. NO_2 pollutions are mainly from industrial process and transport emission. Increase of NO_2 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 NO_2 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.

3. Conclusion and Policy Implications

This part analyzes the environmental impacts of China's WTO accession using a two-region Chinese CGE model. The model results show the significant changes in the composition of domestic production will influence the level and composition of emission effluent. But the effect of WTO accession on pollution is quite neutral.

Our simulation results show that emission for 6 pollutants (three toxic pollutants, NO2, VOC, BOD) increase, while 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. Combined the scale effects, technology effects and product effects caused by trade liberalization, accessing WTO would lessen the China's pollution pressure, but this degree is small. But the overall situation of environment protection is still severe. To be responsible to global society and human development as whole, we recommend the following policy suggestions:

1. China should continue to follow the principles of Johannesburg Meeting, implementing a sustainable development strategy with coordinated social, economic, and environment development.

2. China will implement a new pattern of industrialization, i.e. a pattern of low consumption of natural resources and energy, high efficient in production.

3. Due to the dominance of coal of the primary energy resource, clean energy technology should be adopted. All means should be adopted to push forward the environment sound technology.

4. Green labeling or eco-labeling has become practice of developed countries, it is necessary to improve the life cycle process of the production chain, to improve the product based on international practice. And ISO 14000 management practice should be pushed further.

5. Strengthen international cooperation to develop environment sound technology and develop products and industry for environmental protection.

The results of this report provide useful insights in understanding the impact of China's accession to the WTO. However, there are also several obvious limitations. First, it captures only one aspect of the issue at hand, does not take into account other major aspects of WTO membership. Second, the CGE model used in this paper is a highly stylized simplification of the Chinese economy, and is far from perfect. Finally, there are uncertainties about the size of parameters, while the actual size of the impact is very sensitive to those key parameters. Therefore, the results reported in this report need to be interpreted with caution: they can be viewed as indicative but not as precise real outcomes.

APPENDIX 1 The environment and Economic Structure

I. The environment problem

1. The scope of the environment problem

With the development of the worldwide economy, the living condition of the human has been worsened. The environment problem has been the focus of the world increasingly. The environment problem includes the warm up of the worldwide climate, the destruction of the ozone, the reduction of the diversity of the biology, the losing of the soil and water, the desolation of the land, the over-logging of the forests, the lack and pollution of the water resources, the erosion of the coast and the pollution and the atmosphere pollution.

The greenhouse effect

The greenhouse effect denotes the results such as the warm up of the worldwide climate, the rise of the sea level, the increase of the skin cancer incidence caused by the letting of the carbon dioxide, CFCs, methane, ozone and calcium oxide. The consumption of the fossil resources is the main reason for the greenhouse effect. However in a foreseeable future, the current pattern in which the fossil resource acts as the main resources will not change significantly. In this situation, the warm up of the world climate and the rise of the sea level will be unavoidable, and it may bring serious loss to the coast countries and islands.

The destruction of the ozone

The destruction of the ozone will intensify the warm up tendency of the worldwide climate at one hand and on the other hand, it will intensify the violet radiation, destroy the man's gene and lead an increase in the incidence of the skin cancer. Among the various kinds of substances, CFC and other chemical materials play the most destructive role. According to *the Montreal Protocol* subscribed among related countries, the developed countries are responsible for stopping producing the CFC and tetrachloride before 1996. But having considered the recent situation of the developing countries, the deadline of production and consumption is postponed to 2010. The recent problem is that, some of the countries still dump their product to the developing countries using the clause in the *Montreal Protocol* saying that "the developed countries can sell 10% of the CFC and tetrachloride they produced according to the demands of the developing countries."

Reduction of the biodiversity

The biodiversity is the base for the survival and development of the human society. With the spreading of the human activity, the variety of the creature and biology has been reduced. The protection of the biology resources is a worldwide task and is the important content of the coordination of the environment and development.

The soil erosion

The soil erosion is the destruction of the vegetation, the changes of the terrain brought on by both natural factor and human factor. The man-made losing of soil erosion is the main problem with which the human must deal. The natural factors include the four items: topography, rainfall, soil and vegetation. The man-made factors include: (1) destruction of the grass and forest produced by the plough on the slope land; (2) when exploiting the mine and the repairing the road, the workers destroy the vegetation and the landform of the area. And at the same time, they rave about all the wasted material to the river, which cause vast amount of soil erosion.

Desertification and drought

The Desertification and drought is caused by the changes of the climate and the irrational human economical activity, which has degenerated the land in the drought, semiarid, and semi-humid (sometime with drought) area. After the land has been reclaimed into farm, the environment has changed completely. That the sparse crop can not protect the land from the impulsion of rainstorm, as well as the lost of the moisture and the fecund surface layer and the absorption of the inorganic and organic fertilizer by the monotony crop are the reasons for the Desolation of the land.

Over-logging of the forest

The first reason for the reduction of the forests comes from the pressure of the increasing population. In 2000, the whole population in the world has totaled 6 billion, about 75% are living in the developing countries. The main issues they must affront are food and energy. They have to cut down forests to plant rice, to burn in order to live, which has destroyed many woods at a very egregious speed. The second reason for the reduction of the forests comes from the over logging of the forest. It is not until recent 20 to 30 years does the man begin to use tropic lumber more massively. In the recent 20 years, the import of the developed countries for the tropic lumber has increased about 16 times. They turned to developing countries for lumber resources with an intention to guard their own lumber resources. The European countries import lumber from African, the USA imports from mid-south American and Japan imports from South-East Asia. The third reason for the reduction of the forests comes from the fact that people cut down forest to obtain energy. The energy used by human for burning has exceeded that of the energy produced by water electricity power station and nuclear power station. According to the statistics report of the Environment Bureau of the United Nations, the area of the cut-down forest to burn for food and heating has totaled 22,000 kilometers a year, most of energy is lost during the process. Besides, the frequent happening of fire and the harm from the pests are the reason for the reduction in forests.

The shortage of water resources and the water pollution

About 1/3 of the population in the world are devoid of the access to the safe drinks and suitable sanitation facilities. The water pollution has now become a main factor that does harm to the lives of the people in the developing countries. About 1.5 billion people in the world are depending on the ground water at present. In the area where the ground water is being exploited, the regorging of the seawater and the subsiding of the ground has been very severe. The priority issue to be dealt with for the countries in the vicinity of the sea is to allocate the water resources reasonably.

The eroding of the Oceanic and oceanic pollution

About 60% of the world population live in the vicinity of the sea coast, which means that about 3 billion people live, play, carry on, and dispose garbage near the sea. The exploration of the land has made 1/3 of the coast land degenerate. 80% of the coastland in the European are severely affected while the ratio in the Asia is about 70%. But in a worldwide perspective, the output of the fishery is slowing down because 60% of the sea fish are over-catching.

Air pollution

Recently, the acid rain and air pollution which were serious problems in Europe and North-America at one time has become more and more severe in Asia-Pacific and Latin-America. Almost all the cities in the world are faced with the problem of atmosphere pollution. In the fast growing economy such as Asia-Pacific, east Europe, Latin American and West Asia, there is a growing tendency of urbanization. The health of residents in cities are threatened by the aggravation of the pollution, declining of the air, and the flow of the pollutant among different regions.

2. The level of the environment problem

The environment issues can be classified into global issue, regional issue and local issue according to the scope of regions which they impact.

The global issues indicate the warm up of the world climate, the destroy of the ozone and the reduction of biodiversity. They have global influences.

The regional issues are mainly concerned with the air pollution, water pollution and land pollution. The influences will not be confined to the national but will affect the downstream environment and international downstream environment as well. For example, the oxide produced by the burning coal and the emission of ash will lead a serious the acid rain, and in turn, the acid rain will do harm to the downstream area.

Local environmental problem is about the effects within limited areas. For example, hazard chemical substance producing in process, air pollution and noise in city etc.

3. The environmental situation in China

Recently, China's environmental situation is very severe. The total volume of the pollution emission is great and the extent of pollution is at a very high level. The environment quality in some districts is being worsened. In most cities, the water, air, sound and soil pollution are very serious. The continuing reduction of environment quality in the rural areas is followed by the more severe ecology deterioration.

Water pollution: the most serious problems that the water environment faces are the pollution of the water body and the shortage of the water resources. The main rivers in China are all polluted by organic compound. The Liao river and Hai river are heavily polluted. The quality of the Yellow River is far from being good while the quality of the Song HuaJiang is just so so. The Zhu Jiang and Chang Jiang possess the best water quality. If we draw a sequence according to the extent of the pollution of the seven big rivers, the sequence from heavy to light is as follows: Liao He, Hai He, Huai He, Yellow River, Song Hua Jiang, Zhu Jiang and Chang Jiang. In some of the places, the surface level of the earth has fallen because of the over usage of the groundwater. In most of the cities, the groundwater has been polluted and the trend is aggravating itself.

Sea environment: the seawater near the coast has been heavily polluted. Near the coast sea, the environment situation is rather bad while the trend has not been effectively controlled. The pollution in Dong Hai is most severe, besides is Bo Hai. Comparatively, the water quality of the Nan Hai and Huang Hai is rather good. Of all the provinces and cities near the coast, Shang Hai, Zhe Jiang, GuangDong are well known for their heavily polluted coast while Hai Lan and Shang Dong possess relative good sea water.

Air pollution: the problem of acid rain is still bothering China. The air pollutants are mainly soot, sulfur dioxide, suspending granule and mist. Some of the super cities are well known for the soot and car exhaust gas. In the 338 cities under our survey, 33.1% meet the qualification of the second level of the national standard atmosphere quality, 137 cities exceed the standard of the third level, which occupies 40.5% of the cities under the survey. The total area polluted by acid rain occupies 30% of the country land. The heavily polluted area is distributed among the southern of the Yangtze river, the Qingzhang tableland and Sichuan basin. There are many acid rain encountered places in Mid China, South China, West-south China and East-China. And in the part of the northern area there exist acid rain.

Cultivated land: The land per capita is very limited and the quality of the cultivated land is not high. China has the third largest land area in the world, but the per person is only 0.777 hectares, which equals 1/3 of the world average level. The land per capita for cultivated is about 0.106 hectares, which is about 43% of the world average. In sum, the quality of the cultivated land in China is rather low. The total area of the cultivated land with slope higher than 25 degree is about 6 million hectares. Only 40% of the cultivated land is guaranteed by the water and irrigation facilities. The mid-level and low-level cultivated land occupies 79% of the total cultivated land.

Forest and grassland: The forest-coverage rate is very low and the degradation of the grassland is very serious. The forest area per person is about 0.11 hectares, which occupies 17.2% of the world level and stands 119th in the world. The average cumulating volume of the forest is about 8.6 cu.m, which equals 12% of the world level. China is one of the countries which have the lowest average cumulating volume of forest in the world. The forest cover ratio is about 13.9%, which is much lower than the average level of 26% for whole world. China is abundant for grassland where the total area of the grassland is 390 million hectares which occupies 40% of the country land. But grassland per person is about 0.33 hektare, which equals 1/2 of the world level. The grassland in China is seriously degraded, where 130 million of the grassland has turned into sand and alkali, equaling 1/3 of all grassland. And the total area of the grassland which has turned into the sand is about 1,689,000 sq.km. The sand is distributed between 35 degree of north latitude and 50 degree of north latitude, forming a region of sand blown by wind which starts from Talimu Basin in the west end to Songnei plain in the east end and has a width of 600 Km in North-South Direction.

II. Economic growth, industrial structure change and its impact to the environment

1. General description

There is close relationship between the evolution of the industrial structure and environment. The environment quality is determined by the economic scale, the output structure, the input-output ratio and cumulating effect of the damage from the unit input to the environment. The four factors determining the environment quality are interrelated. The extent of the economic scale will lead to the changes in the output structure and will promote the will of the investment in the environment. The changes in the output structure will help to increase the input-output ratio, the increase in the input-output ratio and the reduction of the effect of the unit input to the environment issues will help to sustain the economic growth. In sum, with the increase of the population, the income and economic scale, the pressure of the economy to the environment and resources became obvious. In order to satisfy the principal of sustainable development, we must improve the output structure, increase the input-output ratio, reduce the pollution of unit input to the environment. Only in this way can we counteract and reduce the potential effect of the economic scale's enlarging.

There is a relation of the unity of opposites between the economic growth and protection of the environment. Factor a means that additional expenses must be added in order to control the pollution. Another factor b reflects that the damage of the environment will do adverse effect to the long term economic growth, the factor c represents the desire to increase the investment on the environment because of the rise in the income level. All those represent that in the recent international society, the developed countries have a relatively strong investment intention and ability. But in some developing countries, limited to the development pattern and their knowledge, they tend to sustain the high growth speed by investing less to the environment. The recognition of the above problem needs further solution.

2. The economic growth in China and the adjustment of the industrial structure

China will remain high economic growth at the beginning of the 21st century. According to the strategic plan of the modernization in China, the GDP will be twice as much in 2010 as that in 2000. The average growth rate of the GDP must sustain a rate of 7.2% in order to achieve the above goal. The analysis shows that it is reasonable for China to achieve the above goals. The rapid development of the economy will increase the ability for China to manage the environment at one hand, and will give rise to new pressure on the environment on the other hand.

When there is a trend of large scale industrial structure adjustment worldwide, China faces the same formidable task to adjust its industrial structure. In the Tenth-Five-Year-Plan, the adjustment of industrial structure will be one of the most important tasks. Recently, there is an irrationality in the industrial structure in China: the proportion of the agriculture and industry in the economy is too large while the development of the service industry is very slow. In the agriculture sector, the scale of production is very small, the agriculture of high efficiency and high quality is lagged. In the industry sector, the industries embodied the most advanced technology with high added value and little impact to environment are not properly developed. In the services sector, the development of the production orientated industries such as finance and consulting are very slow. In the Tenth-Five-Year-P plan, the adjustment of the industrial structure will be proceeded as follows:

(1) Adjust the structure relationship of the agriculture, industry and services. The services sector should be mentioned at a prior importance and its share in the GDP should be raised as soon as possible. The finance, insurance, advertising consultation, tour, accounting, technical and law services should be developed at an even quicker speed as well as the reconnaissance design, the sea transportation, construction and building where China has comparative advantages.

(2) Improve the economic structure of the agriculture and rural industry, raise the modernization level of the agriculture, adjust the plant structure, develop the efficient and characteristic agriculture, promote the industrialization of the agriculture.

(3) Take best advantage of the high technology and the appropriate technical approach to change and optimize the industrial structure, strengthen the research and development of traditional industrial products, greatly raise the technical content and added value of the products. Develop the high-tech industry where China is relatively advantageous, make best use of the technical advantage and labor advantage and develop the industries which are embodied the mid-advanced technology, such as shipping, electric power locomotive, project machine, dynamotor, camion, electric equipment, increase the competitiveness of the above industries in the world. China will also close the companies if they are low-quality producers, they are wasting the resources, they are polluting the environment, they lack the essential safety protection. China will wash out the equipment and techniques out of

data. Companies will be reorganized according to the principal of specialization and scale economy in order to raise the centralization of the industry and R&D ability.

The adjustment of the industry structure in China plays a positive role in the improvement of the external environment.

III. The impact of the globalization to the environment

The international trade will affect the structure of domestic production activity and in turn it can affect environment, the impact includes the followings:

First, in the liberalization of the trade, the developing countries must satisfy the special demand on the protection of the environment, such as potential maleficent materials should be reduced, the packing material should tally with the standard of environmental protection, and the products should be recognized by the authorities related to environmental protection.

Second, the import agency will ask the supplier to follow certain standard, which will put high pressure on the environment protection from the suppliers' side. It will increase the cost of the company in short term, but in the long term, it is advantageous to both the development of the companies and the improvement of the environment. Big companies can afford the prices of the advanced environment equipment while it is relative difficult for the small companies to do so.

Third, the liberalization of the trade and the international cooperation will increase the protection ability of the developing countries.

Fourth, the liberalization of the trade will result in the change of the production method. Its impact to the environment is hard to determine. We can see from the various kinds of facts that a proper policy can do benefit to the trade as well as the environment. For examples, the liberalization of the trade can improve the efficient allocation of the resources, including environment resources. The countries with loose law on the pollution may have comparative advantages. So, pollution can be transferred from the developed countries to developing countries by trade. Some researchers have demonstrated that the average GDP per person has reverse U relationship with intensity of the pollution. However, the result of the research stresses that the reason for the reverse U curve is the changes of the sector structure, that is from industry to service. The service has low impact to environment. It is generally believed that high figure of the pollution per output in developing countries comes from the environment's characteristic of public goods, the high cost of its implementation and supervision. The function of the pollution transfers from the developed countries is relatively limited.

Though some environmentalists and policy makers demand that the environment standards be put into the trade deployment, the economic research tends to conclude that trade is not the root of damaging the environment and trade policy is not as a effective approach to settle the environment problems as previously thought. (Low and Safadi, 1992; Anderson, 1992; Lee and Roland-Holst, 1994; Behgin et al., 1995)

APPENDIX 2 The overview of the environment CGE model

Studies on incorporating environmental components into a CGE frame-work emerged in the late 1980s. Forsund and Strom (1988), Dufournaud, Harrington, and Rogers (1988), Bergman(l989), Hazilla and Kopp (i990), Robinson (1990), and Jorgenson and Wilcoxen (1990) contributed to the early development of environmental CGE models. So far, about twenty stylized or applied environmental CGE models have been described in the literature. These models, in one way or another, endogenize pollution effects into production or utility functions. The models have been applied mainly to environmental and economic impact assessments of two groups of policies: public policies, such as taxation and government spending, and international trade policies.

A few of the first environmental CGE models have roots in Leontief's input-output model. Leontief (1970) presented a stylized environmental I/O table that incorporates a pollution cleaning sector and a physical account of pollutants in a conventional two-sector I/O table. Based on the specification of the Leontief I/O table, Dufoumaud, Harringion, and Rogers (1988),and Robinson (1 990) built their environmental CGE models.

The economic part of Dufoumaud, Harrington, and Rogers's model is standard in CGE modeling, constant elasticity of substitution (CES) sectoral production functions and a Cobb-Douglas utility function are used. To capture environmental effects in a CGE framework, they further included pollution outputs, with fixed pollution coefficients, and a pollution removal activity. They assumed that there was no private demand , for the pollution cleaning` activity, and that all pollutants would be removed by the government through its purchasing of the cleaning sector's output. The second assumption indicates that no pollutants would be discharged. In the model, the government purchase of the pollution cleaning service is financed either by a lump-sum income tax or an indirect tax on polluting sectors. The model is used to compare the effects of two different ways of financing the cleaning activity.

Robinson's model(1990) is also a general equilibrium adaptation of Leontief's stylized environmental I/O model. Like Dufournaud, Harrington, and Rogers, Robinson calibrated his model on Leontief's stylized data and assumed no private demand but only government demand for pollution cleaning. However, Robinson's model differs from that of Dufoumaud, Harrington, and Rogersin its specification of sectoral production technology and in the assumed consumer behavior. The production side of Robinson's model is simplified by using Cobb-Douglas production functions with only two primary factors labor and capital. To represent the societal effects of pollution emission and abatement activities, Robinson introduced a Stone-Geary utility function, in which pollution and cleaning activities are included. Robinson relaxed the rigid assumption of a zero-level of pollution emission in Dufoumaud, Harringion, and Rogers's model. He used fixed pollution coefficients in terms of sectoral outputs to pollution coefficients in terms of sectoral outputs to estimate the amount of pollution generated, and Presented pollution emissions into households' utility functions as Public goods. Pollution cleaning is undertaken by the government and financed via Pigouvian taxes. Given a set of exogenously determined levels of pollution cleaning and tax rates, Robinson pointed out that the model solutions satisfy market, equilibrium conditions but are not welfare-maximizing solutions. In order to generate fully optimal solutions, Robinson further constructed a nonlinear programming model. The CGE model equations serve as the constraints in the program and pollution taxes and a government cleaning activity are included as policy instruments. The programming model simultaneously determines the optimum levels of these instruments, as well as the resulting market equilibrium. Using stylized data, Robinson showed the feasibility of including pollution within an optimizing framework in an economy-wide model . .

Bergman (1990) presented an applied CGE model for impact assessment of reductions in air pollution emissions. in Sweden. Bergman's model is a static, seven-sector, open-economy model. The technology of production is represented by a nested CES-Leontief production function in each production sector. There are four types of domestic inter-sectorally mobile factors of production in the model economy: capital, labor, electricity, and roundwood. The model includes pollution emissions and emission control activities, as well as markets and market prices for tradable emission permits. Pollution emissions from combustion and from industrial processes are distinguished in the model. There is also a distinction between old and new production units in some of the production sectors. The pollution abatement activity for each pollutant is modeled as a central abatement unit that sells cleaning services to the different sectors. The price of a cleaning service is equal to the marginal cost of abatement. The environmental policy goals are expressed as upper limits on total emissions. The government is assumed to sell emission permits, corresponding to maximum allowable total emissions, to the emitters of pollution at market prices. The cost of purchasing emission permits is incorporated into cost functions. A market for emission trading is assumed. The benchmark data of the model come from Sweden's 1985 I/O table. The results of Bergman's model suggest that major emission reductions are likely to have general equilibrium effects and, thus, that emission control cost functions that fail to take these effects into account may give a distorted picture of the economic impact of emission control.

In his latest work, Bergman (1993) further took into account the effects of environmental quality in utility maximization and productivity. He designed an environmental quality index and put the index into both utility and production functions.

Two other early CGE models for environmental policy analysis are worth mentioning in this literature review. One is Haxilla and Kopp's (1990) model; the other is Jorgenson and Wilcoxen's (1990) model. Both models are econometric general equilibrium models, following the pioneering work of Hudson and Jorgenson (1975). An advantage of using the econometric approach in modeling producer behavior is that it allows for substitution possibilities among intermediate goods, which are ruled out in the calibration approach, and inter temporal household consumption behavior. Besides, these two models have other features in common: (l) both are inter-temporal, multi-sector models; (2) both focus on the economic impacts of environmental regulations or programs; and (3) both consider only environmental costs, without taking environmental benefits into account.

Following the Hudson-Jorgenson framework, Haxilla and Kopp (1990) introduced their 36-sector, 1 -consumer econometric CGE model of the U.S. economy to measure the social costs of environmental regulatory programs, such as the Clean Air and Clean Water acts. They believed that measuring social costs requires the use of a household's willingness to pay, rather than the compliance expenditure. They, therefore, modeled household preference using a hierarchy of indirect utility functions. Social welfare is measured using the expenditure function and the Hicksian notion of compensating variation. The expenditure function is derived from an econometrically estimated indirect utility function. The production of each sector, except for government services, is formulated as a hierarchical system of translog cost functions and econometrically estimated using U.S. data from 1958- 1974. To estimate the social costs of environmental regulations, Hazilla and Kopp ran two simulations one with the environmental programs and another without the programs. Their results show that social cost estimates diverge sharply from private cost estimates and that general equilibrium impacts, which. cannot be reflected by using a static partial equilibrium analysis approach, such as the conventional cost benefit analysis, are significant and pervasive.

Similarly, Jorgenson and Wilcoxen (1990) presented a 35-sector, 1 -consumer econometric CGE model to analyze the economic impacts of U.S. environmental regulation. They estimated the costs of pollution control by simulating the long-term growth of the U.S. economy with and without environmental regulations. The model is a revised. version of Jorgenson and Slcsnick's (1985) model. The production and consumption functions are econometrically estimated using time series-data from 1947- 1985. The production function of each sector includes four factors: capital, Labor, energy, and materials. Three types of pollution-related costs are represented in the translog price function for each polluting sector. They are pollution abatement costs, costs of investment for pollution control equipment, and costs of emissions controls on motor vehicles. By running the model with and without the pollution control costs, Jorgenson and Wilcoxen showed that pollution abatement has become a major claimant on the resources of the U.S. economy.

Asides from those environment CGE models introduced by the public policy, multinational CGE models are also used to investigate the international trade and world environment problem by some researchers. Whalley and Wigle (1991) Piggott Whalley Wigle (1992) have done some representative work in the initial phrase of its development. They developed a static multinational CGE model concerning the effect of carbon tax on the international trade and carbon emission. In their model, the world is divided into six sections and each section is endowed with four non-tradable primary production factors: non-energy primary production factor, carbon emission primary production factor, other kind of energy resources, special techniques and equipment used for the energy intensive production sector. In the each sector, CES functions are used to express production and demand. The particular feature of the model is that since the reduction of the carbon emission is assorted with the utility function of the each district, the environment revenue can be realized from the decrease of the trend of the world warm up. Piggott Whalley and Wigle have validated the effect of result of a single country encouragement plan. They believe that the aim of restricting carbon emission can be better carried out with the trade effect, the authorization of the government and economic encouragement.

Recently, there are many papers discussing the application of the CGE models used for regional environment policy analysis. The environment CGE models can be classified into several types according to the extent of the application status for the pollution into the model. The first kind of CGE model is almost the same as the standard CGE model. It is the enlargement and application of the standard CGE model. For example, using fixed pollution coefficients per unit of sectoral outputs or intermediate inputs, or exogenously changing prices or taxes concerning environmental regulations without any changes in model structure. Extending the application of a standard CGE model in such ways does not affect the behavioral specifications of the standard CGE model, but does provide a more detailed description of production results from the environmental perspective.

The second kind of CGE model has introduced the feedback from the environment into the economic system. The model built by Jorgenson and Wilcoxen 1990 is the representative of this kind. It has put the pollution control cost into the production function. The further enlargement of this kind of model has taken account the effect of environment quality into the productivity. The model built by Gruver and Zeager 1994 has given us this kind of examples. They have introduced environment indexes and have put the above indexes into production function in order to estimate the impact of the pollution emission to the productivity.

In order to show the pollution emission and its elimination's effect in consumption, the environmental model is put into the utility function. Robinson(1990) has put the net emission of pollution into the Stone-Geary function. Ballard and Medema 1993 has introduced the health damage into the Stone-Geary consumer composition function. Bergman(1993) used the environment quality index and put the effect of the environment quality into the resident's utility function. Piggott Whalley and Wigle(1992) have added the environment revenue from the reduction in the emission of the carbon into the utility function.

Besides the above modification of the consumption function, there are some models that have added the elimination effect of the pollution and technical function. Robinson(1990) used the Cobb-Douglas production function to denote the pollution dispel action. Nestor and Pasurka(1994) have modeled the process of dispelling atmosphere pollution and the dispel rate depend on an enlarged input-output table. In their research, Robinson Subramanian and Geoghegan 1993 have concentrated on the pollution production process and dispel techniques. They proposed that companies would adopt certain pollution dispel techniques only if the marginal cost of the dispelling of the pollution does not exceed that of the charge of the pollution emission.

In order to simulate the effect of valuing atmosphere pollution to the public healthy, Espinosa and Smith(1994) have introduced the non-market environment value when explaining the consumer behavior. They have investigated in the environment effect of the production activity in the different districts. Having realized the fact that there is no significant impact on the property right in the developing countries for the degeneration of the environment, Devarajan(1993) have proposed an applicable approach of combining the usage of property right into the CGE model of developing countries. Persson 1994 has formulized the property right when well defined or not.

With regards to the uncertainty of the parameter in the CGE model, Abler Shortle 1999 have investigated on the uncertainty of the parameters in the CGE model. The model includes 8 environment indexes: deforestation, pesticide, over-fishing, emission of the dangers, minerals, organic minerals and greenhouse gas, and atmosphere pollution. The parameters are treated as the random variables, and the research result has showed that there is robust between the impact of the environment policy and different parameters levels.

Many CGE models have been applied to the greenhouse air emission. Burniaux(1992) has developed the GREEN model including 12 districts and 11 production departments and this model is a recursive general equilibrium model. The policy parameters include: energy tax, carbon emission tax, right of emission trade. The simulation results show that the distortion of the energy prices is the main reason for the expand of the carbon emission. The correction of the contort will reduce the emission to great extent. The use of the carbon emission tax requires the gradual increase in the tax rate. Recently, the GREEN model has been updated into the LINDAGE model. The research done by Philip Bagnoli(1996) from BROOKING graduate school has developed the G-CUBED model which is a modification of the traditional CGE model. It is a multi-sector and multi-region development model. The special characteristic of the model is the way it estimates GDP and other endogenous variable. It solved the problem from the perspective of future population growth and changes of the industry technical level. Besides, in the problem of the reduction of the emission, the model has quantified the emission of carbon. This model is not a traditional CGE model used for analysis of gas emission and energy. It adds reduction of the energy and carbon into the construction of macro economic growth model and it is useful for us to investigate the estimate of the changes of the economic structure to the future economy. Montgomery(1999) has established the 9 industry sectors MS-MRT model which in nature is a new traditional general equilibrium model. The base year for the model is 1995. It draws analysis and estimate from the *Kyoto Protocol* in 1997 on the world economy. Though somewhat objective, it represents the perspective from the developed countries. K.FarmerK.W.Steirmger 1999 has established the dynamic multi-national CGE model in order to estimate the reduction in carbon emission to the domestic welfare. This model has combined CGE model and recursive multi colony model and its characteristics are to divide the time when the residents entry into the system into two parts and divide those two parts by age. Then it quantifies the residents' welfare with technical process. They believe that reduction of the financial liability can be achieved through emission permission tax though the welfare of the old and young generation would be suffered from the above policy. If the circulation policy of the tax is used, the target for the policy would be achieved by bringing little loss to all kinds of the welfare to all kinds of interest group. Other models include the CGE model discussing the China's economy growth and carbon emission by Mun S.Ho Jorgenson and Perkins in 1995, the numerical general equilibrium model built by Parry and Williams in 1999.

Dr. Xie Jian has built the first environment CGE model about China with 7 production sectors and 3 pollution dispel sectors in 1996. This model is within the frame of the general CGE model and adds the relationship of the environment pollution and production activity, the pollution control activity and changes of the environment policy (such as pollution dispel fee, the subsidy of pollution control and environment investment) into the model. Based on the 1990 input-output table, Xie Jian has established a social accounting matrix with environment account to act as the database for the model. The model can weight the reality effect of the pollution control policy and its impact on the economy growth, occupation, revenue and investment. Compared with other environment CGE models, its distinctive feature is that it defines the pollution dispel activity, the cost of the pollution related to the production department and the optimized output concerning the pollution control cost. Xie Jian has used the model to simulate the four environment policy:(1) raise the tax rate on the slop emission, (2) give subsidy to the slop processing department, (3) impose tax on the garbage and slop from the resident, (4) increase the government purchase on the slope process services. And he has also evaluated the impact of 80% of waste water to be processed in the industrial sectors to the economy.

DRC have developed a recursive dynamic CGE model in order to investigate the changes of the industry structure, the impact on environment, the effect of pollution control on the economic growth and the effect of the liberalization of trade on the environment. The model includes 24 production sectors, town and rural resident sectors, five primary production element: rural land, capital, rural labor, production labor, professional labor. The behavior of the model can be depicted with the CES production function. The advantage of this kind of production structure is that the pollution emission is linked with the intermediate consumption but not the final output. If emission tax is imposed, the department can select the more advanced techniques by choosing the approach that would pollute less according to the intermediate input and the extent of substitution among the production factors. If the Leontief approach has been applied into the model, the only way to reduce the emission is to reduce output. Another special character of this model is that it supposes there is a deflection of the progress of the productivity to the different sectors. The simulation shows that the restriction on the pollution will bring to great structure adjustment and the application of the emission tax as the method to reduce pollution would need high supervision cost.

Though many CGE models have been applied into the environment policy analysis, its application is in the initial phrase. The reasons for this are: (1) it is not perfect and its description of the interaction function is very simply. In most of models, the descriptions of the models have been simplified by hypothesis or would be determined by the external variable. This has brought some damage to the environment CGE models. (2) The model lacks the proper environment data. Besides, most environmental CGE models were designed to the developed countries can not be applied easily to the developing countries.

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