Abstract

Under the terms of its accession to the WTO, China will likely commit to significant liberalization of its agricultural trade regime. In this paper we consider how growing levels of urban unemployment, combined with a restrictive labor market policy, may alter the expected welfare effects of agricultural reform. We utilize a new AGE model of the Chinese economy based on the Harris-Todaro framework, incorporating imperfect labor mobility.

Copyright 2000 by Gilbert and Wahl. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.
1. Introduction

In all likelihood the year 2000 will mark China's formal return to the international trading system. In addition to the commitment to trade liberalization that China needs to show to convince the world that it is ready to join the WTO, entry will impose constraints on future Chinese agricultural trade policy. China will be unable to choose the WTO agreements that it wishes to sign; all agreements, including the one on agriculture, will have to be accepted. Furthermore, under the new agreements it will become difficult for China to introduce or raise agricultural protection once tariffs are bound. Extension of the agricultural reform process that began in 1979 to China's agricultural trade regime therefore seems inevitable, as part of the 'price' of membership of the WTO.

While the rest of the world eagerly awaits the further opening of China's agricultural markets, within China the reform process has led to the emergence of a number of important economic policy concerns that are intimately connected to agricultural trade policy developments. One of these is rural-urban income divergence, which remains at levels higher than anywhere else in Asia. Carter (1997) notes the implications for political stability. Another consequence of income divergence and the gradual erosion of mobility restrictions is rural-urban migration (Wu, 1994; Rozelle et al., 1999). Urban populations have been growing faster than rural populations throughout the 1990s.

A closely related issue that has come into increasing prominence in the latter half of the 1990s is the emergence of high (and rapidly growing) levels of urban unemployment. Part of the problem is a consequence of rural labor inflow, but it also reflects the difficulties associated with restructuring China's state-owned enterprises (SOEs). Since 1993 a massive number of Chinese workers have been laid off from restructuring or closing enterprises. The number of xiagang gongren (literally 'off post' workers) reached 11.5 million by the end of 1997 (Gu, 1999). The household registration system (hukou) and other institutional features of the Chinese labor market also limits the mobility of these workers. Dealing with urban unemployment is regarded as one of the most pressing economic policy issues currently facing Beijing.
A question of considerable interest then, is what effect might these developments have on the outcome of trade liberalization? There has been keen interest in quantitative modeling of the likely effect of Chinese trade liberalization, and a number of recent applied general equilibrium studies have thrown light on the possible outcomes. WTO membership is examined in Wang (1997, 1999), Anderson et al (1997a; 1997b) and Yang (1996). China's self-sufficiency objectives are considered in Yang and Huang (1997). Other general reform issues are considered in Feng and Huang (1997). Wang (1998) has considered income distribution issues in an innovative 22 sector model of the Chinese economy. However, with the exception of Xu (1994), which introduced surplus rural labor into a five sector model of China, the existing literature has utilized models of a strongly neoclassical flavor. As the preceding discussion indicates, the reforming Chinese economy exhibits features closely associated with the development literature – rural urban migration, urban unemployment, and imperfect labor mobility. Since these economic features can have important consequences for analyzing the effect of trade reform, it seems appropriate to also consider Chinese agricultural reform in the context of models that incorporate them. That is what this paper attempts to do.

The paper is organized as follows. In Section 2 we briefly discuss the background to this paper. In Section 3 we use a formal general equilibrium model to illustrate some important agricultural trade policy consequences of urban unemployment and imperfect labor mobility. This model also highlights the underlying structure of a larger (45 sector) numerical general equilibrium model that we describe in Section 4. In Section 5 we present the results of simulations designed to quantify the effects of agricultural liberalization in China under the assumption of dual labor markets with imperfect labor mobility, and discussion of policy implications. Accounting for the second-best implications of urban unemployment and limited factor mobility is shown to have substantial effects on the outcomes of agricultural reform. A key result is that limited liberalization should be accompanied by restrictions on labor movement to maximize the net welfare gains, but with more comprehensive agricultural reform, labor movement should be freed. However, even in cases where the optimal policy is unavailable, liberalizing agriculture is shown to always raise net social welfare. Section 6 contains concluding comments.
2. Policy Background

In the early 1950s, China's priority was the development of heavy industry. It supported this objective by means of a "cheap food" policy and urban household subsidies, which were maintained by introducing a household registration system (hukou) that treated urban and rural populations separately, and limited the number of subsidized urban residents (Carter, 1997). Rural workers were unable to change their residences or their occupations. This policy, coupled with forced grain production and government purchases, kept the incomes of rural workers well below their urban counterparts.

In 1979 China began a process of market-oriented reform, the 'open door' policy. While most of China's extraordinary growth over the next two decades (annual growth in real GDP over the period averaged nearly 10 percent) has been in the coastal, urban regions, an important component of the reform process was liberalization of agriculture. The agricultural program was extraordinarily effective in the early period of economic reform. Agricultural output increased rapidly (growing at 7.6 percent between 1978 and 1984) with the dismantling of the commune system, improved production incentives, and the development of food markets. Strong growth in food demand has continued, although output growth has slowed considerably. The reform process has also gradually changed the policy bias against agriculture and the rural labor force (roughly three quarters of the total). Most urban food subsidies were eliminated by the mid 1990s, and it has become permissible since 1986 for rural residents to purchase an urban hukou through 'rural-urban transfer' programs (nongahuanfei), although at a substantial cost. Others obtain temporary residence to engage in contract jobs. However, very substantial income divergence remains (Figure 1). Overall economic growth has been very uneven, and the division between rural and urban economies remains significant (Carter, 1997).

Numerous analysts have noted that China's inability to integrate the poor inland regions with the rapidly growing industrial economy poses the threat of national instability (Carter, 1997; Yang and Huang, 1997). Other researchers have focused on the emergence of rural-urban migration in response to the income differentials (Wu, 1994; Rozelle et al., 1999). Rozelle et al. present discussion and econometric analysis of extensive survey work undertaken in 1995. By their estimates, in 1995 some 54
million workers (12 percent of the labor force) could be classified as migrants (those with wage-earning jobs outside of their village – only returning to the village for major festivals, during the agricultural busy season, or during factory shutdowns). This is a rise of more than 150 percent over 1988. Under a broader definition including commuters and the mobile self-employed, the total number of migrant workers rises to 102 million.

Figure 1: Ratio of Rural to Urban Per Capita Incomes in China

Source: Statistical Yearbook of China (1997)

There is considerable debate over the importance of different factors as determinants of migration responses. The general economic framework postulates that migrants make rational economic choices – considering the real income adjusted for the probability of obtaining employment at the destination, and the costs of migration. Costs may include transportation, job-search (expenses and opportunity cost), lodgings, etc. They may also include less immediately obvious, but nonetheless real, opportunity costs such as giving up locational preferences, and attachments to existing arrangements. These costs may be
offset by chain effects – the availability of information through networks of previous migrants. Rozelle et al. (1999) find evidence supporting positive and highly significant chain effects, while their estimates of the effect of the availability of transportation facilities is negative but insignificant.

In the case of China, government policies also have an important impact on the migration decision. Clearly, there is the impact of the hukou system that restricts access to the urban labor market, and the lack of social services and educational facilities for migrants and their children. Also important are rural institutions that may constrain or increase the cost of migration. Rozelle et al. consider the importance of enduring remnants of the planning era: collectively managed land (and the collateral weak land tenure security), mandatory delivery quotas (particularly in grain markets), and township and village enterprise hiring practices that tie potential migrants to their land. They also note the potential of emerging institutions, such as informal credit markets, to lower the costs of migration. Their estimates of the effect of rural institutions is mixed, with the right to rent land and the availability of informal credit having a positive and marginally significant effect on migration, and other variables being insignificant. However, their rural survey data is not able to capture the effects of urban institutions such as the hukou on the migration decision.

In summary, rural-urban migration in China is significant and growing, but remains constrained by government policy, institutional rigidity at the village and township level, and other costs of migration. Moreover, the Chinese government has treated the migrant labor force with ambiguity. While labor migration may lead to a more efficient allocation of resources in a first-best framework, it may also weaken levels of political control.

In a second-best framework migration may worsen problems of urban congestion and unemployment, significant levels of which have developed in urban China in the latter half of the 1990s. Under the centrally planned economy, the state sector was characterized by a full-employment policy. The legacy of this policy has been to burden the majority of SOEs with a large number of redundant workers. That is to say, until the 1990s, the phenomenon of 'full employment' concealed high levels of hidden unemployment in the state sector (as was true in many other centrally planned economies).
As the state-owned enterprises restructure and close, large numbers of these redundant workers are being laid-off. Massive lay-offs are also occurring in collectively-owned enterprises in China, where many of the government regulations imposed on the SOEs also take effect (Gu, 1999). While official unemployment figures remain relatively low (3.1 percent in 1997), these statistics do not include laid-off workers, since they are not required to register themselves as unemployed. These workers still maintain nominal labor relations with their work units. The figures also do not include migrants from rural areas who are under or unemployed, or subsisting in the informal sector. Gu estimates the actual rate of urban unemployment to be approximately 9.4 percent in 1997 (up from 4.4 percent in 1993).

Gu (1999) also notes a number of interesting features relating to the urban unemployment problem in China. The first is that many enterprises employ a large number of temporary (migrant) workers while simultaneously laying off a large number of formal workers. Second, in many cities the number of immigrant workers in the labor force is much larger than local laid-off workers, indicating that many newly created jobs are captured by the migrant labor force. Third, many laid-off workers exhibit very specific preferences in terms of re-employment. In particular, they prefer to be re-employed in the state sector than in the non-state sector. One explanation is the Chinese social welfare system. Because this has been limited to the state sector, the mobility of laid-off workers to the non-state sector has been hindered, as has the mobility of rural workers wanting to enter the urban workforce.

So, we have a number of very important economic developments in China: high and increasing urban unemployment; development of urban labor markets with new hires being largely on a temporary basis and drawn from the migrant workforce; a household registration system that is beginning to loosen its tight grip on movement between rural and urban sectors; and increasing flows of migrants from rural to urban areas in search of better income opportunities. Into this heady mix of domestic economic transformations comes China’s bid to join the World Trade Organization (WTO), which will clearly entail further reform of its external (trade) policy.

China withdrew from the GATT in 1950, and has applied to rejoin the organization and its successor since 1986. As part of its bid to re-enter the trading system, China has already made a number of concessions. In 1993 it reduced its tariffs on 3371 import items and abolished import controls on more
than 367 commodities. In 1996, it lowered its nominal tariff by approximately one third. In late 1999, the United States reached an agreement with China to support WTO membership (although the fate of permanent extension of normal trading relationships has yet to be resolved by Congress). A similar agreement has been reached with the European Union. So, barring any cataclysmic political developments (such as war with Taiwan), China will likely accede to the WTO some time this year. Agricultural trade liberalization will form a part of the accession agreement, and has already been included on the agenda for the new round of WTO negotiations in which China will for the first time be an active participant. The remainder of the paper explores the consequences of agricultural trade reform given the domestic problems of urban unemployment and rural-urban migration.

3. Theoretical Framework

In order to help reinforce the structure of the numerical model we describe in Section 4, we present a formal derivation of some key results concerning agricultural liberalization in a model with rural-urban migration, and how these may be altered by imperfect labor mobility. Consider a developing economy with distinct rural and urban regions. An industrial good $X$ is produced in the urban region, and exported. An agricultural good $Y$ is produced in the rural region and imported. Full employment of labor prevails in the rural region, but a rigid wage in the urban region creates unemployment. Following Harris-Todaro (HT), migration occurs between the two regions until the expected urban wage is equal to the actual rural wage. Capital is fully mobile. To keep things simple, prices and factor endowments are exogenous. A compact algebraic description of the model is then:

\begin{align*}
    c_x (\bar{w}, r) &= 1 \\
    c_r (w, r) &= p_r \\
    w &= \pi \bar{w} \\
    a_X X + \pi a_Y Y &= \pi \bar{L} \\
    a_X X + a_Y Y &= \bar{K}
\end{align*}
Equations (1) and (2) are zero profit conditions (we have chosen $p_x$ as numéraire), which can be solved for the factor prices. Once these are known, Shepherd's lemma enables us to derive the optimal input-output coefficients $(a_{ij})$. Equation (3), the HT labor market equilibrium condition, can then be solved for the equilibrium rate of employment $\pi$. Equations (4) and (5) are the factor market constraints, which can then be solved for output levels. Finally, (6) is the budget constraint expressed in terms of the GNP and expenditure functions, which can be solved for the welfare level. All the usual assumptions apply, production functions are homogeneous of degree one, continuous, and strictly concave, the utility function is continuous, quasi-concave and increasing in consumption of both goods. To guarantee stability, assume that $X$ is capital intensive (the Neary condition). Now, totally differentiating the budget constraint yields:

$$dW = (p_y - p^*_y) dM_y + \bar{w} dL_x + \pi \bar{w} dL_y$$

(7)

where $dW \equiv E_u du$, and a superscript * designates a world price. Following Corden and Findlay (1975), define the total urban labor force as $L_U$, then $dL_x = \pi dL_U + L_U d\pi$. Substituting into (7) we have:

$$dW = (p_y - p^*_y) dM_y + \bar{w} L_U d\pi$$

(8)

where we have simplified by making use of the fact that $dL_U + dL_y = 0$. Thus the incremental change in welfare is the sum of a Harberger effect, and the effect of changes in the probability of employment. As is well-known, free trade is sub-optimal, since $dW \neq 0$ when $p_y = p^*_y$ (only the first term drops out).

Let $t$ be an tariff imposed on $Y$, so that $p^*_y (1 + t) = p_y$. Using this, and dividing both sides of (8) by $dt$ we have:

$$dW/dt = tp_y (dM_y/dt) + \bar{w} L_U (d\pi/dp_y)(dp_y/dt)$$

(9)
Which is the basic decomposition of the welfare effect of an agricultural import tariff. The first term
reflects the deadweight loss, and is negative. However, \( dp_r/dt = p_r^* > 0 \), and hence a sufficiently small
tariff will raise social welfare if it raises the probability of employment.

Factor prices are determined entirely by goods prices by construction, and so from
logarithmically differentiating (1) and (2) and solving we obtain:

\[
\dot{w} = \hat{p}_r / \theta_{Lr} \tag{10}
\]

where a circumflex denotes a proportional change, \( \theta_{Lr} \) is the cost share of labor in agriculture and
\( \hat{p}_r = (p_r^*/p_r)dt > 0 \). It is clear from (1) that the return to capital is fixed. Now from (3) we know that
\( \pi = \dot{w} - \hat{w} \), hence the probability of finding urban employment improves with a small tariff on \( Y \).
Reversing the arguments: liberalizing agricultural trade may lower welfare.

The preceding analysis has cast the neoclassical HT model of the developing economy in a
slightly different light – the model is generally used to illustrate the negative welfare consequences of
restricting imports of capital-intensive goods. Less often emphasized is the positive welfare effect of
agricultural export subsidies, and, for food import-dependent developing economies, the clearly implied
(second-best) role for agricultural protection.

However, as discussed above, one of the key features of the Chinese economy has been
restrictions on the mobility of labor. While changes are occurring, it seems unreasonable to assume
perfect mobility. Two recent papers have attempted to incorporate imperfect labor mobility into the HT
framework (Parai and Beladi, 1997; Gilbert and Mikic, 1998). The latter introduces the concept of the
'elasticity of labor migration'. Consider a situation where there is a differential between the rural wage
and the expected urban wage, \( \rho \), and hence (3) becomes \( w = \rho + \pi \hat{w} \). The variable \( \rho \) may represent
locational preferences, attachments to existing arrangements, a high cost of relocation, and/or the effect of
a restrictive government policy, as discussed in Section 2. The elasticity of labor migration can then be
defined in a natural way as \( \varepsilon = \hat{L}_r / \hat{\rho} \), the proportional change in the total urban population induced per
proportional change in the expected wage differential \( (0 < \varepsilon < \infty) \). All other equations remain
unchanged, as does the fundamental welfare derivation for a tariff on $Y$ given above (9). However, the proportional change in the probability of employment is now:

$$
\pi = \frac{\epsilon w \hat{\nu} - \rho (\hat{a}_x + \hat{X})}{\epsilon \pi \hat{\nu} - \rho}
$$

which is of ambiguous sign in general.

A full analytical description of the properties of this model, while interesting, is beyond the scope of this paper. However, note that \(\lim_{\epsilon \to 0} \pi = \hat{a}_x + \hat{X}\), which in the case of a tariff on $Y$ discussed above will be negative. Hence, the less labor movement is allowed, the greater the potential for gains from agricultural liberalization. Note also that \(\lim_{\epsilon \to \infty} \pi = \hat{\nu}\), and so this model converges to the standard HT case. It is also clear that there will be a critical value of $\epsilon$ (such that $\pi = 0$) beyond which the model will behave in the same manner (qualitatively) as the standard HT model.

The intuition behind the result is quite straightforward. An agricultural tariff in the standard HT model draws labor and capital out of the urban region, but because agriculture is labor intensive, more labor is drawn than capital. The end result is an improvement in urban employment. Now consider the limiting case of no labor migration. The rural wage rises as before and agricultural output expands. Now, however, labor cannot move to fill the needs of agriculture. A reduction in production of $X$ then leads to higher urban unemployment. Welfare subsequently declines. Hence, the level of labor mobility, in addition to the prevalence of urban unemployment, becomes important variables when evaluating the consequences of agricultural trade liberalization in a developing economy.

4. An Applied General Equilibrium Model

The simplified framework described above, while helpful in formalizing the issues involved, makes a number of major abstractions in the interests of tractability. The most obvious is the dimensions of the model, but we should also consider market power (China is unlikely to be a price-taker in
international markets), and the effect of other policy distortions in the equilibrium system, which can have important second best implications. While it is difficult if not impossible to take all of these factors into account within the constraints of an abstract formal model, applied general equilibrium (also known as computable general equilibrium or CGE) models are well-suited to the task. These models take data from an actual economy or set of economies, and combine it with a structural description of the behavior of agents within the system, and the constraints that they face. The system can then be solved numerically, and the effect of policy intervention can be quantitatively examined within a consistent framework that accounts for important market interrelationships.

In this section we describe an applied counterpart to the formal model analyzed above. A complete algebraic description of the model is presented in Table 1. Our notation generally uses the Greek alphabet to denote free and calibrated parameters, lower case letters to denote policy variables, and bars to denote those variables that have been fixed by the closure assumptions. A full set of definitions is contained in Table 2. The basic model structure is the well-established single-country Armington trade model, of which a number of very accessible descriptions exist (see, for example, Devarajan and Lewis, 1990), so we present only brief details.

The production block consists of a set of CES production functions (1), with intermediates used in fixed proportions. Equations (2) and (3) are the corresponding demand functions for intermediates and primary factors, respectively. Note that a subset of factors have prices fixed exogenously in a subset of sectors, corresponding to the rigid urban wages of the HT specification. This implies unemployment of that subset of factors, with the rate of employment defined by (4). Equation (5) is our modified HT factor market equilibrium condition, and (6) introduces an inelastic migration response as in our simplified model above. Finally, (7) defines the factor market constraints.

The demand block consists of two levels. At the first level households maximize a Stone-Geary LES system, the objective function of which is (9), subject to their income as defined in (8). Equation (10) defines the corresponding demand functions. Having allocated their expenditure across these commodities, society then chooses the optimal combination of imports and domestic production (the
### Table 1: Equations of the Model

#### Sets:
- \( i(j) \) : Sectors
- \( u \in i : \) Urban sectors
- \( f \) : Endowment commodities
- \( g \in f : \) Under-employed endowments

#### Production:
\[
Q_i = \{x_i^0 \left/ \left(1 - \sum_j (a_j)\right)\right\} \left(\sum_j \theta^0 \beta^0 - \theta^0 \beta^0\right)^{-1/\theta^0} \tag{1}
\]
\[
V_i = \sum_j a_j Q_j \tag{2}
\]
\[
PF_i = PN_i \left[\left(1 - \sum_j (a_j)\right) \left(\sum_j \theta^0 \beta^0 - \theta^0 \beta^0\right)^{-1/\theta^0} \theta^0 \beta^0 \right] \quad PF_{gu} = \overline{PF_{gu}} ,\ PF_f = PF_f \quad f \not\in g \tag{3}
\]
\[
ER_i = \sum_j FD_j \left/ \left(\sum_j FD_j + UN_j\right)\right\} \tag{4}
\]
\[
PF_{gu} = ER \overline{PF_{gu}} - COST_k \quad i \not\in u \tag{5}
\]
\[
\sum_j FD_j + UN_j = \alpha_k COST^k \tag{6}
\]
\[
\sum_j FD_j = \text{END}_j - \text{UN}_j \tag{7}
\]

#### Demand:
\[
NDI = \sum_i Q_i PN_i + \sum_j \text{t}_i \text{PWM}_i \text{M}_i + \text{X}_i + \sum_j \text{t}_j \text{PD}_j X_j - \sum_j \text{t}_j \text{PD}_j Q_j - \sum_j \text{t}_j X_j - \text{CA} \cdot \text{XR} \tag{8}
\]
\[
U = \alpha \prod (C_i - \lambda_i)^{\theta^0} \tag{9}
\]
\[
\lambda_i = \lambda_i + (\theta_i^0 / \lambda_i) \left(NDI - \sum_j \lambda_j P_j\right) \tag{10}
\]
\[
A_i = \alpha_j^0 \left(\theta^0 \beta^0 - \theta^0 \beta^0\right) \left(1 - \theta^0 \beta^0\right) \tag{11}
\]
\[
D_i = \frac{\alpha_j^0 \left(\theta^0 \beta^0 - \theta^0 \beta^0\right)}{\left(\theta^0 \beta^0 \text{PM}_i / \text{PD}_i \right)^{\theta^0 - \beta^0} \left(C_i + \tilde{V}_i + \tilde{L}_i + \tilde{G}_i\right) - \theta^0 \beta^0} \tag{12}
\]
\[
M_i = (\theta^0 / \left(1 - \theta^0 \beta^0\right))^{\theta^0} \left(\text{PD}_i / \text{PM}_i\right)^{\theta^0} D_i \tag{13}
\]

#### Prices:
\[
PM_i = \text{PWM}_i \left(1 + \text{t}_i\right) X_i \tag{14}
\]
\[
PD_i = \text{PWM}_i \left(1 + \text{t}_i\right) X_i \tag{15}
\]
\[
P_i = \alpha_j^0 \left(\theta^0 \beta^0 \text{PM}_i / \text{PD}_i\right)^{\theta^0 - \beta^0} \tag{16}
\]
\[
PN_i = PD_i \left(1 + \text{t}_i\right) - \sum_j a_i P_j \tag{17}
\]
\[
X_i = \alpha_j^0 \text{PWM}_i X_i \tag{18}
\]
\[
\sum_j Q_j P_j = 1 \tag{19}
\]

#### Equilibrium Conditions:
\[
Q_i = X_i + \text{D}_i \tag{20}
\]
\[
\sum_j \text{PWM}_i M_i + \text{CA} = \sum_j \text{PWM}_i X_j \tag{21}
\]
### Table 2: Notation

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_{ij}$</td>
<td>$PM_i$</td>
</tr>
<tr>
<td>World price of importables</td>
<td>$PD_i$</td>
</tr>
<tr>
<td>PM</td>
<td>Domestic price</td>
</tr>
<tr>
<td>END</td>
<td>$PWX_i$</td>
</tr>
<tr>
<td>Institutionally rigid factor returns</td>
<td>$P_i$</td>
</tr>
<tr>
<td>$f_i$</td>
<td>Domestic-import aggregate price</td>
</tr>
<tr>
<td>Investment</td>
<td>$PN_i$</td>
</tr>
<tr>
<td>$t_i$</td>
<td>Net prices</td>
</tr>
<tr>
<td>Government expenditure</td>
<td>$PF_f$</td>
</tr>
<tr>
<td>CA</td>
<td>Factor returns</td>
</tr>
<tr>
<td>$tm_i$</td>
<td>$Q_i$</td>
</tr>
<tr>
<td>$tx_i$</td>
<td>Factor demands</td>
</tr>
<tr>
<td>$ty_i$</td>
<td>Intermediate demands</td>
</tr>
<tr>
<td>$\alpha_{ij}^Q$</td>
<td>$ER_f$</td>
</tr>
<tr>
<td>Production function shift</td>
<td>$UN_f$</td>
</tr>
<tr>
<td>$\theta_{ij}^Q$</td>
<td>$COST_f$</td>
</tr>
<tr>
<td>Production function share</td>
<td></td>
</tr>
<tr>
<td>$\sigma_{ij}^Q$</td>
<td></td>
</tr>
<tr>
<td>$\rho_{ij}^Q$</td>
<td></td>
</tr>
<tr>
<td>$\alpha_i$</td>
<td>Utility level</td>
</tr>
<tr>
<td>Utility function shift</td>
<td>$C_i$</td>
</tr>
<tr>
<td>$\theta_i^C$</td>
<td>Total household consumption</td>
</tr>
<tr>
<td>Subsistence consumption level</td>
<td>$NDI$</td>
</tr>
<tr>
<td>$\eta_i$</td>
<td>Household income</td>
</tr>
<tr>
<td>Income elasticity of demand</td>
<td>Imports</td>
</tr>
<tr>
<td>$\varpi$</td>
<td>Domestic demand</td>
</tr>
<tr>
<td>Frisch parameter</td>
<td>Armington aggregate</td>
</tr>
<tr>
<td>Armington shift parameter</td>
<td>Armington share</td>
</tr>
<tr>
<td>Armington share</td>
<td>Armington elasticity</td>
</tr>
<tr>
<td>Armington elasticity</td>
<td>$(1/\sigma_{ij}^A) - 1$</td>
</tr>
<tr>
<td>$\alpha_{ij}^X$</td>
<td>Export demand shift</td>
</tr>
<tr>
<td>Export demand shift</td>
<td>Export demand elasticity</td>
</tr>
<tr>
<td>$\alpha_i^M$</td>
<td>Migration function shift</td>
</tr>
<tr>
<td>Migration function shift</td>
<td>Migration elasticity</td>
</tr>
</tbody>
</table>

**Notes:**

* These parameters are independent of the base year data (‘free’) and are supplied independently. Other parameters then follow by calibration.

† These parameters do not appear in the model, but are used in the calibration process of the Stone-Geary utility function (to determine the subsistence parameters). The Frisch parameter (minus the reciprocal of the marginal utility of income) scales the price elasticities.
Armington composite). This is reflected in the CES functions (11), and the corresponding demands for domestic production (12) and imports (13). Introduction of product differentiation via this mechanism is the major departure of the model from the models of standard trade theory, and is incorporated virtually all quantitative general equilibrium analysis. Note that we have assumed investment and government demands are fixed in this closure, and that demand for these and intermediates is also for the composite good.

Equations (14)-(19) describe the price equations of the model, and have straightforward interpretations. Equation (16) defines the price of a composite of imports and domestic production, and is derived from the assumption of CES aggregation described in (11). Similarly, we have used CED functions to describe how world prices respond to changes in the trade volume (18). Equation (19) defines a 'no inflation' numéraire for the system.

Finally, we impose equilibrium conditions on the model. Equation (20) defines the material balance conditions, and (21) the balance of trade. The exchange rate is assumed to adjust to maintain a fixed current account balance. Since Walras' law implies the equilibrium conditions are not independent, any one of them can be dropped.

To summarize, the AGE model presented here incorporates the key features of our formal modeling: institutionally rigid urban wages and corresponding urban unemployment, rural-urban migration in response to expected wage differentials, and an imperfectly elastic migration response. It also makes a number of extensions. It can accommodate many endowment factors, each of which may be fully or partially employed, fully or partially mobile, or specific to a given economic activity. It can accommodate many sectors, each of which can be classified as rural or urban. The model also incorporates product differentiation, allowing the model to accommodate simultaneous export and import activities in the same sector, and downward sloping foreign demands. Finally, the model incorporates a complete set of trade and output taxes to ensure accounting for the second-best implications of policy interventions.

The GTAP4 database (McDougall et al., 1998) is used as the primary source of the production, protection and trade data used in the model, and also for the free parameters. The base year is thus 1995.
Although virtually all of the now extensive applied general equilibrium literature based on the GTAP database utilizes the GTAP model described in Hertel (1997), or derivatives thereof, it is a straightforward procedure to extract the information necessary to construct a single-economy model such as that used here. Also, because we are using a single country model, we are able to work at a much greater level of disaggregation (45 sectors) than most of the GTAP-based literature. Using the GTAP data ensures not only that our starting point is consistent with much of the existing research, but also that the data is widely available to other researchers to replicate our results. We supplement the GTAP data with rural and urban labor force counts from the FAOSTAT database, which are used to estimate rural and urban wages consistent with the GTAP4 payments data. Agricultural and resource based industries (forestry, fishing and mining), along with processing activities that are generally located close to source (food production, lumber production, etc.) are assumed to be rural activities, while textiles, heavy manufactures and services are classified as urban. The urban unemployment rate of 6 percent is from Gu's (1999) estimates for 1995. The implied expected wage differential in 1995 is nearly 200 percent (i.e., the rural wage is just over one third of the expected urban wage) – reflecting the substantial impediments to labor mobility that remain a feature of the Chinese economy. As there are no available estimates of the elasticity of labor migration, we use two limiting values – low (1.0e-5) and high (100).

The model is implemented and solved in levels form. In the following section we present the results of our policy simulations.

5. Results and Policy Implications

Although the actual level of agricultural liberalization that China will undertake when it becomes a member of the WTO is still unclear, a reasonable starting assumption is that it will reduce agricultural trade barriers by the same levels as required of developing economies under the Uruguay Round Agreement on Agriculture (URAA). This agreement required that developing economies reduce their average tariff on agricultural and food products by 24 percent. Export subsidies were to be reduced by the same margin. Domestic support was to be reduced by 13 percent, subject to de minimis provisions not
requiring levels lower than 10 percent of value. Although other countries have displayed considerable ingenuity in the way that they have complied with their obligations under the URAA, in the absence of any further information on the case of China, we implement the requirements at face value and evenly across all agricultural activities. As an alternative, we consider the effect of more comprehensive reform – the removal of agricultural and food product distortions (positive and negative) in the system.

The results of the simulations are presented in Tables 3–5. Table 3 presents some important summary statistics for the estimated effects of agricultural liberalization. The first column gives the estimated change in welfare, measured as the equivalent variation in $US1995 millions. The second column gives the welfare change as a percentage of initial GDP. The third column is the estimated rate of urban unemployment. Finally, the fourth column gives the rural labor wage as a percentage of the urban labor wage. Table 4 presents estimated proportional changes in agricultural production, while Table 5 presents the estimated proportional changes in agricultural imports.

Consider first the effect of WTO accession. When labor movement is heavily constrained, welfare is estimated to rise by just over $965 million. When a high level of labor mobility is allowed the gains remain positive, but drop by over $250 million. This result leads us to two conclusions. First, it confirms the importance of the migration elasticity parameter. As our simple abstract model indicated would be the case, when labor is immobile agricultural trade liberalization will improve the urban unemployment problem. When labor is mobile, however, agricultural trade liberalization leads to expanded migration to urban areas, and hence to expanded urban unemployment. This has a significant and detrimental effect on the net welfare gains from liberalization.

Second, the result also indicates that the potential allocative efficiency gains from agricultural liberalization in China are substantial. Even with high labor mobility, the effects of liberalization on unemployment and adverse terms-of-trade movements are not sufficient to outweigh the allocative efficiency gains of China's WTO commitments.

Now consider the case of full agricultural reform. Here we have a result that at first glance appears to contradict our arguments. The gains from a comprehensive reform program remain
substantial, but now higher levels of labor mobility lead to higher levels of welfare. At $2.2 billion the estimated gains with high mobility are over four times those with low mobility. What drives this result?

Table 3: Summary Statistics

<table>
<thead>
<tr>
<th>Simulation</th>
<th>Welfare Change ($US millions)</th>
<th>Welfare Change (% of GDP)</th>
<th>Unemployment Rate</th>
<th>Rural Wage (% of Urban)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Equilibrium</strong></td>
<td>-</td>
<td>-</td>
<td>6.00</td>
<td>30.04</td>
</tr>
<tr>
<td><strong>Low Mobility</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WTO Accession</td>
<td>965.16</td>
<td>0.14</td>
<td>5.70</td>
<td>29.91</td>
</tr>
<tr>
<td>Full Reform</td>
<td>530.84</td>
<td>0.07</td>
<td>6.25</td>
<td>32.66</td>
</tr>
<tr>
<td>Tax Elimination</td>
<td>-1449.57</td>
<td>-0.20</td>
<td>7.16</td>
<td>33.11</td>
</tr>
<tr>
<td><strong>High Mobility</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WTO Accession</td>
<td>712.94</td>
<td>0.10</td>
<td>6.05</td>
<td>29.99</td>
</tr>
<tr>
<td>Full Reform</td>
<td>2176.94</td>
<td>0.31</td>
<td>3.95</td>
<td>32.10</td>
</tr>
<tr>
<td>Tax Elimination</td>
<td>963.95</td>
<td>0.14</td>
<td>3.79</td>
<td>32.27</td>
</tr>
</tbody>
</table>

Table 4: Estimated Effects on Production of Key Agricultural/Food Commodities

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Initial Output Value</th>
<th>Volume % Change</th>
<th>Volume % Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Low Mobility</td>
<td>High Mobility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WTO</td>
<td>Full</td>
</tr>
<tr>
<td>Paddy Rice</td>
<td>32053.7</td>
<td>0.05</td>
<td>2.06</td>
</tr>
<tr>
<td>Wheat</td>
<td>8228.6</td>
<td>-0.12</td>
<td>2.41</td>
</tr>
<tr>
<td>Other Grains</td>
<td>10605.8</td>
<td>-0.43</td>
<td>-2.01</td>
</tr>
<tr>
<td>Vegetables and Fruit</td>
<td>51418.7</td>
<td>0.01</td>
<td>1.24</td>
</tr>
<tr>
<td>Oil Seeds</td>
<td>3820.1</td>
<td>-0.64</td>
<td>8.67</td>
</tr>
<tr>
<td>Plant-based Fibers</td>
<td>8018.9</td>
<td>-0.32</td>
<td>-4.79</td>
</tr>
<tr>
<td>Other Crops</td>
<td>11430.0</td>
<td>-0.24</td>
<td>0.41</td>
</tr>
<tr>
<td>Cattle</td>
<td>5560.5</td>
<td>0.30</td>
<td>-0.22</td>
</tr>
<tr>
<td>Other Agriculture</td>
<td>56567.8</td>
<td>0.19</td>
<td>2.28</td>
</tr>
<tr>
<td>Meat Products</td>
<td>925.2</td>
<td>0.38</td>
<td>54.78</td>
</tr>
<tr>
<td>Other Meat Products</td>
<td>9024.2</td>
<td>0.43</td>
<td>32.24</td>
</tr>
<tr>
<td>Vegetable Oils</td>
<td>7910.7</td>
<td>-1.71</td>
<td>-12.56</td>
</tr>
<tr>
<td>Dairy Products</td>
<td>1077.8</td>
<td>-0.51</td>
<td>-1.10</td>
</tr>
<tr>
<td>Processed Rice</td>
<td>21416.2</td>
<td>0.05</td>
<td>2.06</td>
</tr>
<tr>
<td>Other Food Products</td>
<td>22850.2</td>
<td>-1.35</td>
<td>-6.02</td>
</tr>
<tr>
<td>Beverages and Tobacco</td>
<td>30288.8</td>
<td>-0.57</td>
<td>32.71</td>
</tr>
</tbody>
</table>
Table 5: Estimated Effects on Imports of Key Agricultural/Food Commodities

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Initial Import Value</th>
<th>Volume % Change Low Mobility</th>
<th>Volume % Change High Mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>WTO Full</td>
<td>WTO Full</td>
</tr>
<tr>
<td>Paddy Rice</td>
<td>0.5</td>
<td>-0.62</td>
<td>-55.81</td>
</tr>
<tr>
<td>Wheat</td>
<td>1677.5</td>
<td>-1.19</td>
<td>-13.72</td>
</tr>
<tr>
<td>Other Grains</td>
<td>1162.5</td>
<td>0.81</td>
<td>14.39</td>
</tr>
<tr>
<td>Vegetables and Fruit</td>
<td>100.7</td>
<td>14.86</td>
<td>116.75</td>
</tr>
<tr>
<td>Oil Seeds</td>
<td>157.0</td>
<td>-1.43</td>
<td>35.50</td>
</tr>
<tr>
<td>Plant-based Fibers</td>
<td>1586.4</td>
<td>5.07</td>
<td>19.18</td>
</tr>
<tr>
<td>Other Crops</td>
<td>930.5</td>
<td>9.03</td>
<td>67.62</td>
</tr>
<tr>
<td>Cattle</td>
<td>0.8</td>
<td>2.86</td>
<td>23.05</td>
</tr>
<tr>
<td>Other Agriculture</td>
<td>549.5</td>
<td>16.47</td>
<td>144.04</td>
</tr>
<tr>
<td>Meat Products</td>
<td>107.3</td>
<td>0.08</td>
<td>-54.14</td>
</tr>
<tr>
<td>Other Meat Products</td>
<td>200.8</td>
<td>-0.23</td>
<td>-54.79</td>
</tr>
<tr>
<td>Vegetable Oils</td>
<td>2659.3</td>
<td>5.27</td>
<td>34.61</td>
</tr>
<tr>
<td>Dairy Products</td>
<td>64.0</td>
<td>10.80</td>
<td>64.07</td>
</tr>
<tr>
<td>Processed Rice</td>
<td>416.4</td>
<td>-0.63</td>
<td>-45.85</td>
</tr>
<tr>
<td>Other Food Products</td>
<td>1627.0</td>
<td>9.41</td>
<td>51.06</td>
</tr>
<tr>
<td>Beverages and Tobacco</td>
<td>483.6</td>
<td>52.39</td>
<td>288.86</td>
</tr>
</tbody>
</table>

The result is in fact a consequence of the structure of the distortions in Chinese agriculture. Figure 2 describes the tax rates in this model for key agricultural commodities. Export and output taxes, rather than subsidies, dominate, reflecting the policy bias against agriculture. Of course, tariffs (in some cases quite substantial ones) also exist for many agricultural products, and this tends to temper the negative effects of the other policies, but the net bias remains considerable. Under WTO agreements, China would be required to reduce import tariffs and export and output subsidies, but is unlikely to have to make any commitments on programs that restrict output and exports. Hence, reducing tariffs, while holding other restricting measures in place, tends to push average domestic agricultural prices, and hence agricultural output, down. The effect on output is more pronounced the more labor mobility is allowed (see Table 4).

In the case of complete domestic reform, the removal of export and output taxes has the effect of increasing average domestic agricultural prices. This results in an increase in agricultural output (Table 4). Expansion of agriculture draws capital out of industry, and causes a decline in urban production. Ideally, we would like labor to migrate back to rural areas in response. However, mobility restrictions
work in both directions, hence this is prevented in the low mobility scenario. The result is a jump in urban unemployment. By contrast, in the high mobility case there is a substantial fall in urban unemployment (as migrants return to rural areas). The welfare results reflect the importance of these urban employment changes.

**Figure 2: Chinese Trade and Output Tax Structure (1995) – Negative Values Subsidies**

![Graph showing Chinese Trade and Output Tax Structure](image)

*Source: GTAP4 (MacDougall et al., 1998).*

To nail down this result, briefly consider the simulation labeled 'Tax Elimination' in Table 3. This experiment considers the removal of export and output taxes only (holding import taxes/export subsidies constant). The results are like an extreme version of the full reform case – without labor mobility welfare falls dramatically as urban unemployment rises sharply. Hence, the seemingly contradictory result is really indicative of net policy changes in different directions (WTO accession increases the net bias against agriculture, while full reform causes it to decrease).
From column 4 of Table 3, accession to the WTO does not appear to have a strong effect on rural wages in the model. In both the high and low mobility cases there is a slight decline, as we would expect. The decline is larger where labor is unable to move easily to other activities, again as intuition would lead us to anticipate. In the simulations where the bias against agriculture is reduced the effects are more significant. Rural wages rise by up to 10 percent.

As a further depiction of the sensitivity of the model results to the value of the migration elasticity, we have constructed Figure 3, which illustrates how the three key variables (net welfare, unemployment, and rural wages) change in response to changes in the value of this parameter, for the WTO accession case. The upper diagram depicts the relationship between the welfare measure and the elasticity. Evident is that the net welfare gains from WTO accession decline rapidly as labor becomes increasingly mobile. The lower diagram depicts the percentage change in the rate of employment, and the percentage change in the rural wage. Note that there is a clear trade-off between maximizing the extent of net welfare gains from WTO accession, and minimizing the harm inflicted on rural workers. Also, we observe a rapid decline in the rate at which the rate of urban employment improves as mobility increases. At the critical value of $\varepsilon = 2.895$, WTO accession has no effect on urban employment levels, and beyond this point the change in rural wages and the probability of employment take the same sign. With an elasticity beyond the critical value the model behaves much like the standard HT model examined in Section 3 above.

The estimated effect of the reform scenarios on China's pattern of imports is presented in Table 5. Two main patterns emerge. The first is that a more comprehensive liberalization would lead to more substantial expansion of imports, as we might expect. Second, the results also indicate that the most substantial changes in import volumes are likely to be for high value-added products, such as vegetables and fruit, dairy products, and beverages and tobacco.

In summary, the results of the model generate several valuable policy lessons. The first and most important point is that, even in a model that accounts for imperfect labor mobility and urban unemployment, the net effects of WTO accession for China are estimated to be positive. Second, China's labor policy needs to be closely coordinated with its trade liberalization program. It is clear that the net
Figure 3: Sensitivity of Key Results to the Labor Mobility Parameter

- **EV (US$1995 Millions)**
- **Proportional Change in Employment**
- **Proportional Change in Rural Wage**
benefits to China of WTO accession are maximized if controls on labor mobility are maintained to prevent a worsening of the urban unemployment problem. Third, the benefits a labor restrictions are rapidly lost as mobility increases (as Figure 3 indicates), so labor mobility controls, if implemented, should be strictly enforced. However, such a strategy also maximizes the hardship imposed by reform on the rural population. Although the estimated reductions in rural wages are small, they may be a burden that an already heavily encumbered rural population is unwilling to bear.

A final crucial lesson is that if China were to commit to a more substantial reform program, eliminating not only import barriers and export subsidies, but also the disincentives to agricultural production, the potential net welfare gains would be more than doubled. Moreover, this could be achieved without having to resort to mobility restrictions. In fact, if China were to commit to a more substantial reform program, this should be accompanied by the elimination of mobility restrictions to maximize the benefits. Our model suggests that such action could have a substantial positive effect on urban unemployment, and a smaller positive effect on rural wages, thus also helping to alleviate two of China's most pressing economic concerns.

6. Concluding Comments

Like all economic models, the applied general equilibrium techniques utilized in this paper are based on a highly stylized structural framework, and this raises a number of issues. One problem with the approach used here is that it is difficult to separate rural and urban activities cleanly using sectoral lines. Another is that the single country specification means we are unable to account for the effect of China gaining access to other markets, or the effect of Chinese liberalization on other economies. In respect of the latter issue, there have now been a number studies using global general equilibrium models, so there is little need to add to that literature. Most of the gaps that remain to be filled involve China-specific issues, and more detailed single-country models are an appropriate analytical tool. With respect to the former, to paraphrase Whalley (1985), the contribution of applied general equilibrium models is to increase the level of understanding of how institutions affect outcomes, to tell a story that is consistent with a set of stylized
facts, and to provide a consistent framework for the policy debate. The results presented in this paper should be interpreted in this context.

As in other East Asian economies, agricultural trade liberalization continues to be a highly sensitive area in China, and as some of the results in this paper have indicated, one that can have substantial consequences for the economy as a whole. As China's accession to the WTO draws closer, it is clear that Beijing will have to carefully consider the course of its agricultural trade policy regime. Should China reaffirm the distinction between the rural and urban economies and clamp down on migration? Should they instead move towards fully liberalizing the agricultural sector, and allowing labor markets to develop? There remain conflicting objectives in the China's policy stance. On the one hand they would like to remain self-sufficient in key agricultural commodities, but accession to the WTO constrains their ability to use price mechanisms to achieve this goal. They would also like to address the problem of rural-urban income divergence, but allowing labor to move into other, more profitable, activities contradicts the objective of self-sufficiency and may exacerbate the problem of urban unemployment.

There are no easy answers here. Of course, as economists we know that in a first-best world optimal policy would involve the elimination of the cause of urban unemployment (or a set of equivalent wage subsidies), coupled with free labor mobility and the elimination of all of the policy distortions in the system (excepting small 'optimal' trade taxes in the absence of retaliation). Income equality could then be achieved by an appropriate set of lump-sum transfers. But such an outcome is unlikely to be feasible in practice.

Our results suggest that, given the existence of urban unemployment and its second-best implications, going beyond the requirements of the WTO and removing the disincentives to agricultural production could raise net social welfare substantially, and discourage rural-urban migration by improving the incentives to stay in rural activities. At the least, this would relieve the some of the pressure resulting from urban unemployment and rural-urban income divergence.
References


McDougall, R.A., A. Elbehri and T.P. Truong (eds.) (1998) "Global Trade, Assistance, and
Protection: The GTAP 4 Data Base" Centre for Global Trade Analysis, Purdue University.


