Regional and National Perspectives of China's Integration into the WTO: A Computable General Equilibrium Inquiry

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China's integration to the World Trade Organization (WTO) is already on its fast track. Understanding the complexity of China's dynamic adjustment resulting from its membership in the WTO and the differential regional impacts within China is very important and poses crucial challenge in evaluating its impacts. In this study, we make an attempt to incorporate seven regional commodity-detailed models into a highly dis-aggregated China Computable General Equilibrium (CGE) framework. This framework has allowed us to evaluate the impacts of China's integration into WTO at both national and regional levels and analyze the inter-linkages between China's provincial agricultural markets. Using the framework and assumptions about factor mobility, we assess the impacts on China's agricultural and non-agricultural sectors (regionally and nationally) by reduction of its trade policy distortions, such as tariffs rate changes and quantitative restrictions. We also evaluate the structural changes on China's national and regional production and trade as China implements its commitments and moves into WTO.

Key words: China, WTO, regional CGE, trade reforms, TRQs.

1. Introduction

After 15 years of continuous efforts, China was finally admitted to the World Trade Organization (WTO) in December 2001. During this period, China has witnessed considerable progress in economic liberalization and reforms even without being a WTO member. This process is in harmony with the general trend of globalization elsewhere, which, through the flows of trade, financial capital movement, technology and information transfer across national boundaries, has led to and continues to lead to restructuring of the world economy.

As a result of the economic reform and opening-up since 1979, China has achieved a remarkable rate of economic growth. The nation's GDP has grown at nine to ten percent per annum, outperforming most of developing countries in the world. The reform was initiated in the agriculture sector, and has led to a rapid transformation in rural China. Grain output increased from 305 million tons in 1978 to 508 million tons in 1999, with an annual growth rate of 2.5 percent per annum. Such growth is much faster than China's population growth rate of one percent per annum. The value added of agriculture rose at an even higher annual rate of 4.8 percent, due to increased diversification of agricultural production. Rapid growth in agriculture has led to an even more impressive reduction in rural poverty (Zhang and Fan, 2001).

Many studies based on data in the past several decades have shown a strong positive relationship between openness in trade and economic growth and this relationship is particularly strong for low-income countries (Easterly and Levine, 2000; Waziarg, 2001). Thus, we can expect that China's accession to the WTO will accelerate its economic growth as the country will become more integrated into the world economy and have more opportunity to take advantage of globalization.

However, the gains from past reforms are not equally distributed among China's regions. Less-developed areas, such as the Northwest and Southwest, have seen less progress and regional inequality has become increasingly large over the last two decades (Kanbur and Zhang, 1999). With China's entry into the WTO, the economic prospects of these less developed regions are questionable, especially in the short-run, as the regions' economies are still predominantly agricultural with poor access to capital and markets. With inadequate infrastructure and shortage in human capital, it will be hard for farmers in these regions to switch and adopt new production activities of high value-added crops or to engage into non-farm activities. This, in turn, could hold back China's economic progress and perhaps increase the concentration of rural poor in these regions.

The objective of this study is to quantify the effect of WTO accession on China's economy both at the national and regional levels. The analytical framework to be used in the study is a multi-sector, multi-region CGE model. Previous CGE studies on China's WTO accession have mainly focused on the possible impacts at the national level (DRC, 1998; USITC, 1999; Wang, 1999; Martin et al., 1999; Walmsley et al., 2000; Lejour, 2000; Fan and Zheng, 2000.)[1] Almost all these studies were conducted before China's accession into the WTO, when information on China's WTO commitments was not available to the public. Thus, most of these studies were not able to accurately assess the impacts of China's WTO accession using China's commitment schedule. Most of these studies only considered the reductions in tariffs (or tariff equivalents), while quantitative trade barriers such as tariff-quotas were ignored. It is well known that quantitative barriers, instead of tariffs, mainly restrict China's imports of grain, vegetable oils, and cotton. One of the most important commitments that China made to the WTO is the implementation of a tariff-rate-quota (TRQ) system for these commodities. Accounting for TRQ barriers is crucial for estimating the impact of WTO accession on China's grain imports.

Most previous studies, only evaluate China's agricultural trade protection policy effects at the national level and may overestimate the impact of China's accession to the WTO. This might be the case, as under WTO accession, these studies show that China's production would shift away from protected grain crops to more profitable high-value crops such as vegetables. Although China is a large country, the switch into more profitable crops might be limited by land quality, climate conditions, and capital availability in the various regions. Moreover, under existing gaps among the regions in

[1] For a comprehensive survey of CGE assessments of trade liberalization in China, see Gilbert and Wahl (2000).

economic development and openness, a positive impact at the national level does not imply that all regions in China would benefit equally; in fact some regions may be hurt..

This paper tries to fill in gaps in analysis on China's WTO accession. Specifically, we conduct our CGE model simulation based on China's announced WTO commitments, and we incorporate into the model the quantitative constraints of TRQs for major agricultural commodity imports in a manner consistent with the theory. Furthermore, the national data are disaggregated to the regional level. This allows greater realism in evaluating the impact on China's crop production. The paper is organized as follows. We first describe differences in economic development and openness across regions within China. Then we employ a CGE model with disaggregated regional production to simulate the effects of the WTO accession on the agricultural and rural economy at the national and regional levels. Policy implications from the study conclude the paper.

2. Regional disparities in the rural economy

We divide China into seven regions based on geographic location, agricultural production structure, and the level of economic development at the provincial level. The classification of the regions is listed in Table 1. Differences in economic development among the seven regions can be gauged by the per capita GDP and the agricultural share in regional GDP, as well as per capita income in the rural areas (Table 2). Measured by both per capita GDP and rural income, the Northwest and Southwest are the two least-developed regions in China with poor factor endowments. In 2000, per capita GDP in the Southwest and Northwest was around 5,000 yuan, about half the income level in the East and South (table 2). The rural income gap between these two regions and the other five is particularly large. Per capita rural income in the Northwest and Southwest was 1,518 and 1,662 yuan, respectively, only 40 percent of the income level in the East. Shares of agricultural GDP in total GDP for these two regions (20 and 23 percent) are much higher than those in the other regions (11-15 percent) indicating that farming is still the major source of rural income in these two areas (table 2).

The difference in the share of the rural labor force employed by the rural non-farm sector contributes significantly to the regional gap in rural income (Rozelle, 1994). Many factors, including economic, social, institutional, and other factors have restricted labor mobility in the less-developed regions. Such restrictions have been shown to contribute to widening regional disparities and differential rates of economic development (Kanbur and Zhang, 1999). In 1997, for the nation as a whole, about 29 percent of the rural labor force was engaged in nonagricultural activities, such as rural industry, construction and services, and the non-farm sector provided rural residents more than one-third of income. However, in the Northwest and Southwest, the two least-developed regions, the percentage of the rural labor force employed in non-farm activities is below 20 percent, compared to 40 percent in the more developed areas such as the East.

With an overwhelmingly large share of the rural labor force employed in agricultural activity, labor productivity is low in these less developed regions. In 1997, for example, labor productivity in the Southwest was half of the national average. Poor natural resource endowments and infrastructure limit the potential yield of agricultural land, while the high illiteracy rate and lack of investment and personnel in science and research restrain the adoption of new technology and the improvement of agricultural productivity. Moreover, difficulties in accessing both national and international markets constrain the choice of cropping mix and the development of high value agricultural products in these regions. A study by Fan et al. (2001a) shows that the growth rates of agricultural land and labor productivity in the Northwest and Southwest have been far below the national average in the last two decades. With the rise in the gap of agricultural productivity and rural income between the less developed regions and the rest of the nation, the poverty level has been increasingly concentrated in the less developed regions. It is estimated that more than 60 percent of the rural poor live in the two least-developed regions (Fan et al. 2001b) even though they account for only 20 percent of national population.

The difference in the degree of openness across regions might contribute to the income gap across regions as well (Kanbur and Zhang, 2001). In 1978, with China's adoption of "opening-to-the-outside-world" policy, the degree of the openness of China's economy, measured both by trade and foreign capital flows, increased dramatically. For example, the trade to GDP ratio quadrupled, from 8.5 percent in 1978 to 36.5 percent in 1999 (Wei and Wu, 2001). However, due to the difference in geographical and social economic conditions, the degree of openness varies sharply among the provinces and regions. In Table 3, we use the trade to GDP ratio and per capita foreign direct investment figures to measure the gap in openness across provinces and regions in China. As Table 3 shows, the three-year (1997-99) average of the trade to GDP ratio was 97 percent for the South and 40 percent for the East. However, it was as low as 7-9 percent in the Southwest, Central and Northwest. Similarly, the per capita foreign investment (in 1999) in the South and East was 1,860 and 1,452 U.S. dollars, but was only 90 and 121 U.S. dollars for the Northwest and Southwest, respectively.

3. The data and model

The data

For purposes of our analysis, we developed a China regional CGE model based on various sources of data. The 1997 national level social accounting matrix (SAM) for China is used as the base. However, the original 1997 SAM includes only two aggregate primary agricultural sectors: crops and livestock. Since the focus of our study is agriculture, we need more disaggregated agricultural sectors. For such disaggregation we follow the GTAP (Global Trade Analysis Project, 2001) version 5 database. Using the production data from *China's statistic year books* and the input-output relationship provided by the GTAP database, the aggregated crop sector is disaggregated into nine sectors: wheat, rice, corn, vegetables, fruits, soybeans, other oilseeds, cotton, and other crops (see sectoral details in Appendix).

An ideal or standard multi-regional CGE model would have production and consumption activities disaggregated at the regional level, including details in inter-regional activities, such as commodity and factor flows across regions. To develop such a multi-region model, it requires data equivalent to a social accounting matrix at the regional level. Unfortunately, such data, especially the regional input-output relationship and inter-regional commodity and factor flows, are not available for China. Given the focus of the study is agriculture, we tried to disaggregate agricultural production data into the seven regions according to *China's Statistical Yearbook* and *China's Agricultural*

Yearbook. While almost all crops (i.e., 9 aggregate crop groups included in the national SAM) are produced in each region, the production system, i.e., either the level of productivity, factor endowments, or the combination of land, labor, and capital, are quite different across regions. For example, land is quite abundant in the Northeast, while agricultural production is relatively labor-intensive in the East. It would be inaccurate to use the national level input-output technical coefficients provided by the national SAM for all seven regions. Lacking regional input-output matrices for agriculture, we use the maximum entropy approach, as employed by Zhang and Fan (2001), to estimate region-specific input-output technical coefficients. The entropy approach gives us both production elasticities for inputs by crop and shares of each crop in total input use by region. We then use three-year average estimated shares for the inputs and output data by region to disaggregate inputs of land, labor, capital, and intermediates included in the national SAM to the regional level.

While the input-output coefficients of crop production (sectors 1-10, appendix 1) is disaggregated to the regional level, other agricultural production (sectors 11-16, appendix 1), all nonagricultural production (13 sectors, appendix 1), and other economic activities such as trade and consumption are kept at the national level due to lack of data. This is a shortcoming, as the model simulations cannot capture the resource adjustments between crop and non-crop production within a region or across seven regions. Moreover, the model only includes two aggregate household groups – rural and urban – at the national level and the feedback effect from consumers to the regional production activities is hardly captured. In order to partially amend these deficiencies, we have modified the model's structure as discussed in the following sub-section.

The model

Similar to most CGE models that are neo-classical in their structure, the China-regional CGE model assumes that the representative producer for each production sector (in the case of crop production for each sector within each region) chooses levels of inputs and outputs in order to maximize profits and consumers (aggregated into rural and urban at the national level) maximize their utility by making consumption decisions subject to their income constraint. Labor and capital are categorized as rural and urban, the land is only employed in crop production, and returns to land compensate the rural household.

To take into account the rapid growth in rural non-farm activities, rural labor and capital are assumed to be utilized in both agriculture and non-agricultural production, while urban labor and capital are employed in non-agriculture sectors only. The shares of non-agricultural labor and capital in total rural labor and capital supplies are calculated according to the share of the gross value of rural industrial product in the gross value of national industrial product. As rural industries are more labor intensive, we allow the share of rural labor to be high in the labor-intensive sectors, such as the textile, apparel, transportation, sales, and construction sectors, while the share of urban labor is high in the capital-intensive sectors such as the other industry, urban electricity supply and other utility services, financial services, and social services.

In order to amend the deficiencies caused by the lack of data on the non-crop, non-agricultural production, and factor allocation at regional level, the model specification allows factor mobility between crop production within regions and labor migration from regional crop production to non-crop and non-agricultural activities at national level. In the simulations, we allow regions' labor forces to migrate from crop production into a pool of labor force employed by all other production activities at the national level, if the returns to labor in crop production at the regional level declines relatively to the returns to non-crop and non-agricultural production at the national level. The degree of factor mobility is determined in the model by the different employment opportunities for rural labor across sectors and the elasticity of the substitution between rural and urban labor. Even though rural labor and capital can be employed by non-agricultural sector, rural labor and urban labor are not perfectly substitutable in the model. Moreover, migrant rural labor cannot be employed by urban industries, such as urban electricity supply and other utility services, finance services, and social services, but can be absorbed by textile, construction, transportation, and sales industries, in which production is quite labor-intensive and requires low labor skills.

All agents, producers and consumers, respond to prices. For example, when the relative prices change due to removal or reduction of import tariffs, producers adjust their production level while consumers adjust their demand for commodities. In the international market, the country is assumed to be "small" in the sense that it takes world prices as given. Following a commonly used assumption in CGE models, there exists imperfect substitution between foreign goods and domestically produced goods, and hence, the domestic price for a commodity, e.g., wheat, is not necessarily equal to (even though highly affected by) the world price. Detailed discussion of the "standard" structure of the CGE model can be found in Löfgren et al. (2001).

With regional disaggregation for crop production, we further allow commodities produced by each region be differentiated. That is, the same commodity, such as rice, produced in different regions is not perfectly substitutable. As most commodity groups are quite aggregate, many crops and different varieties of the same group constitute a commodity group. Considering the market size of China, the difference in the distance between producers and consumers, and the discrepancies in transportation and other transaction costs, this seems a reasonable and necessary assumption.

We further distinguish the model's seven regions as import-substitutable and export-substitutable according to different crops. The specification of a region as an import-substitutable or an export-substitutable is based on each region's trade-GDP share (table 3), the income level, and the crop mix. With this distinction, the reduction of trade barriers will cause different effects on the relative prices for commodities across regions. As imported commodities mainly compete with domestic production in the import-substitutable regions, the production effects due to trade liberalization would relatively large in these regions. On the other hand, trade liberalization may stimulate exports from some sectors, such as vegetables and fruits, in which the trade barriers are relatively low. However, such export opportunities cannot be equally realized among regions. Export opportunities will be mainly captured by regions with advantages in information, transportation, technology, and, hence, relatively easy access to foreign markets. We define such regions as export-substitutable and distinguish them from the other regions.

We report the results of comparative static experiments in which we simulate the reduction of tariff rates and the increase of TRQ levels according to China's commitment for 2002-04. The model is static, and hence we do not explicitly consider other adjustments, such as an increase in total labor supply, capital investment, technology transfer, productivity shifts, etc., all of which might occur due to China's WTO accession. Because TRQ is a quantitative constraint for potential imports, with growth in China's GDP, increase in demand for commodities may cause a TRQ to become binding. In order to capture such a possibility, we allow the country's total factor productivity to exogenously grow such that China's GDP rises by 7 percent annually in 2002-04 period. This growth rate is quite close to the China's reported growth rate in GDP for the last ten years as well as its predicted growth rate in the next few years. However, with its static features, the model does not capture many dynamic adjustments, such as the linkage between trade openness and economic growth, which are statistically proven to be strong and important factors in explaining China's economic growth and rural development.

The China regional CGE model is used to evaluate both the national and regional effects of China's WTO accession. Details about the terms of China's commitments for 2002-04 are from the WTO website, and are used as the policy base for the study (see tables 4-5). However, with the exception of TRQs for specific agricultural commodities, the model ignores many other non-tariff barriers to agricultural trade, including import licenses and the use of state trading companies. Given the agricultural focus of the study and the difficulty in obtaining non-tariff barriers data for non-agricultural sectors, the model does not account for any non-tariff barriers in the non-agricultural sectors, such as in the automobile industry and services, which are crucial components of China's commitments and would also generate a large effect on the Chinese economy. Also, the study does not take into account the potential conflicts between China's domestic policies and institutional arrangements and WTO requirements. While the harmonization between China's domestic policies and institutions with China's commitments to WTO is a necessary condition to make the following effects happen (Colby et al., 2001), we have to ignore such important linkages in the current study due to the difficulties in quantifying the effects of these domestic policies and institutions.

4. Aggregate effect of China's WTO accession

4.1 Modest welfare gains

At the national level, we focus on evaluating the effect of China's WTO accession on some macroeconomic indicators. We first simulate the "base-run" for 2002-04. In the base-run we exogenously increase the total factor productivity (TFP) to a level such that the growth rate in GDP is around six to seven percent. The trade policy, however, is status quo, i.e., the China's WTO commitments are not included in the base-run. In the second group of simulations, China's WTO commitments are implemented according to the time schedule for 2002-04, with the same TFP growth rate included in the base-run. As expected, China's WTO accession, by reducing import tariffs and quota constraints, would benefit its economy at the national (aggregate) level. However, the welfare gains are modest. We use changes in real GDP, total consumption in quantity (weighted by the expenditure share for each sector's commodity), and real income by rural and urban households to evaluate the welfare effect at national level. As exogenous growth in TFP is included in the base-run, gains in welfare originate only from a more efficient allocation of factor endowments. Trade liberalization due to China's WTO commitments would raise GDP by 0.2 – 0.7 percent in 2002-04. While total consumption increases, rural consumption would increase less than urban consumption. The domestic price level, measured by the consumer price index, would fall slightly in 2002 due to the inflow of cheap foreign goods, but would stay unchanged thereafter. For the same reason, the real exchange rate depreciates, implying improvement in the terms of trade, which benefits China's exports. While the real income for the rural household group rises, income from agriculture falls in 2002 (table 6). Moreover, increases in the rural income are much smaller than the increases in urban income in the first year. These results indicate that the income gap between rural and urban areas may be further widened after China's joining the WTO.

While the welfare results are comparable with those from other studies [e.g., China's GDP rises by one percent in USITC (1999) and 1.4 – 2 percent in Lejour (2000)], our results are relatively modest. Besides excluding the growth effects associated with trade openness and spillover effects due to trade liberalization, another important reason is that the model's incorporation of seven regions reduces factor mobility across sectors at the national level while facilitating more realistic factor re-allocation.

Other studies have shown, as expected, world prices, especially prices for wheat, corn, soybeans, and some other agricultural products, will be affected (rise) as China increases its grain imports, since China is a large player in the world market for these commodities. In order to capture the effect of China's WTO accession on the world's economy, a global CGE models with endogenously determined world prices is an ideal choice. Indeed, many studies on this issue, such as those we have referred above, have been using global CGE model for analyzing China's accession to the WTO. However, as one of the focus in our study is the regional impacts within China and a sensible allocation of its resources, it is very hard to handle regional disaggregation within China in a global world CGE model framework. A comprehensive trade liberalization after China joining WTO would affect world prices in a wide range of agricultural and non-agricultural products, but many of such price effects would be cancelled out and the relative level of agricultural prices may not rise as much as would be predicted by commodity or sector analysis. In fact the domestic price level only slightly falls in the first year in our WTO scenarios (table 6), so the magnitude of possible bias in the model results due to the small country assumption might be minimal.

4.2 Grain TRQs would not fill

Given the focus of the study is agriculture and grain imports mainly bear quantitative restrictions under a tariff-rate-quota system, we further look at the possible impact of increasing the level of TRQs, and reducing in-quota and above-quota tariffs on grain imports. Given data availability, we only incorporate TRQs for six agricultural commodities: wheat, rice, corn, cotton, soybean oils, and grain mill products, including mainly milled rice and wheat flour.

In general, a TRQ is a quota for a volume of imports at a particular tariff-rate. If a volume of imports is below the level of the quota, an in-quota (lower) tariff is applied. Once the quota is filled an above-quota (higher) tariff is applied on additional imports. (Skully, 2001). Before China's accession to the WTO, its tariff-rate quota system had not actually been implemented. Even though it is well known that grain and some other agricultural imports have been quantitatively controlled for many years in China, China has never officially provided any information about quota levels on its agricultural imports before the year 2001. The TRQ levels for the first year (2001) in China's WTO commitments were set according to the average level of China's imports in the last ten years. Due to the two-year surge in grain imports in 1994/95, imports in the years after 1994/95, especially in the most recent five years, were far below the quota levels for most TRQ commodities. While the applied tariff rate for the in-quota imports is extremely low (e.g., one percent for grain imports), the domestic prices for these commodities are actually higher than the prices for similar commodities on world markets. This implies that there exists, implicitly, a shadow quota rent for imports. For this reason, the model is set up so that the nominal protection rate, i.e., the gap between domestic prices and prices for similar goods in the international markets, is treated as an implicit tariff in the base year. The nominal protection rate is then updated to 1999's level in the model (table 4, first column). In the simulations, the nominal protection rates (the initial tariff rates) are first reduced to the level equivalent to the in-quota tariff. Then, quota levels are further increased and the above-quota tariffs are further reduced according to China's commitments. Replacing the base-year's nominal protection rate by the in-quota tariff rate definitely would raise in-quota imports. However, given the fact that the base-year's nominal protection rate for the commodities subjecting to TRQ is often lower than the above-quota tariff rate, increased volume of imports would be below these quota levels, and the quotas will not be filled in the three years. Over time, the quota may be eventually filled. However, if the level of the shadow rent for imports is lower than the above-quota tariff rate by then, it is still hard to observe any imports at the high above-the-quota tariff levels.

In the "base-run" simulations, both imports and exports rise with the growth in GDP. With income growth, demand for food and other primary agricultural products may not rise at the same speed as growth in income. In the model the crop production (except for vegetables and fruits) either declines or increases less than the increase in livestock, processed food, and non-agricultural sectors (table 7). Decline in production implies that the demand growth (though slower than the income growth) has to be met by imports. Thus, agricultural imports rise rapidly.

We focus our discussion on the four crops that are subject to quotas, and soybeans. In the base-run rice, corn, and soybean production falls (the soybean production declines the most) and wheat production rises slightly (table 7). This results in a rapid growth in imports of these commodities. The annual growth rates are 12 to 15 percent for rice and wheat imports, 19 to 42 percent for cotton, soybean, and corn imports.

We calculate the ratio of imports in total consumption for the grain products. Except for soybean imports, imports of each individual grain accounted only for a small share of total consumption in the domestic market. Note that imports of wheat, rice, and corn in the base year are extremely low (table 8). In total, imported grains accounted for two percent of domestic consumption in the base year. With economic growth, this ratio rises to 2.7 to 4 percent in 2002-04 period in the base-run scenarios. Even though the annual growth rate of wheat imports is 15 percent, imports still only accounted for less than one percent of total wheat consumption in the domestic market in 2002-04 period (table 9).

Reducing in-quota tariffs and raising the quota levels would further increase grain imports. Corn's imports would triple, and imports of wheat would rise more than 50 percent annually (table 10). On the other hand, since China's domestic price of rice is actually lower than the world price, rice imports actually fall slightly.

Even though China would drastically increase wheat, corn and cotton imports in the model due to the rise in the TRQ level and reduction in tariff rates, the gap between the volume of its imports in the base year and the in-quota level is still very high, implying that the quota level would not be filled and the above-quota imports would not be observed. The model simulation results show that for the five TRQ commodities included in the model, quota levels would be filled by 8 to 60 percent (table 11). As expected, the lowest fill rate is observed for rice imports, about 8 percent annually. The highest rate is for vegetable oil imports, about 59 to 61 percent annually.

Our study's outcomes are relatively modest compared to those of other studies. Regional disaggregation enforces reasonable constraints on the mobility of labor and other factors, and hence agricultural production at the national level is more sensible as it is based on feasible allocation of factors. Except for corn and soybeans, in which output declines by 10 to 18 percent as imported foreign goods replace domestic production, other agricultural commodities experience only slight changes in output (table 12).

It has to be pointed out that the model results would be different if there were different estimates of the initial gap between domestic and world prices. If the gap were wider than assumed in our base case, the surge in imports would be relatively large. For this reason, we conduct a sensitivity test in which the nominal protection rate for wheat is 87 percent and that for corn is 94 percent. Under these assumptions, the TRQs for wheat imports would be filled, but the TRQs for corn imports would not be filled in the 2002-04 period. This result implies that the TRQ filling rate depends critically on the gap price between domestic and global markets. If grain and cotton prices continue to decline in the world market, while China's domestic prices do not fall or rise, China's imports of grains and cotton would rise steadily in the future. However, even though wheat imports would rise significantly in the future, given the high above-quota tariff rate, China's grain and cotton imports would not be likely to rise above the quota level in the near future.

Estimated nominal protection rates for China's agricultural trade vary substantially across studies. For example, using recent survey data on the border prices, Huang et al. (2002) found relative low nominal protection rates for many agricultural products: 12 percent for wheat, 32 percent for corn, and 15 percent for soybeans. The information on China's domestic prices used in Huang's study is comparable to that used in our study. However, Huang et al. use their own survey data to estimate an average border price for wheat, which is much lower than the hard wheat gulf price used in our study.

5. Differential effects of China's WTO accession at the regional level

At the regional level, we focus on the possible impact of China's WTO accession on resource allocation and rural income. It is known that non-farm income now accounts for about one-third of rural income in China. However, due to lack of data on rural non-farm sectors, we cannot disaggregate rural non-farm activities from national non-agricultural sectors. Thus, in the model, the effects of China joining theWTO on rural income at the regional level are captured by the net labor migration from agriculture (crop production) within regions to the non-crop and non-agricultural activities at the national level. That is, we only consider the net increase in rural labor income for each region caused by net increase in employment in non-crop or non-agriculture. At the same time, we ignored any change in rural income due to the labor mobility between non-crop and nonagricultural activities. Given the fact that non-farm income accounted for only 10 percent of rural income in the less-developed regions, far below the one-third of national average level, in the simulations we assume that agricultural labor in the Northwest and Southwest cannot freely move into non-agricultural activities. Furthermore, considering natural resource constraints (such as water), difficulty in market access, and lack of export markets, cropping mix is also restricted in these two regions. We assume that agricultural production in these two less-developed regions is only sold on the domestic markets while the other five regions mainly produce exportable commodities. Production of rice, vegetables, and fruits cannot exceed the level observed in the base year's data for the Northwest due to water limitations.

Regional analysis reveals large differential impacts on agricultural production. For example, at the national level, wheat production is expected to rise 0.7 percent, relative to the base-run for 2004 in the WTO simulations. But at the regional level, wheat production would fall in the regions of Central, East, South, and Southwest by 2.4 to 5 percent. In the North, a major wheat producing region, which accounts for almost 60 percent of national wheat output, wheat production would rise at close to the national rate. About ten percent of China's wheat production is produced in the Northwest region. Given cropping limitations, wheat production rises by 3.5 percent in this region. For the Northeast, due to a big drop in soybean and corn production, wheat production would also increase (Table 13).

Given the regional difference in cropping mix, and especially the difference in the share of non-farm income in total rural income, the WTO accession accentuates regional differences in rural income. In the first year in the simulation (2002), there are five regions in which rural income would fall. After the first year's adjustment, rural income recovers and starts to rise in six regions. However, the less-developed Northwest would still suffer, as its total rural income continues to decline. Among the six regions in which total rural income rises in the 2003-04 period, the smallest increase is observed in the Northeast, the major soybean production region in China, and the Southwest, the other less-developed region. For the Northeast, this is mainly due to international competition from soybean and corn imports, while for the Southwest, the limited access to export markets is critical.

In the more advanced regions, such as the East and South, non-farm income accounted for as much as 70–80 percent of total rural income (Fan et al. 2001b), while in the less-developed regions, the share was often less than 20 percent. Table 6 shows that the returns in the nonagricultural activities rise more than those in agriculture, which benefits advanced regions as their non-farm income ratio is high. With more labor moving from agricultural to non-agricultural sectors, the developed regions would further benefit, considering the fact that there are more non-farm employment opportunities in these regions. However, for the less-developed regions, as agriculture still remains the main income source, rural households gain relatively little from engaging in non-farm activities. With the majority of the rural labor force still in agriculture, rural income either declines or stagnates in these regions. Table 15 shows the changes in the rural income by source, which helps to explain model results in table 14.

6. Conclusions

This study constructs a China regional CGE model to analyze both the national and regional impacts of China's WTO accession on agricultural production, factor mobility, trade, and farmers' income. We divide China into seven regions (for agricultural production) and 28 sectors, including 15 disaggregated agricultural sectors for grain, cash crop, livestock, and processed agricultural activities. We utilize the model to simulate China's WTO accession effects through comparison with a base-run, in which a 6 – 7 percent annual GDP growth rate is assumed. In the WTO simulations, we incorporate TRQs as quantitative constraints in agricultural imports. Reductions in both in-quota and above-quota tariffs and increases in TRQ levels are simulated according to China's commitment schedule in the 2002-04 period. Results show that China's WTO accession would generally improve the country's total welfare with modest increases in GDP and household income, but may widen existing gaps among regions and sectors. It is expected that the rural income from agricultural sources may decline. While lifting trade barriers in both agriculture and non-agriculture will benefit farmers at the national level, the increase in rural income is still smaller than the increase in urban income in the first year, which implies that the rural-urban income gap may be further widened. Furthermore, among the regions, the less-developed rural areas will benefit little or even be hurt because their major income sources are still from agriculture, especially from traditional agricultural activities such as grain production.

The WTO simulations are conducted based on the assumption that China will implement its commitments according to schedule. As 2002 is the first year after China's accession, there are many uncertainties in terms of the policy implementation process. Given these uncertainties, the results from the model exercise may be quite different from what actually happens in 2002 and thereafter. With more information available on future implementation, we will continue our efforts to update the model and to incorporate any newly available information. The model results should be read as a general direction to capture the possible impacts of China's WTO accession. Even though the model outcomes of China's WTO accession are relatively modest at the national level, differential regional and sectoral effects remind us of conflicts of interests among different groups within China.

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Table 1. Regions in the study

Region (Number of provinces included)	Province
Northeast (3)	1. Liaoning 2. Jilin 3. Heilongjiang
North (7)	4. Beijing 5. Tianjin 6. Hebei 7. Shanxi 8. Shandong 9. Shaanxi 10. Henan
Northwest (6)	11. Inner Mongolia 12. Gansu 13. Qinghai 14. Ningxia 15. Xinjiang 16. Tibet
Central (4)	17. Anhui 18. Jiangxi 19. Hubei 20. Hunan
East (3)	21. Shanghai 22. Jiangsu 23. Zhejiang
Southwest (4)	24. Sichuan 25. Chongqing 26. Guizhou 27. Yunnan
South (4)	28. Guangdong 29. Guangxi 30. Hainan 31. Fujian

Table 2. Major Economic Indicators in the Seven Regions, 2000

Region	Population (10,000)	Per Capita GDP (Yuan)	AgGDP/GDP (%)	Rural Per Capita Income (Yuan)
Northeast	10,454	9,328	13	2,175
North	35,560	7,747	15	2,592
Northwest	5,409	5,317	20	1,518
Central	16,358	6,092	19	2,200
East	18,942	11,716	11	3,845
Southwest	19,027	4,496	23	1,662
South	15,545	10,280	15	2,733

Source: Fan et al. 2001b

Table 3. Measures of openness by province and region

Province/region	Trade-GDP ratio 3-year (97-99) average (%)	Per capita foreign investment 1999 (US$)
Beijing	68.9	3,129
Tianjin	72.5	3,067
Hebei	8.3	220
Shanxi	12.4	147
Inner Mongolia	7.4	96
Liaoning	31.0	1,033
Jilin	12.8	273
Heilongjiang	10.4	239
Shanghai	74.6	6,156
Jiangsu	30.6	1,011
Zhejiang	29.5	614
Anhui	7.9	145
Fujian	46.8	1,490
Jiangxi	6.3	115
Shandong	23.2	429
Henan	4.4	127
Hubei	7.1	274
Hunan	5.5	110
Guangdong[1]	136.7	2,968
Guangxi	9.5	231
Sichuan[2]	6.9	149
Guizhou	6.6	54
Yunnan	7.7	104
Tibet	12.1	100
Shaanxi	11.7	213
Gansu	5.3	72
Qinghai	6.5	172
Ningxia	11.9	151
Xinjiang	12.3	72
North	22.3	430
Northwest	8.7	92
Northeast	20.5	559
East	40.1	1,452
Central	6.7	163
South	96.6	1,860
Southwest	7.1	121
Nation	33.8	615

1. Including Hainan
2. Including Chongqing

Source: *China Statistical Yearbook*

Table 4. Tariff rates reduction schedule (%)

	Base year	2002	2003	2004
Wheat				
In quota	50.0	1.0	1.0	1.0
Over quota	74.0	71.0	68.0	65.0
Rice				
In quota	1.0	1.0	1.0	1.0
Over quota	74.0	71.0	68.0	65.0
Corn				
In quota	60.0	1.0	1.0	1.0
Over quota	70.0	60.0	50.0	40.0
Vegetables	19.4	18.0	16.5	15.1
Fruits	26.1	24.2	22.2	20.3
Soybeans	39.0	19.0	17.0	15.0
Other oilseeds	21.9	19.0	17.0	15.0
Cotton				
In quota	13.0	1.0	1.0	1.0
Over quota	62.0	54.4	47.2	40.0
Other crops	17.8	15.3	12.7	10.6
Livestock	19.4	18.1	16.8	15.6
Other agriculture	22.1	18.7	16.1	15.6
Meat, eggs and dairy products	26.8	21.6	18.5	15.3
Vegetable oils				
In quota	22.0	9.0	9.0	9.0
Over quota	61.0	48.0	35.0	22.0
Grain mill products	18.0	20.4	17.6	14.4
Other processed food	48.4	42.2	35.6	28.0
Cotton textile	13.0	11.0	8.0	4.1
Other textile	20.7	18.1	15.1	11.4
Apparel	21.7	19.4	13.0	10.9
Leather products	18.5	16.3	11.5	8.4
Fertilizers	12.2	11.0	8.0	4.1
Agricultural machinery	10.2	8.4	5.7	2.4
Other industry	20.4	18.3	9.5	6.4

All tariff rates for the commodities without over quota rates are bound rates.
Sources: Base year's tariff rates for the agricultural commodities with quotas are calculated by authors using the gaps between world prices and China's domestic prices in 1999/2000, with the price data from USDA/ERS database. Tariff rates for the other commodities are from GTAP version 5 database. Tariff reduction schedule is from WTO website.

Table 5. Level of TRQ quota (1000

	Base year imports[*]	2002	2003	2004
Wheat	1916	8468	9052	9636
Rice	261	3990	4655	5320
Corn	287	5850	6525	7200
Cotton	787	819	856	894
Vegetable oils [**]	1650	2518	2818	3118

[*] We choose the year in which imports were the highest during 1996-2001 as the base year. 1997 for wheat, rice, corn, and soybean oil and 1996 for cotton.

[**] Soybean oil only

Sources: Data for base year from USDA/ERS database; TRQ quota level from WTO website

Table 6. Macroeconomic effects in the model

	Base-run: without WTO commitments			*With WTO commitments*					
	2002	**2003**	**2004**	**2002**	**2003**	**2004**	**2002**	**2003**	**2004**
	---------- Annual growth rate -----------------------						**% change from the base-run**		
GDP	6.89	6.80	6.71	7.11	7.44	7.50	0.20	0.60	0.73
Total consumption	6.56	6.45	6.35	7.17	7.17	7.22	0.57	0.68	0.81
Rural consumption	6.96	6.82	6.69	7.10	7.54	7.58	0.14	0.68	0.83
Urban consumption	6.99	6.86	6.77	8.06	7.68	7.73	1.00	0.77	0.90
Consumer price index	1.79	1.80	1.80	1.29	1.87	1.94	-0.49	0.06	0.13
Real exchange rate	-0.81	-0.82	-0.82	0.03	2.72	3.93	0.85	3.57	4.79
Rural income, real[1]	6.16	5.98	5.81	6.46	7.92	8.35	0.28	1.83	2.41
from agriculture	7.09	6.82	6.54	6.06	7.85	8.00	-0.97	0.96	1.37
Urban income, real	5.29	5.15	5.05	6.60	7.06	7.48	1.25	1.81	2.32

[1] Normalized by CPI.

Source: model results.

Table 7. Growth in sectoral production in the model (base-run)

	2002	2003	2004
		Annual growth rate	
Wheat	1.02	0.99	0.98
Rice	-0.16	-0.06	0.03
Corn	0.08	-0.24	-0.61
Vegetables	2.48	2.39	2.30
Fruits	2.28	2.21	2.10
Soybeans	-8.23	-9.56	-10.82
Other oilseeds	-2.17	-2.14	-2.10
Cotton	-0.54	-0.83	-1.11
Other crops	0.95	0.91	0.87
Livestock	3.52	3.45	3.40
Meats and eggs	3.16	3.26	3.37
Grain mills	1.06	1.06	1.08
Vegetable oils	0.29	0.05	-0.10
Other agriculture	3.15	3.14	3.14
Other food products	5.67	5.51	5.38
Fertilizers	2.08	1.98	1.88
Ag machinery	6.90	6.84	6.77
Cotton textile	3.82	3.83	3.86
Other textile	2.13	2.18	2.26
Apparel	4.82	4.85	4.90
Leather	4.33	4.50	4.69
Other industry	6.35	6.27	6.19
Utility	5.63	5.55	5.48
Construction	9.27	9.03	8.81
Transportation	5.11	5.05	5.00
Sales	5.02	4.99	4.97
Finance	5.56	5.46	5.38
Social services	6.49	6.36	6.25

Source: model results.

Table 8. Imports of selected agricultural commodities 1994-2000 (1000 ton)

	Wheat	Rice	Corn	Soybeans
1994	10,256	1,998	4,287	155
1995	12,531	852	1,476	795
1996	2,705	322	75	2,274
1997	1,916	261	287	2,940
1998	829	178	262	3,850
1999	1,010	278	71	10,100
2000	195	267	88	13,245

Source: ERS database.

Table 9. Ratio of imports in total consumption for selected agricultural commodities

	Base-run: without WTO commitments				*With WTO commitments*		
	Base year	**2002**	**2003**	**2004**	**2002**	**2003**	**2004**
Wheat	0.58	0.66	0.75	0.84	1.01	1.15	1.28
Rice	0.15	0.16	0.18	0.21	0.16	0.18	0.20
Corn	2.69	3.87	5.49	7.67	18.45	24.43	30.88
Soybeans	19.77	25.45	31.99	39.15	33.84	42.65	51.11
All grains	2.14	2.67	3.30	4.04	5.45	6.98	8.64
Cotton	10.66	12.45	14.58	17.07	17.46	19.29	21.71
Vegetable oils	14.53	16.88	19.41	22.08	21.69	23.94	26.14

Source: model results.

Table 10. WTO impact on value of imports by commodity

	2002	2003	2004
	Percent change from the base-run		
Wheat	54.37	55.16	53.94
Rice	-2.72	-2.23	-2.81
Corn	406.96	389.33	359.26
Vegetables	2.06	2.41	3.60
Fruits	-6.69	-2.66	-0.58
Soybeans	30.38	33.17	33.22
Cotton	43.81	44.38	41.60
Other crops	1.19	3.61	6.69
Livestock	-2.61	-2.35	-0.72
Meats and eggs	10.51	17.42	26.98
Grain mills	18.41	17.77	16.92
Vegetable oils	30.14	25.51	21.02
Other agriculture	2.43	0.83	3.22
Other food	12.46	25.90	52.91
Fertilizers	0.75	0.29	8.47
Ag machinery	4.17	2.99	11.06
Cotton textile	4.49	7.98	18.90
Other textile	4.39	7.35	16.10
Apparel	2.80	10.08	10.32
Leather	1.60	5.59	9.98
Other industry	2.89	21.69	29.34

Source: model results.

Table 11 Ratio of the import volume in the model to the TRQ level

	With WTO commitments (%)		
	2002	**2003**	**2004**
Wheat	40.26	43.44	46.21
Rice	8.51	8.22	8.50
Corn	36.33	45.34	54.87
Cotton	18.14	20.69	23.09
Vegetable oils	58.78	59.90	61.22

Source: WTO website.

Table 12. WTO impact on production by sector

	2002	2003	2004
	Percent change from the base-run		
Wheat	0.17	0.47	0.67
Rice	1.08	1.79	2.23
Corn	-9.80	-12.01	-14.56
Vegetables	0.18	0.25	0.24
Fruits	1.25	1.29	1.31
Soybeans	-12.99	-15.75	-18.03
Other oilseeds	-2.90	-2.09	-1.12
Cotton	-2.78	3.85	6.12
Other crops	0.78	0.99	0.91
Livestock	1.07	2.01	2.43
Meats and eggs	1.38	3.05	3.69
Grain mills	0.77	1.25	1.55
Vegetable oils	-4.10	-3.27	-2.34
Other agriculture	0.66	1.24	1.43
Other food products	0.80	0.95	0.80
Fertilizers	-0.93	0.36	-0.66
Ag machinery	-0.07	1.07	1.28
Cotton textile	1.76	6.43	7.77
Other textile	3.02	10.14	12.54
Apparel	2.30	7.56	10.86
Leather	3.92	11.31	15.90
Other industry	0.34	-0.15	-0.11
Utility	0.53	1.20	1.57
Construction	0.02	1.07	1.36
Transportation	0.68	2.35	3.04
Sales	0.88	2.49	3.16
Finance	0.62	1.58	2.02
Social services	0.25	1.26	1.59

Source: model results.

Table 13. Change in regional crop production

	North	*Northwest*	*Northeast*	*Central*	*East*	*South*	*Southwest*	*Nation*
2004			Percent change from the base-run					
Wheat	0.72	3.47	12.23	-2.35	-2.98	-4.95	-3.18	0.67
Rice	5.48	17.07	11.57	0.17	-0.70	-0.22	3.63	2.23
Corn	-16.10	-27.61	-7.18	-21.38	-18.00	-21.11	-31.77	-14.56
Vegetables	-0.44	11.79	0.22	-4.56	1.94	-1.57	10.78	0.24
Fruits	2.55	3.48	2.65	-0.93	-0.11	-1.37	-2.20	1.31
Soybeans	-18.48	-27.92	-15.20	-20.73	-21.53	-22.61	-32.83	-18.03
Other oilseeds	1.08	3.71	1.88	-3.22	-1.67	-2.89	-2.04	-1.12
Cotton	6.14	11.19	11.65	2.71	2.97	8.21	8.57	6.12
Other crops	2.39	4.39	3.14	0.32	1.01	0.75	1.54	0.91

Source: model results.

Table 14. Change in rural income by region[1]

	2002	**2003**	**2004**
	Percent change from the base-run		
North	-0.48	1.05	1.42
Northwest	-2.65	-0.48	-0.24
Northeast	-1.41	0.15	0.38
Central	-0.42	1.30	1.70
East	0.51	1.54	2.02
South	0.49	1.58	2.06
Southwest	-1.94	0.31	0.59
Nation	0.28	1.83	2.41

1. Income from livestock production is not included in the regional results, but include in the national results

Source: model results.

Table 15. Change in rural income by source and by region

	2002	2003	2004
Agriculture	Percent change from the base-run		
North	-3.07	-0.74	-0.52
Northwest	-2.65	-0.48	-0.24
Northeast	-3.20	-1.21	-1.11
Central	-2.88	-0.57	-0.30
East	-2.73	-0.20	0.12
South	-2.55	-0.14	0.14
Southwest	-1.94	0.31	0.59
Non-agriculture			
North	3.13	3.63	4.33
Northwest			
Northeast	3.35	3.91	4.64
Central	5.63	6.11	7.09
East	1.56	2.12	2.68
South	1.74	2.32	2.90
Southwest			

Source: model results.

Appendix

1. Sector aggregation of the model

Agricultural and processed food sectors in the model:

1. Wheat
2. Rice
3. Other cereals
4. Vegetables
5. Fruits
6. Soybeans
7. Other oilseeds
8. Cotton
10. Other crops
11. Livestock and products
12. Meat, processing eggs and dairy products
13. Grain mill products
14. Vegetable oil and forage
15. Other agricultural products
16. Other food product

Manufacturing sectors in the model:

17. Fertilizer and pesticides
18. Agricultural machinery
19. Cotton textile
20. Other textile
21. Wearing and apparel
22. Leather product
23. Other industry

Service sectors in the model:

24. Electricity and other utility
25. Construction
26. Transport services
27. Sales services
28. Finance services
29. Social services

China's map with seven regions