Standards Driven Rural Development:
A General Equilibrium Model with Market Imperfections

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Abstract

Using a general equilibrium model this paper analyses the overall process through which high standards production and consumption affect development. Market imperfections are so critical in modeling the real effects of high standards that we have to take into account four kinds of them: labor market segmentation, labor migration costs, credit constraints and fixed costs. Our model allows to measure structural production changes and welfare effects on rural and urban households through various channels. We calibrate and simulate the model using the dataset of China, which is just in its middle development phase. The simulation results show that the issue of exclusion depends on the neutrality of shocks or policies leading to the expansion of high standards sector, that inequality and poverty would decrease when the world price for high standards food increase and when richer consumers increase preferences for high standards food, and that the gain from labor market can cover the loss of exclusion from high standards farming if more efficient farms expand their output in high standards sector. The interaction of several related markets also provides some insights for the logic of China-style gradual markets reform.

1 INTRODUCTION

A series of recent studies have identified the spread of 'high standards'[1] as having a fundamental impact on the process of development (Farina and Reardon, 2000; Fulponi, 2007; Henson et al., 2000; McCluskey, 2007; Swinnen, 2007). The growing demand of wealthy consumers for high quality, safety, health, and ethical standards put pressure on governments to increase public regulatory standards and on private processing and retailing companies to introduce or tighten private corporate standards (Swinnen and Vandemoortele, 2008). Generally, growing demand for high standards is a natural consequence of income growth. In the recent years it has been also reinforced by several additional events. For example, international campaigns against child labor and genetically modified food, NGO activities for the environment and several food safety crises, such as the food dioxin crisis and the appearance of BSE in Europe, have all contributed to a rising demand for high quality, safe and traceable products in the production chains of many nations (Buzby, 2003; Vos, 2000).[2]

Although high standards products play a much larger role in developed countries, they also affect less developed countries (LDC). First, standards in relatively rich countries are also imposed on imports and consequently have an impact on producers and exporters in the less developed exporting countries (Jaffee and Henson, 2005; Otsuki et al., 2001; Unnevehr, 2000). Second, global supply chains play an increasingly important role in the world food markets and, according to Swinnen (2007), the growth of these vertically coordinated

[1] The concept of standards is very general and include many aspects pertaining to outcomes or processes as Farina and Reardon (2000) has stated: '(1) quality (e.g., appearance, cleanliness, taste), (2) safety (e.g., pesticide or artificial hormone residue, microbial presence), (3) 'authenticity' (guarantee of geographical origin or use of a traditional process); and (4) the 'goodness of the production process' (e.g., with respect to worker health and safety, or to environmental contamination).' Even though it's general, the relevant issues under the concept of standards have common characteristics so that we can consider them as a single factor in our model, as we will demonstrate later.

[2] This paper focuses on the development implications of changes in the demand for product standards. There are several related areas of the literature on standards, including a.) analyses of asymmetric information problems which may be reasons for companies or public regulators to introduce standards (Fulton and Giannakas, 2004; Gardner, 2003); b.) studies on the role of standards in reducing consumption externalities (Besley and Ghatak, 2007; Copeland and Taylor, 1995); c.) the role of standards in providing non-tariff trade protection (Anderson et al. 2004; Fischer and Serra 2000), and (d) the political economy of standards (Swinnen and Vandemoortele, 2008).

marketing channels is facilitated by increasing standards. For example, modern retailing companies increasingly dominate international and local markets in fruits and vegetables, including those in poorer countries, and have begun to set standards for global food quality and safety (Dolan and Humphrey, 2000; Henson et al., 2000). Third, rising investment in processing and retailing in developing countries is translated into higher standards, as buyers are making new demands on local producers in order to serve the high-end income consumers (Reardon et al., 2003).

Early studies argued that the penetration of international marketing chains is widespread in LDCs (e.g. Gulati et al., 2007; World Bank, 2005; Reardon and Timmer, 2005) and predicted that the implications of these developments would be vast. Importantly, the early literature posited that the rise of standards might have sharp negative impact on equity and poverty.[3] Several of the 'early studies' argued that the modern supply chains in developing countries systematically exclude the poor and negatively affect the incomes of small farmers; unlike other waves of rising economic activity, the poor would suffer from the penetration of international marketing chains (Farina and Reardon, 2000)[4]. For example, studies in Latin America and Africa argued that small farmers were being left behind in the supermarket-driven horticultural marketing and trade (Dolan and Humphrey, 2001; Humphrey et al., 2004; Key and Runsten, 1999; Reardon et al., 2003; Weatherspoon et al., 2001). In Kenya, Minot and Ngigi (2004) demonstrated that modern marketing chains put intense pressure on smallholders (although smallholders were still participating). Even more extreme, in the case of Côte d'Ivoire, almost all of the fruit and vegetables being produced for exports were being cultivated on large industrial estates owned by wealthy capitalists.

[3] For a broader view, the literature on agricultural exports has touched on the welfare impacts of exports on equity and poverty earlier. For example, Carter et al. (1996) described the negative effects of agricultural exports: '… lessening access to land, insufficient and uncertain labor opportunities, and rising food prices all squeeze the rural poor who are struggling for subsistence'.

[4] The reason why the excluded farmers suffer lies in the implicit assumption that the sector, from which they are excluded, is more profitable than their alternative choices. Therefore, we have to assume different profitabilities if we want to analyze welfare impact of exclusion.

Likewise, Weatherspoon and Reardon (2003) reported that the rise of supermarkets in Southern Africa failed to help small producers who were almost completely excluded from dynamic urban markets due to quality and safety standards.

In contrast, the more recent research suggests a more nuanced picture of the effect of the international marketing chains on poverty and development. For example, Dries and Swinnen (2004) find that high standards lead to increased vertical coordination in supply chains that is realized in their study area by the emergence of extensive contracting between processing companies and farmers. They show that the rise of contracting improves access to credit, technology and quality inputs for poor, small farmers that heretofore were faced with binding credit and information constraints due to poorly developed input markets. Minten et al. (2007) and Maertens and Swinnen (2009) also find increased vertical coordination in newly emerging supply chains between buyers and poor, small farmers in African countries, such as Madagascar and Senegal. According to their results, poor rural households experienced measurable gains from supplying high standards horticulture commodities to global retail chains. In China Wang et al. (2007) find that while rising urban incomes and the emergence of a relatively wealthy middle class are associated with an enormous rise in the demand for fruits and vegetables, almost all of the increased supply is being produced by small, relatively poor farmers that sell to small, relatively poor traders. Despite sharp shifts in the downstream segment of the food chain towards 'modern retailing' (e.g. there has been a rapid increase in the share of food purchased by urban consumers in supermarkets, convenience stores and restaurants), modern marketing chains have almost zero penetration to the farm level.

An important shortcoming of this 'second generation literature' – in addition to the empirical problems – is the absence of consistent and comprehensive conceptual framework for interpreting the empirical findings. Related to this, hardly any of the empirical studies actually measures welfare or poverty effects. The vast majority of these studies analyze

distributional consequences and/or the impacts on productivity or investments of supplying farms. The only study that actually examines poverty effect is Maertens and Swinnen (2009). They find strong anti-poverty effects of high standards exports in Senegal. In addition, they show that much of the welfare benefits for the poor come through the labor market, which is ignored by most other studies.[5]

Therefore, from the literature, we have found two hotly debated questions: first, whether the small holders are excluded from taking part in the high standards sector? second, even there is exclusion of small holders, whether they are actually harmed? However, ever though the two questions are very important for development policy making, there are no consensuses. The reasons may lie in their different research-based cases, methodologies or time horizons. First, variations in structural and institutional factors of different cases may have substantial impact on the issue of exclusion (Carter et al., 1996; Swinnen et al., 2008) and on the welfare of small holders. Different growth processes of high standards sector under different conditions may have quite different impact on inclusion. On the welfare effects, the share of high standards sector is important for the actual effects of exclusion. In some countries, just at their beginning of development, e.g. most Sub-Sahara African countries, high standards markets may be a substantial part of agricultural economy and the income from inclusion in high standards sector may be very important for poor rural households (Minot and Ngigi, 2004). While in other countries, which have advanced far along the development ladders, e.g. China, nonfarm labor market may be efficient and allow for a good wage for those labor excluded from the high standards sector (Zhao, 1999). Second, the main methodological tool in the literature is partial equilibrium and much attention is paid to the benefit for farmers either from participation in high standards production (e.g. Farina and Reardon, 2000) or from labor market (e.g. Maertens and Swinnen,

[5] However, the overall labor market effects depend on the factor intensities of the farms in high standards sector, which will be touched further in the following sections.

2009), without a combination of both. Furthermore, the literature nearly doesn't touch on another effect that, as consumers, households may also indirectly benefit or be harmed from relative price changes, which come from interaction of relevant commodity and factor markets after standards are imposed, and may be substantial under some situations (de Janvry and Sadoulet, 2002). There are so many interactive effects that we may make wrong judgments by focusing only on one of them while overlooking others. Third, the literature may focus too much on effects in short term while overlooking the long-term effects. Even though research on the short-term inclusion is reasonable since the imposition of high standards is really a shock in a short term in the meaning of difficult adjustment of capital input, the medium- and long-term effects coming from the comparative advantages based on households' different technologies may be more important and quite different, and deserve more research highlight (Carter et al., 1996).

The demand for integrating several markets into a single model leads to the use of general equilibrium as the most suitable modeling tool (See, e.g., Mas-Colell et al. 1995, for a comparison between general equilibrium and partial equilibrium.). First, our model has both a low standards and high standards supply chain and explicitly integrates key style facts of many developing and emerging economies, such as credit constraints and labor market imperfections. The technical reason for taking into account market imperfections is that the implicitly assumed higher profitability in high standards food sector can mostly exist under the condition of market imperfections according to the view of Industrial Organization.[6] Second, our model has several representative households to allow us to analyze how and through which channels the welfare of rural and urban households is affected. By performing scenario simulations we measure welfare effects of the growth of a high-standards economy

[6] Farina and Reardon (2000) pointed out the possible higher profitability after higher standards are imposed and described several reasons, such as entry barriers resulted from standards. In another word, there will be zero profits for all sectors under conditions of perfect markets. The existence of positive profit distinguishes our CGE model with most others.

and show how exogenous variations in structural and institutional factors affect the welfare of different households. Third, our model is designed to show the medium- and long-term effects rather than short-term effects because general equilibrium have more feed-back effects, which are time-consuming and can't be captured by partial equilibrium.

We choose China as an illuminative case of our study since the development of high standards food sector in China is particularly relevant for three reasons. First, China is the largest developing country with peculiar characteristics. Even though China has sustained relatively high growth rates for nearly thirty years since the beginning of the economic reforms and the continuously increasing income per capita leads to structural change of Chinese diet (Gale and Huang, 2007), the distribution system remains laggard until very recently. However, from the late 1990s on, the system starts responding abruptly by entering a new development period, characterized by the fast rising supermarkets (Hu et al., 2004; Wang et al., 2007). The transition from a system occupied mainly by low standards food produced by millions of small farms (Rozelle and Swinnen, 2004) to one mainly by high standards food will undoubtedly have huge impact on both producers and consumers. Second, despite of the high macroeconomic growth rates, an increasing inequality between wealthy and poor households becomes a more and more acute issue, especially after the accession to the WTO (Ravallion, 2001). And after the initially fast decrease of poverty rate, in the last decade China faces more difficulties in reducing the rural poverty (Park and Wang, 2001; Riskin, 2004). Hence, the policy decision becomes more and more sensitive to the welfare effects associated with the expansion of high standards food sector. Third, both the agricultural commodity and factor markets are under transition. Whereas the commodity market is becoming more and more efficient (Huang and Rozelle, 2006), the factor markets are not so equally good, with labor market somehow efficient while capital and land markets still highly constrained (Rozelle and Swinnen, 2004). Therefore, China provides a quite

interesting case for research on the interaction between the food system transition and the acute equity and poverty problem under conditions of market imperfections.

The paper is expected to make three contributions to the existing literature. First, a CGE model including market imperfections is constructed to analyze the impact of standards development; second, we show how the model works by calibrating and simulating the model with Chinese data; last, the simulation results can be used by policy makers to find suitable policies for development, or help them take into account all the possible effects at least.

2 THEORETICAL FRAMEWORK

The underlying theoretical framework is based on the general equilibrium approach to household models addressing development issues, such as de Janvry and Sadoulet (2002) and Stifel and Thorbecke (2003). We extend the underlying approach to integrate low and high standards food and also take seriously into account market imperfections. Except for these market imperfections, however, markets are assumed to be perfect in the meaning that all agents are price takers and prices are determined by interaction of supply and demand.[7] Figure 1 and Table 1 summarize the model structure.

There are two kinds of agents: households (*C*) and corporate farms (*CO*). In order to study the distributional consequences of standards and based on their endowments and activities, we further distinguish between urban and rural households, which can be further sorted into several subgroups to show more elegant welfare impacts. Rural households (*RC*) own three types of production factors: rural labor (LR), land (A) and capital (K) while urban household (*UC*) own urban labor (LU) and capital (K). Hence, there are four types of factor inputs in total: rural labor, urban labor, capital and land.

[7] Actually, as we have stated, agricultural commodity markets are often more efficient in developing countries like China (Huang and Rozelle, 2006), while factor markets are not very efficient and face much constraints (Dries and Swinnen, 2004; Swinnen and Gow, 1999). This phenomenon can be partially explained by the developing countries' development stages and different transaction costs attached to commodity and factor markets.

Five commodities are produced in the economy, among which there are three types of final goods: low standards (*PL*) and high standards food (*PH*) and other commodities (*O*)[8], and two types of agricultural intermediate products: low standards (*L*) and high standards (*H*), exclusively used by their respective food processing sectors to produce the respective final food. All sectors have zero profit except for high standards intermediate sector, where all rural households and corporate farms are initially involved and earn positive profits because of credit constraints. As we assume an partially open economy, all final goods are traded with the rest of the world (*ROW*) while intermediate goods and factors are domestically used.

For simplicity, we don't include government and taxes in the model. Given that the main focus of the paper is on food standards, we also don't include intermediate goods in other sectors except for the processing sectors.[9]

2.1 Production and factor demand

The intermediate sectors produce goods according to a constant elasticity of substitution (*CES*) function of the rural labor, land and capital. Final food sectors produce goods by using a *CES* function to combine their respective intermediate products and the bundle of the basic factors, aggregated through a *CES* function with a sub-nest of Cobb-Douglas (*CD*) function for the two types of labor. The gross output of the other commodities sector is a *CES* function with a sub-nest of Cobb-Douglas (*CD*) function for labor. The factor demand from these activities is derived from the above production functions except for in the following situations:

[8] Given the difficulty of constructing a benchmark equilibrium data base for a CGE model, there are obvious advantages in a model specification which has a large 'residual' sector. However, there are important drawbacks associated with this backdoor approach to arriving at a complete CGE model. (Hertel, 1999) In spite of the drawbacks, we take the specification of a large 'residual' sector because of its simplicity and wide acceptance in the literature (e.g. Trela et al., 1987; Fischer et al., 1988; and Peterson et al., 1994).
To differentiate with activity set, noted as *I*, we use *O* as the notation for the industrial sector.

[9] Note that this assumption may have implications for the income of rural and urban households. For example, in the presence of inter-regional trade costs and input-output linkages, firms located in the larger region would have access to cheaper intermediates and hence could pay higher wages to factors (Krugman and Venables, 1995). However, we treat this effect as not critical considering data paucity and additional complexity.

Credit constraints

As noted in the literature, rural households are often credit constrained (See, e.g. Swinnen and Gow, 1999). Take China as the example. According to Hallward-Driemeier et al. (2003), only a small share of farms have access to formal finance in China. In order to study the impact of credit constraints on rural and urban household welfare, we assume that, because of rural credit market imperfections, rural households and corporate farms face constraints in their access to credit when entering the high standards intermediate product market. To model this we assume that the supply of capital in the high standards farming sector (K_H^c) for the engaging households and corporate farms are constrained as follows[10]:

(1) $K_H^c = COLL^c r^{\varepsilon^c}, c \in RC \bigcup CO$

where $COLL^c$ is the collateral, r the price of capital, and ε^c the capital supply elasticity. The constraints on capital supply allow for the existence of profits in this sector, critical to the issue of exclusion as we have mentioned.

Labor market

To motivate the modeling of the labor market, we consider a stylized fact from a 'typical' developing economy. Net wages of rural workers are generally lower than wages of urban workers, even when rural workers migrate to urban areas. This can be explained by different skills or transaction costs of migration (Stifel and Thorbecke, 2003). To account for both reasons, first we model the labor market as two separate markets competing through a partial substitution in the final goods sectors using both rural and urban labor. Second, inter-regional migrating from rural to urban region is subject to iceberg transaction costs, i.e. only a fraction (*T*) of each unit of rural labor migrating from rural region arrives at urban region.[11] Thus, $wr_U = wr_R / T$, where wr_U and wr_R are the wages for rural workers

[10] We only cite the most critical equations in our model while keep the set of all equations in Table 1.
[11] See, for example Zhai (2008), which uses iceberg costs in commodity market.

working in urban and rural regions respectively. Finally, as usual, we assume that leisure is not an argument of the worker's utility function so that labor is supplied inelastically.

Fixed costs (FC)

In order to produce high standards intermediate product, farms have to make some investment to satisfy the standards requirement (Farina and Reardon, 2000), which forms fixed costs. Following Harris (1984) and without loss of generality, we assume that fixed costs exist in form of mixture of rural labor (*FCL*) and capital (*FCK*), mostly compatible to the reality. Other forms of fixed costs, e.g. only rural labor or capital, can also be assumed.

2.2 Income and consumption

Rural households and corporate farms' profits ($\prod^c$) in high standards intermediate sector are given by a value-added net of factors payments:

$$(2)\quad \prod^c = PX_H f_H(LR_H^c, A_H^c, K_H^c) - wr_R(LR_H^c + FCL^c) - tA_H^c - r(K_H^c + FCK^c), c \in RC \bigcup CO$$

Since corporate farms consist of a small part of agriculture and are state owned in China's case, and in order to avoid impact on households welfare because of arbitrary handling, we assume that corporate farms' profit belongs to the government and is transferred completely to savings. The profits of rural households become one source of their incomes so that a rural household's net income (Y^c) is equal to its profit in high standards farming plus factor incomes while the urban household's income is only composed of factor incomes from labor and capital:

$$(3)\quad Y^c = \begin{cases} wr_R LR^c + tA^c + rK^c + \prod^c, & c \in RC \\ wuLU^c + rK^c, & c \in UC \end{cases}$$

Households' demand for consumption goods is a function of their disposable income, savings, and the vector of consumer prices. To show difference between low and high standards food, we assume high standards food as a luxury good compared to low standards

food products. Accordingly, household consumption is described by the following system:[12]

$$(4a)\quad X_{PH}{}^{c} = \frac{a_{PH}^{c}(1-mps^{c})Y^{c}}{PQ_{PL}} - a_{PL}^{c}Z^{c}, c \in C$$

$$(4b)\quad X_{PL}{}^{c} = \frac{a_{PL}^{c}(1-mps^{c})Y^{c}}{PQ_{PL}} + \frac{PQ_{PH}}{PQ_{PL}}a_{PL}^{c}Z^{c}, c \in C$$

$$(4c)\quad X_{O}{}^{c} = \frac{(1-a_{PL}^{c}-a_{PH}^{c})}{PQ_{O}}(1-mps^{c})Y^{c}, c \in C$$

subject to the household budget constraint:

$$\sum_{m} P_{m}X_{m}^{c} = (1-mps^{c})Y^{c}, c \in C$$

where a_{m}^{c} is the commodity share parameter in the household consumption function, mps^{c} the saving rate for household and Z^{c} the parameter determining the degree of preference for high standards food. The merit of the above consumption system lies in that given the income level for a specific household, smaller Z^{c} always means larger preference for high standards food. This characteristic helps us easily simulate the exogenous changes of preferences of households.

2.3 Savings/investment and foreign trade

In order to model savings and investment, we make the following three widely used assumptions: (1) Savings are generated by exogenous constant rates for households; (2) Private investment is saving-driven; and (3) Investment spending is allocated to commodities in fixed proportions.[13] For simplicity and the data paucity, we further assume that only the final commodity production requires investment, while intermediate production not. As usual, total savings have to equal total investments.

[12] This is a modified Linear Expenditure System derived from Stone-Geary utility function (Stone, 1954). 'This demand system has the advantage of specifying non-discretionary and discretionary expenditure.' (Savard, 2005)

[13] Following Dewatripont and Michel (1987), this neoclassical closure is the most common one in comparative static CGE models and widely used in the literature (e.g. de Janvry and Sadoulet, 2002).

The economy, as we have stated, is partially open and trades final goods with the rest of the world. The relationship between the economy and the rest of the world is determined by the substitutability between imported and domestic goods on the consumption side through a *CES* aggregation function, which yields the total domestic supply (Armington substitution function between local and imported goods), and substitutability between local markets and export markets on the production side through a constant elasticity of transformation (*CET*) function. The allocation of goods between the domestic and international markets for demand and supply occur in response to the relative prices of foreign goods, which are determined by international prices and the exchange rate.

2.4 Equilibrium conditions and other price equations

As usual, the total demand and supply of factors, goods and intermediate products must be equal in equilibrium. The market for foreign exchange equilibrates via adjustments of the net export, with fixed foreign exchange rates. Pressures to adjust export or import quantities (and hence, demand and supply of foreign currency) are therefore equilibrated by adjustments in the trade surplus.[14] Equilibrium on the foreign exchange market is achieved by changes in the real exchange rate, such that a (fixed) trade balance is equal to the outflow of capital.

The aggregate consumer price index (*CPI*) and the aggregate producer price index (*PPI*) are defined as sum of composite prices (PQ_m) weighted by the value shares of final goods (ν_m) and the sum of producer prices (PI_m) weighted by the value shares of output (μ_m), respectively.

(5a) $CPI = \sum_m \nu_m * PQ_m$

[14] This is compatible with Chinese situation even though this assumption has no important impact on results. In fact, if savings does not enter households' utility function, then fixing either the exchange rate or the trade balance is the same right approach for welfare analysis, since it prevents an arbitrary shift away from savings towards current consumption from being confused with a welfare improvement.

(5b) $PPI = \sum_m \mu_m * PI_m$

PPI is normalized so that the comparative analysis is meaningful.[15]

3 MEASURING THE WELFARE EFFECTS

The general equilibrium model we adopt in the present study allows us to analyze two types of comparative static effects: nominal income effects and price effects from consumption. The total real income effect is the net effect of the two effects.

Hence, we measure household welfare (W^c) by real income, which is nominal income (Y^c) normalized by consumer price index (P^c):[16]

(6) $W^c = \frac{Y^c}{P^c}$

where $Y^c = \begin{cases} \prod^c + YF^c & c \in RC \\ YF^c & c \in UC \end{cases}$, and YF^c is factor income of household.

The welfare effect of changes in exogenous parameters can be disaggregated into profit effect, factor income effect and price effect. Based on equations (3), the nominal income of rural households can be divided into profit income and factor income while urban household have only factor income:[17]

- Profit effect: $\prod^c - \prod^{c0}, c \in RC$

- Factor income effect: $YF^c - YF^{c0}, c \in C$

- Price effect: $Y^c(1 - \frac{P^{c0}}{P^c}), c \in C$

[15] As stated by de Janvry and Sadoulet (2002), the choice of numeraire has no impact on real income effects, but has impact on decomposition of real income effects, which should be born in mind when we explain simulation results.

[16] This part is mostly consistent with de Janvry and Sadoulet (2002).

[17] The change in welfare due to changes in exogenous parameters is decomposed as follows:

$$P^0 \Delta W = Y^c - Y^{c0} - Y^c(1 - \frac{P^{c0}}{P^c}) = (\prod^c - \prod^{c0}) + (YF^c - YF^{c0}) - Y^c(1 - \frac{P^{c0}}{P^c})$$

where the superscript 0 refers to the base value of variables before any changes. The profit effect refers to the profit change in high standards farming for rural households. The factor income effect comes from changes in nominal income from all factor endowments and can be further disaggregated into income effects of specific factors. The price effect is caused by adjustments in relative commodity prices.

The way of including different kinds of rural households in our model allows us to measure rural poverty by the welfare of representative household, i.e. poor rural household in our case.[18] For this inference to be reasonable, we need to assume that the within group income distribution does not change.[19] Another important index measuring the inequality can be roughly calculated by Gini coefficient using the trapezium rule:

$$(7)\quad G = 1 - \sum_{c=1}^{4} (N^c - N^{c-1}) * (Y^c - Y^{c-1}), c \in C$$

where N^c is the cumulated proportion of population and Y^c is the cumulated proportion of income.

4 EMPIRICAL IMPLEMENTATION

We calibrate the model to the Chinese data for 2005 (see appendix A for details). As usual in CGE models, the data base is organized in form of a Social Accounting Matrix (SAM), which is shown in Table 2a. From the SAM, especially the matrix of average expenditure propensities (Table 2b), and descriptive data of China, we can find several

[18] Note that poor rural household defined in our model does not exactly correspond to the official definitions of poverty level, as there are also people who are included in the rural poor households group but not poor. Actually, in China's case, the poorest rural defined by the national statistics has a share of 11.4% of the whole population and may be larger than the share of the really poor people. The size of the group that is defined as poor in our model is thus not completely comparable to statistical definitions, since it is largely dependent on the aggregation scheme.

[19] Given that we do not have information on intra-class income distribution, we cannot count the number of poor in each class. Modeling intra-group income distributions in a CGE framework remains a major challenge (Stifel and Thorbecke, 2003). 'In the absence of any knowledge about intra-group income distributions, the best that a CGE modeler can say regarding poverty is how the mean incomes of the poorest groups are affected by the exogenous shocks applied to the baseline model.' (Stifel and Thorbecke, 2003) Hence, we simply refer poor rural households to representative of rural poverty.

characteristics critical to our following simulation results. First, profit in the high standards sector is not substantial and only plays a minor role in the total income of rural households: 0.3% for poor rural household, 0.7% for middle-income and rich rural households. This is mainly because high standards farming is a very small sector in current China's economy as we expect and assume. Another reason is that nonfarm income is becoming more and more important for Chinese rural households (Zhao, 1999). Second, high standards farming is relatively labor intensive comparing with other activities. For instance, the contribution of rural labor in poor rural high standards farming is 61.35%, larger than the contribution in low standards farming (45.52%). Third, labor market is somehow effecient, shown by the not too high iceberg transaction costs: 0.18 unit labor disappears when one unit labor moves from rural to urban region.

The CGE model is operationalised using the General Algebraic Modelling System (GAMS) software and is solved using the CONOPT and MINOS solvers (Brooke et al., 1988).[20] The model is calibrated such that the model reproduces the macroeconomic benchmark data from the SAM. The calibration includes the determination of all parameters and elasticities and processes as follows:

First, measurement units for factor categories are chosen such that all factor prices, except for wage of rural labor working in urban, and commodity prices are initially equal to unity.[21] Similarly, measurement units for domestic commodities, imports and exports are chosen such that consumer prices and the exchange rate are equal to one in the base year. With these normalization rules, all initial quantities and remaining prices can be computed, rendering the parameters that are directly computed from these values. Other initial quantities, such as labor-output ratios in the agricultural sectors, distributional shares of labor income, land income, capital income and profit, and investment, reflect the values observed in the

[20] The source code is available from the authors upon request.
[21] This is a standard treatment in computable general equilibrium models and will have no impact on the results since the model is homogenous of degree zero (Shoven and Whalley, 1992).

base data

Second, elasticities are drawn from relevant literature. Appendix B provides detailed overview of all relevant elasticities with references to their sources in the literature and Table 7 summarizes elasiticities applied in our model. The income elasticities of low standards products are 0.9, 0.7, 0.4 and 0.1 for poor, middle-income, rich rural households, and urban household respectively. Such structure is compatible with previous literature and the stylized fact that poor households consume a relatively larger share of staple (low standards) food compared to wealthy households (Lipton, 2001). On the import side, relatively low aggregation elasticity between imports and domestic consumption goods is assumed (elasticity of 0.5) for the other commodities sector. This reflects product differentiation between the domestically produced commodities and imports of these large aggregates. For the food sectors, including both low and high standards food, we assume a rather high elasticity of substitution (3.0). On the export side, the level of elasticities of transformation depends on the homogeneity of the aggregated sectors (Shoven and Whalley, 1992). Given the large sectoral aggregations in our study, we assume intermediate values (1.2) for both the low and high standards food sectors, and lower value (0.8) for the other commodities sector. On the supply side, all production functions are *CES* in the top nests, with a medium value of substitutability among these factors equal to 0.7, 0.15 and 0.9 for intermediate, processing and the other commodities sectors respectively. The choice of smaller elasticity of substitution between intermediate input and other factors is very standard and caters to the reality. (See Wang and Schuh, 2002 for an example) The elasticity of substitution between factors in the sub-nest *CES* of processing sectors is equal to 0.8. The price elasticities of variable capital supply for the high standards farming of rural households and corporate farms are set rather moderately (0.7, 1.0, 1.3 and 1.6 for poor, middle-income, rich rural households, and corporate farms respectively).

5 SIMULATIONS

We simulate the expansion of high standards food production and assess the impacts on households' welfare. Given that both demand and supply are endogenous in our model, we cannot directly change quantities of the high standards food. Therefore, we exogenously change other variables which give rise to comparable changes in demand and supply of high standards food. There are at least three direct channels, based on either demand or supply aspect, to simulate the expansion of high standards farming under our model's specification: (I) increasing world price for high standards food, (II) increasing households preferences for high standards food, and (III) relaxing credit constraints on high standards farming. Tables 3, 4 and 5 report the respective simulation results.

5.1 An increase in world price for high standard food

China has continuously increased its export in agricultural products and the ratio of agricultural trade to agricultural GDP (Huang et al., 2000). According to Gulati et al. (2007), the outward-looking trade policies contribute particularly to the growth of high quality products fulfilling international standards and safety regulations, the demand for which is considerably higher in the China's main trading partners in the developed world. In order to study the potential impact of these developments, we simulate the export growth of high standards food by exogenously increasing the world market price, pwe_{PH}.

The simulation results, when the world price for high standards food increases by 25%, are as follows: The real GDP increases by 0.08% and the *CPI* index decreases by 0.07%, which implies lower inflation compared to the *PPI*, since we normalize the *PPI* as numeraire. The output of high standards food increases by 14.74%, while the output of low standards food and other commodities decrease by 0.08% and 0.15%, respectively, because of factor competition from the high standard sector. All the outputs of agents in high standards farming increase, but with different ratios, mostly because their production function have different

factor intensities. The output of rural poor household increases by the largest ratio (21.93%), meaning that growth of high standards sector due to increasing trade is quite inclusive. This unexpected inclusion of poor rural household can be explained as follows: The increase of world price leads to a higher price for high standards food, which results in higher profit and income for rural households. The increasing income leads to more consumption, and hence a higher price, of their preferred food, i.e. low standards food. The factors highly used in these two sectors increase prices with different ratios (0.16% and 1.39% for rural labor and land respectively). The land rent increases more because the large low standard sector is land intensive comparing with high standard sector. The household, i.e. poor rural household in the present case, which uses more cheaper factor in their production of high standards intermediate product, has comparative advantage and expand their output more.

The real incomes of poor, middle-income and rich rural household increase by 0.56%, 0.66% and 0.72%, respectively, resulting mainly from increasing profits in high standards farming and increasing factor incomes. In contrast, urban household income decreases (-0.17%), because the gain from their decreasing price index is less than the loss from factor income.[22] Hence, the simulation results suggest that poverty will decrease because all rural households benefit. As the Gini coefficient decreases by 0.46%, our results suggest that the overall inequality would decrease.

In summary, trade expansion in the high standards food sector is quite inclusive and will benefit all rural households in China. The issue of inclusion depends not only on the technologies used by different agents with different factor intensities but also on the affected changes of relative factor price. Another critical issue making poor rural households better off and urban household worse off is factor ownership, i.e. rural households benefit because they own relatively more those factors that are employed in the expanding high standards food

[22] The reason, why their price index decreases, lies in their relative changes to the normalized PPI. Because the PPI increases more, the price index of urban households declines relatively even though their nominal index may increase.

sector.

5.2 An increase of preferences for high standard food

The preference for high standards food increases gradually with increasing income (Gale and Huang, 2007) and sometimes sharply when there happens some special event like the recent scandal (Xinhua Net, 2008) in the dairy sector of China. In this section we attempt to assess the welfare effects of preference changes for the rich rural and urban households. We finish the tasks through decreasing the preference parameter, Z^c by 25% for the household in question. The simulation results are reported in Table 4.

The simulation results of decreasing preference parameter of urban household Z^{UC} by 25% are shown in the last column of Table 4. Real GDP increases slightly (0.01%). Outputs of high standards food and other commodities increase by 15.29% and 0.26% respectively while output of low standards food decreases by 2.15%. All the agents in high standards intermediate sector increase their outputs, especially for poor rural household (22.62%), indicating this change as inclusive.

The real income of poor and middle-income rural households increase by 0.27% and 0.15%, respectively, caused mainly by the increasing profit and decreasing price indices, which covers the negative effects of decreasing factor income. Profits increase because the price of high standards intermediate product increases by 18.88% while most relevant factor prices decrease.

Since the representative poor household benefit from this change, the poverty decreases. As a result of decreasing incomes for rich rural and urban households (-0.02% and -0.05% respectively), inequality decreases (Gini coefficient decreases by 0.01%).

In summary, preference changes are inclusive and anti-poverty and pro-equity. Urban household lose because generally, others equal, it will result in lower real income for those who change their preferences to commodities produced with factor owned mostly by other

households.[23]

5.3 Impact of credit constraints

In China credit constraints are likely to constrain rural households from entering (or expanding) the high standards food production (Hallward-Driemeier et al., 2003). In order to support rural households in taking part in production of high value-added products, Chinese government has decided to take steps to help rural households get easier access to finance (CCCPC, 2008). In this section we attempt to assess the possible income and welfare effects of relaxing credit constraints within a low and high standards rural economy. We simulate the effect of relaxing credit constraints for rural households and corporate farms, which we model as a 50% increase in the collateral value, $COLL^c$ due to, e.g. state guarantees. We run three separate simulations, when we relax credit constraints for poor and rich rural households, and corporate farms. The simulation results are reported in Table 5.

The first set of simulation results, when the collateral of poor rural household increases by 50%, is shown by the first column of Table 5. Given that poor rural household produces lower share of high standards intermediate product than rich rural household, the aggregate real GDP increases with a small rate (0.01%). The profit of poor rural household increases, contributing 0.25% for the total income increase, because of lower credit constraints, which lead to a larger production scale for poor rural household, i.e. increasing 49.71%. Hence, relaxing credit for poor rural household is very inclusive. The real income of poor rural household increases by 0.26%, caused mainly by increasing profits in the high standards intermediate sector. Given that poor rural household gains from relaxed credit constraints, poverty decreases. The Gini coefficient decreases by 0.04% indicating that the inequality decreases too.

[23] This general equilibrium income effect can also partially explain why rural households prefer products produced by themselves, the so-called self sufficiency paradox (Bardhan and Udry, 1999), especially when the factor markets are imperfect.

The third column reports simulation results, when the collateral of the rich rural household increases by 50%. The aggregate real GDP increases by 0.06% and the CPI index increases by 0.01%. The output of high standards food increases by 26.60%, while the output of low standards food and other commodities sector decreases by 0.77% and 0.05%, respectively. Even though the decrease of output of poor rural household is not essential, it is a signal of defined exclusion. However, the real income of poor and middle-income rural households increases by 0.07% and 0.09%, respectively, caused mainly by the increasing factor income (0.12% and 0.13% respectively), which covers the negative effects of decreasing profits in the high standards farming and negative price effects. Profits decrease because the price of high standards intermediate product decreases by 1.05% while most factor prices increase, except for capital, because of increased competition for factors from the advantageous rich rural household. The price effect for poor and middle-income rural households is negative (the aggregate consumption price increases), because rural households consume more low standards food and less high standards food. Whereas the price of the latter decreases, the price of the former increases, leading to the negative price effect. Given that poor and middle-income rural households gain from output expansion of rich rural household, the rural poverty decreases. In contrast, rich rural household benefit (0.47%) and urban household loses (-0.04%). The Gini coefficient decreases by 0.16%, implying that the inequality decreases.

The last column shows the results of increasing collateral of corporate farms by 50%. The aggregate real GDP increases by 0.02%. The output of high standards food increases by 6.53%, while the output of low standards food and other commodities sector decreases with small rates (-0.22% and -0.00%, respectively). This process leads to a decline of poor rural household output by 0.42%. However, the real income of poor, middle-income and rich rural households increases slightly (0.00%, 0.01% and 0.02%, respectively), mainly by the

increasing factor income of rural labor and land, which covers the negative profit effects and price effects. Given that all rural households gain from output expansion of corporate farms, the rural poverty decreases. The Gini coefficient decreases by 0.16%, implying that the inequality decreases.

In summary, the effects of asymmetrically relaxing credit constraints for different types of rural households and corporate farms may be exclusive if targeted to other agents instead of poor rural household, but will benefit all rural households with different rates, with those rural households whose credit constraints are relaxed benefiting more. These results seem to be counterintuitive because most literature argue that poor rural household will lose because they are excluded from the high standards sector after the entry of large farms, represented by rich rural household and corporate farms in our simulations. However, when the labor income plays a substantial role in the total income and the high standards sector is small, the overall effect of more entrance of large or corporate farms may be positive. This effect was first shown by Maertens and Swinnen (2009).

5.4 Sensitivity analysis and limitations

In order to assess the robustness of our results we perform sensitivity analysis of the key assumptions. First, our results are not sensitive to alternative specifications of income elasticities of low standards products ($\sigma_{PL}^{RP} \in (1.35,\ 0.9,\ 0.45)$ for poor rural, and structural modification of elasticities for the other households).

Second, alternative choices of the elasiticities of transformation ($\sigma_{PL}^{t} \in (0.6,\ 1.2,\ 1.8)$, $\sigma_{PH}^{t} \in (0.6,\ 1.2,\ 1.8)$ and $\sigma_{O}^{t} \in (0.4,\ 0.8,\ 1.2)$) and the elasticities of substitution ($\sigma_{PL}^{q} \in (1.5,\ 3.0,\ 4.5)$, $\sigma_{PH}^{q} \in (1.5,\ 3.0,\ 4.5)$ and $\sigma_{O}^{q} \in (0.25,\ 0.5,\ 0.75)$) yield only marginal changes to our comparative static results in the simulations of trade and credit constraints while having some impacts on the simulations of preference changes. In the

sensitivity analyses of preference change, higher values of elastisities of substitution between domestic and foreign markets will benefit those consumers and producers who are highly involved in the outward-oriented sector. In our specific case of China, rich rural and urban households can benefit.

Third, alternative choices of the substitution elasticities between factors ($\sigma_R^s \in (0.35,\ 0.7,\ 1.05)$, $\sigma_{po}^s \in (0.075,\ 0.15,\ 0.225)$, $\sigma_{PS}^s \in (0.4,\ 0.8,\ 1.2)$ and $\sigma_O^s \in (0.45,\ 0.9,\ 1.35)$) yield only small changes to the simulation results in the simulations of trade and credit constraints while having some impacts on the simulations of preference changes.

As all models, our inter-regional CGE model is based on several assumptions, which may limit the generalization of results presented here. Assumptions such as static framework, highly stylized sectors, etc, may be too strong and inflexible especially for the long-run effects. For example, the consumption share parameters of households may change with increasing income and may have significant impact on the results presented here because of the lack of dynamic and endogenous determination of the underlying structural parameters. In reality, with rising income households usually consume more high standards food. This will decrease the negative impact of change in price indices when low standards food price increases because of factor competition of high standards food and the other commodities sectors.

6 CONCLUSION AND DISCUSSION

In this paper we analyze how the expansion of high standards food production affect the structural production changes, the incomes of different types of rural and urban households, and the rural poverty and equity by adopting an inter-regional CGE model with several kinds of market imperfections. The methodological contributions of this model are twofold. The

first contribution follows from the explicit modeling of profit resulted from market imperfections, i.e. credit constraints in our model, and its consequent effects on poverty and equity. Using a similar decomposition method proposed by de Janvry and Sadoulet (2002), this paper shows that the effects of profit on poverty analysis in a CGE model depend not only the profitability of the specific sector but also on its importance in the components of income. Even though positive profit can only exist in short-run equilibrium as most economists argued (Harris, 1984), it's essential to the issue of inclusion *vs.* exclusion of small farmers. Hence, explicitly modeling positive profit in our case is suitable. The second contribution is the way in which households change their preferences for high standards food. We use a Stone-Geary utility function to explicitly model and easily simulate the preference for high standards food.

We use the dataset of China 2005 to simulate our model through three ways: trade expansion, preference changes and relaxing credit constraints. First, the simulation results show that poor rural household will expand their production of high standards intermediate product and inequality and poverty would decrease after the increase of world price for high standards food. Hence, trade expansion in high standards food sector is inclusive and contributes toward anti-poverty and pro-equity development. Second, expansion of high standards sector resulted from preference changes is inclusive and increases real incomes of poor and middle-income rural households, and hence reduce poverty. The Gini coefficient decreases, indicating the pro-equity effect of such changes. Third, studying differential relaxation of credit constraints, we show that the role of inclusion in high standards farming in reducing poverty is critical but not completely decisive on the overall effects. Compared to the former two scenario, relaxing credit constraints has differential effect on the welfares of different households. As expected, the household targeted by the policy will gain more, while other rural households can gain less, instead of losing, because the labor market effect can

cover the loss of profits. In summary, rural financing policies can be more asymmetrical and allow for a more targeted policy approach to rural poverty.

The simulation results also show that as expected, the general equilibrium effects are different from the partial equilibrium effects, which dominate the previous literature. The overall welfare effects of standards on poor rural household are determined by the tradeoff of all the relevant effects, which can only be assessed in a general equilibrium framework.

This model also allows the exploration of some important policy issues. First, the most important general conclusion is that market imperfections, whether considered in our model or not, are important for the real effects of policies. Profitability and profit share in the households income are critical for the issue of inclusion *vs.* exclusion. From the view of industrial organization, profitability mostly comes from market imperfections like entry barriers, resulted from standards or credit constraints, etc. Take the effect of standards as an example. Higher standards mean higher entry barriers, and hence possibly higher profitability, which may result in a substantial negative effect for the excluded farms. Therefore, from the angle of production, the welfare effect of too high standards may be harmful. Furthermore, the quality of factor markets, especially labor market, may play an important role in the meaning that after being excluded from the high standards sector, households can get possibly higher wages from the labor market if the labor market is efficient to relocate the excluded labor.

Second, market imperfections interact with each other and should be taken into account comprehensively. The Chinese gradual reform process seems reasonable if there are so many kinds of market imperfections in the transition process. For the moment, China has established an relatively efficient agricultural commodity market (Huang and Rozelle, 2006) while letting the agricultural factor markets under slow development except for labor market. Recently, China is reforming the land market to allow for exchange of land use right,

(CCCPC, 2008) which will essentially relax the land constraints especially for those efficient farmers. Somebody worry that those households losing land may be harmed. However, if the labor market is mature and reliable, the labor liberated from land can seek new jobs, probably with higher wages since there are also wage differences between regional labor markets resulted from transaction costs like transportation costs. But if the transaction cost in the labor market is so high that the labor can't move to more beneficial labor markets, they may become unemployed labor without farming as income source of subsistence. Therefore, the mature labor markets provide the precondition for reforming rural land market.

Third, the policy makers should take into account all the relevant effects. Overlooking some effects may arrive at biased, and sometimes wrong, measures. For example, if governments focus on the possible exclusion of small farms, they may limit the development of corporate farms, while the latter probably can reduce poverty by increasing employment and wage.

There are some direct caveats indebted in our model. First, the intra-group welfare distribution may lead to different welfare impact to subgroups. If the individual rural households are rich of labor while not entering the high standards sector initially, they will definitely benefit from the labor market effects coming from the expansion of high standards farming. Second, our empirical results can only be regarded as illumination of our model because of the intensive use of data, which roughly mimics China's situation, where profit in high standards sector is not substantial, high standards farming is relatively labor intensive, and labor market is nearly mature, etc. Variations in structural and institutional factors, especially in critical parameters or factor intensities of production functions, may lead to totally different results. Last but not the least, the way dealing with the issue of exclusion in our model is different from those mainly touching on the shock of imposition of higher standards such as Farina and Reardon (2000). According to our understanding, their methods

care about the short-term effects while our methods touch on the long-term effects. Reardon et al. (2001) even discusses how to overcome the short-term impact through several ways. Even though the entry of poor rural household seems to be somehow important and our model doesn't allow for handling it explicitly[24], we believe that the comparative advantages of agents are most decisive for the long-term inclusion in the high standards sector.

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[24] A possible way to deal with this effect in our model is to simulate increase of fixed cost in high standard intermediate sector. However, since we assume perfect competition in high standard intermediate sector, the price will not increase with the increasing fixed cost, which results in loss of welfare. For the future research, we make relax the assumption of perfect competition to account for the increasing price after imposition of higher standards.

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APPENDIX.

A Data

The structure and characteristics of China's economy are shown in Table 2. The System of National Accounts and its related data sets for China provide the starting point for our

dataset of 2005, which is also the latest available dataset. Most data are collected from China Statistics Yearbook (CNBS, 2006). For those that can't be found from the yearbook, we complement from other sources, like China Agriculture Yearbook (CMA, 2006) and the Input/output Table 2002.[25]

Essentially the procedure required to produce our data set involves extensions, modifications and redefinitions of concepts for portions of the national accounts data; the addition of further detail to this system; and final adjustments between blocks of data in order to restore mutual consistency. Since the concept of standards includes many aspects such as child labor, genetically modified food and environment etc, we cannot differentiate exactly which food belongs to high standards or not. Hence, we only make some approximation to describe a rough figure.

A.1 Production

GDP is 18.67 trillion Yuan and divided into the final commodity sectors: low and high standards food, and the other commodity sector. We estimate that the share of high standards sector is very low (5% of the whole food sector) even though we don't have precise data.[26] The shares of rural households and corporate farms in the high standards farming are estimated according to their farming areas.

The parameters in production functions are determined by using either cost/revenue table or the input/output table according to the availability of data. The cost/revenue tables for the agriculture are used to calculate the contribution rates of low and high standards farming under our following assumption: The low standards farming takes the weighted average

[25] The input/output tables of China are edited once per five years. The Input/output Table 2002 is, hence, the latest available table.

[26] We can have several alternative proxies, e.g. first, Hu, et al (2004) estimated that roughly 30% of food are sold through supermarkets; second, the large wholesale and retail companies defined by Chinese Economic Yearbook (CEYC, 2006) sold 8.7% of total food; third, 87.5% is safe according to the sample checks in China Hygiene Statistic Yearbook (MHPRC, 2006). forth, the adoption rate of HACCP is 21.9% for 2005 (Jin et al, 2008).
In the following calculation, without additional notification, this ratio may be applied to many other places, e.g. investment shares, etc.

contribution rates of traditional staple goods, i.e. wheat, corn and grain, as proxies to calculate the contribution rates. We use different crops, based on their different profitabilities, as proxies for the high standards farming of rural households and corporate farms, i.e. tea, peanut, sugar cane and beet for poor, middle-income, rich rural households, and corporate farms respectively.[27] The incomes from labor, land and profit are clearly indicated in the data while the income from capital is lacked. We assume that all the capital contribution rates are 7.1%, which is calculated in Gu and Zhong (2007). The net profit after less capital income is regarded as the final profit for the high standards intermediate sector.[28]

The contribution rates of factors in the processing sector are calculated from the Input/output Table 2002 (CNBS, 2006). The labor wages, amortization and intermediate input of construction sector are proxies of contributions of labor, capital and land. The wages in processing and industrial sectors are divided into rural and urban labor according to the aggregate ratio of rural to urban labor revenues.

A.2 Household income, savings/investment and consumption

From the expenditure side, GDP is divided into consumption, investment and net export. All the aggregate amounts can be found in the GDP structure from the yearbook. The disaggregate data of households are collected from the income and expenditure structures of individual households.

The investment and net export are added up to the amount of savings. The individual household savings are calculated as income less consumption. However, the calculated saving rates seem too low, probably because of lack of treatment of government and corporate savings, and are enlarged to suit the aggregate saving amount according to their relative shares. The investments are sorted into the final commodity sectors according to their

[27] All of the crops are labor intensive products, compatible to the reality of China, where high standards food are mainly composed of labor intensive products like fresh fruit and vegetable.

[28] Because of lack of precise data, our use of data seems to be arbitrary. However, when we do simulation based on somehow modified datasets with different factor intensities and profitabilities, the results are robust.

shares in input/output table.

The division of income between rural[29] and urban households is based on the income per capita and ratio of population. The rural households are sorted into three groups by their income level.

The consumption structures are calculated from the expenditure of households. Engel indices are used to divide food and non-food consumptions. The expenditure on food is divided into consumptions of low and high standards food. The poor rural household and urban household are assumed to consume the largest shares of low standards food (99.9%) and high standards food (6.7%) respectively. The consumption ratios of middle-income and rich rural households are calculated by inserting numbers proportionally so that the overall consumption is equal to production minus investment.

As far as the household income structures are concerned, the yearbook only divides income data into four parts: Income from wages and salaries, from household operations, from properties, and from transfers. The divisions among these items of income are not very clear and can't be easily sorted into factor income and profit. We deal with them as follows: Income from wages and salaries is treated as wages and income from properties as capital income straightforwardly. Income from transfers is excluded since there is no government in our model. The most important income for rural households is the income from household operations. It is sorted into profit and factor incomes, including those from labor, from land and from capital, which are added into other factor incomes to get the final income structures of rural households. Even though the statistical income from operations includes other

[29] Rural Households, according to the explanation of the yearbook, refer to usual resident households in rural areas. 'Usual resident households in rural areas are households residing on a long term basis(for more than one year) in the areas under the administration of township governments (not including county towns), and in the areas under the administration of villages in county towns. Households residing in the current addresses for over one year with their household registration in other places are still considered as resident households of the locality. For households with their household registration in one place but all members of the households having moved away to make a living in another place for over one year, they will not be included in the rural households of the area where they are registered, irrespective of whether they still keep their contracted land.' (CNBS, 2006)

activities, like transportation, we use its total amount as proxy to farming operations since we can't differentiate them. As for urban household, its income from wages and salaries is treated as income from labor. And the incomes from household operations and from properties are added up to income from capital.[30]

Because of transportation cost of migration between rural and urban regions, the wages earned in the two regions are different. The gap between wage of rural labor working in urban region (8520 Yuan according to PBC, (2006)) and average income[31] per labor in rural region (6948 Yuan) is treated as the iceberg costs. The implicit assumption under the use of income per labor in rural as the comparison base is that rural labor make the decision of migration by comparing it with wage in urban region.

A.3 External sector

All final commodities are tradable and have both export and import. China has expanded in labor intensive food such as vegetables and decreased in land intensive food such as soybean. We treat the labor-intensive food as high standards including vegetables, fruits, fishery and livestock, and treat staple food, including grains and bean, as low standards raw material. The results in the SAM show that China export more high standards food while import more low standards food, consistent to the intuition.

A.4 'RAS' adjustments[32]

After the adjustments, modifications and additions listed above are completed, the remaining inconsistencies in our data set involve major data blocks which need to be realigned so as to satisfy (or restore in certain cases) equilibrium conditions.

In the 'RAS' procedure a non-negative matrix which does not initially meet prescribed non-negative row and column sum constraints is restored to a situation of consistency

[30] Even though the migrants from rural to urban may keep their rights in the rural land, we don't count it in because of the unavailability of data.
[31] Because all the incomes earned by rural households are attached to their operations in rural activities, they are the best alternative choice to wages earned in urban area.
[32] This method is referred to St-Hilaire and Whalley (1983).

through a sequence of alternating operations on rows and columns of the matrix. First row constraints are satisfied, then column constraints, then row constraints, and so on until a consistent matrix is achieved. The sums of prespecified row and column constraints must be the same since they both provide the matrix sum. If the matrix is everywhere dense, convergence is assured.

After the 'RAS' procedure, the GDP as a whole only increases 0.7%. The largest modification is to decrease the consumption of high standards food for middle-income rural household by 57.8%. This may be a signal that we have no precise data on high standards food consumption and that high standards food consists of a very small part of the whole economy and is more vulnerable to change. Considering the limited data availability against intensive use of data, such scale of data modification is thought to be acceptable.

B Elasticities

B.1 Production elasticities

Regarding the choice of elasticities, the literature was consulted in search of plausible values for these parameters. Even though the actual elasticities are determined by all kinds of factors, such as availability of substitutes and time dimension, and difficult to be comparable, we can construct 'central tendency' tables or do sensitivity analyses to decrease the impact of arbitrary dealing. There are few papers providing estimates for China except for Zhuang and Abbott (2007), especially at the aggregate level defined by us. Therefore, the model mainly uses proxies for these parameters based on the estimates found in the literature for other countries or for different aggregation.

The elasticity of substitution among inputs is critical in assessing the impact of high standards products expansion on factors' income. For the short-run modeling the elasticity may be considered close to zero because the factor composition, especially the stock or replacement of investment capital, is not expected to change substantially, even though the

true elasticity is higher than zero. In the long-run modeling, however, all factors may change thus important is to know true value. The literature especially lack estimation of elasticity of substitution between intermediate input and other factors. Normally the elasticities of substitution between intermediate input and other factors is quite smaller than those among basic factors. A survey of the literature on the estimated elasticity of substitution is provided in table 8. The median of the estimates ranges from 0.2 to 1.1. Table 7 (row 2) gives values applied in the model.

B.2 Output demand elasticities

Concerning the Armington assumption of product differentiation, the literature in most cases is supportive for this assumption. Most notably, Trefler (1995) finds that modeling an Armington home bias is statistically and economically significant in explaining trade flows between countries. This differential perception of actually physically identical goods may arise because of differences in convenience of purchase, availability in time, after-sales service bundled with the good, or even consumers' perceptions of inherent unobservable quality. The paper of Blonigen and Wilson (1999) brings some evidence, among others, that trade barriers may increase home bias, thus lowering the Armington elasticity. A theoretical study of Turrini (2001) argues that home bias arises due to higher legal cost when business is done abroad because of the differences in legal systems of trading countries, thus making it cheaper to buy from domestic producers. Further, he suggests that legal system harmonization may increase cross-border trade. A short survey of the literature on Armington elasticity of substitution, is given in table 9, and table 7 (row 3) gives values applied in the model.

The literature hardly provides estimation of elasticity of transformation between domestic and export products. Under some approximations, the own-price elasticity of a commodity is determined primarily by the elasticity of substitution in the lowest level of the

nesting in which it appears (Shoven and Whalley, 1992). Therefore, we can use the own-price elasticity as the elasticity of transformation as a proxy. Regarding the own-price elasticity of foreign demand, a short examination of the literature is summarized in table 10, and table 7 (row 4) gives values applied in the model.

A survey of income elasticities of food demand is given in table 11. The income elasticity varies from a very low value of 0.079 to a value of 1.143. The explanation for this relatively high variation is ambiguous. First of all, the estimated income elasticity depends on functional form specification. On the other hand, it is generally accepted that the income elasticity of food as a whole should decline in absolute value as income increases.[33] De Crombrugghe et al. (1997) estimated the income elasticity for the Netherlands increased over time, from 0.34 in 1980 to 0.47 in 1988. This implies an increase of elasticity with income. However, the same paper also reports a decrease in the income elasticity over time for the United States (US), from 0.610 in 1941 to 0.551 in 1950 and 0.386 in 1972. Table 7 (row 6) gives values applied in the model.

B.3 Capital supply elasticities

The literature lacks the estimation of capital supply elasticities according to our search. Considering the relatively high interests in rural area, generally high elasticities are expected. Another economic intuitive is that the richer the loaner, the higher the elasticites. Table 7 (row 8) gives values applied in the model.

[33] The argument is based on Engel's Law, stating that if income elasticity declines with income, then the income effect component of own-price elasticity decreases, thus leading to smaller own-price elasticity.

Figure 1. Model structure

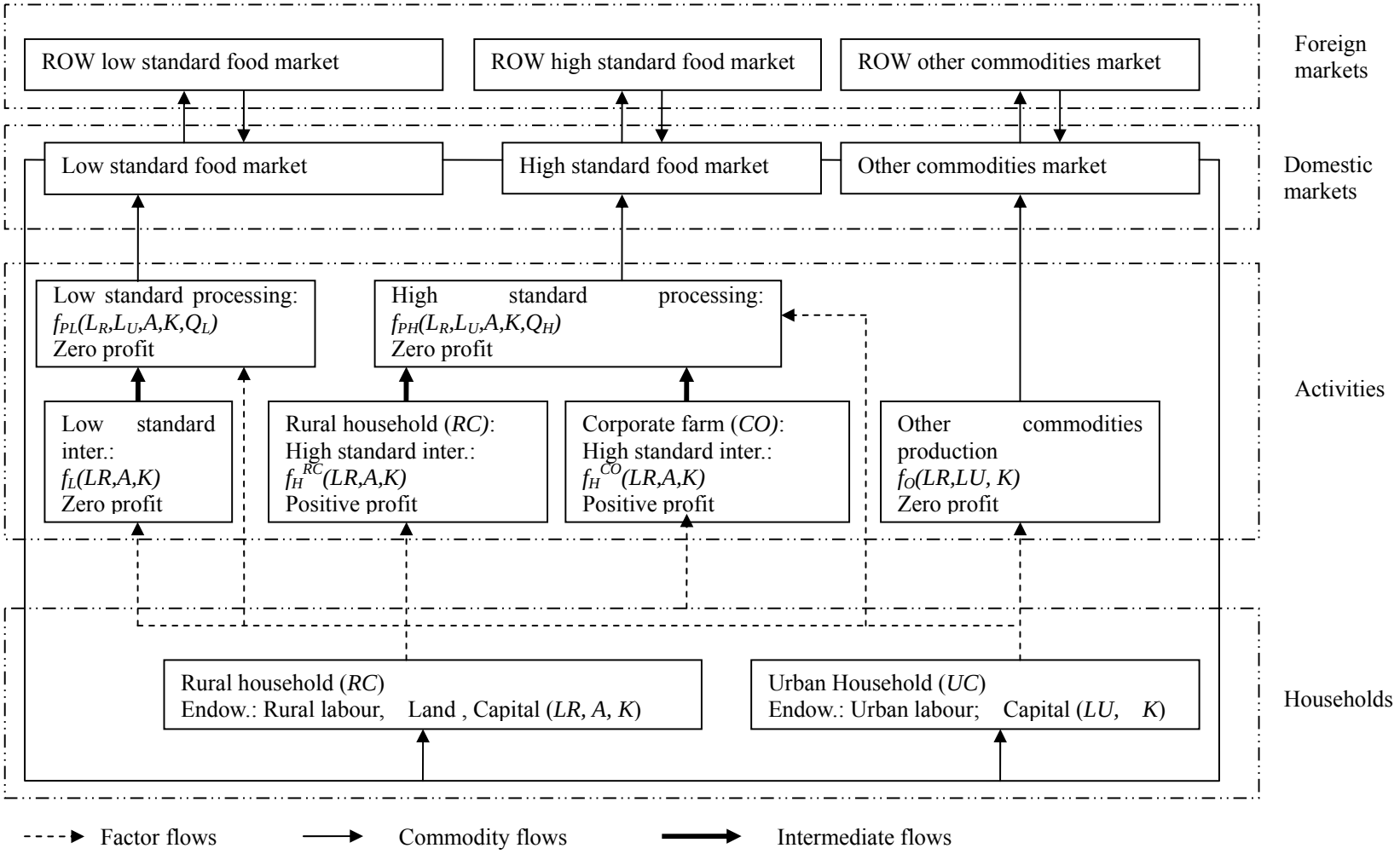

Table 1 The Model

Production and factor demand

$$QX_b = \phi_b CES(LR_b, A_b, K_b) \quad \text{(A1)}$$

$$QX_O = \phi_O CES(CD(LR_O, LU_O), K_O) \quad \text{(A 2)}$$

$$QX_{po} = CES(\phi_{po} CES(CD(LR_{po}, LU_{po}), A_{po}, K_{po}), QXI_{po}) \quad \text{(A 3)}$$

$$K_H^c = COLL^c r^{\varepsilon^c}, c \in RC \bigcup CO \quad \text{(A 4)}$$

$$LR_L = LR_L^*(PX_L, wr_R, t, r) \quad \text{(A 5)}$$

$$LR_H^c = LR_H^{c*}(PX_H, wr_R, t; K_H^c), c \in RC \bigcup CO \quad \text{(A 6)}$$

$$Ll_{po} = Ll_{po}^*(wr_R, wu, t, r, PXI_{po}) \quad \text{(A 7)}$$

$$Ll_O = Ll_O^*(PX_O, wr_U, wu, r) \quad \text{(A 8)}$$

$$A_L = A_L^*(PX_L, wr_R, t, r) \quad \text{(A 9)}$$

$$A_H^c = A_H^{c*}(PX_H, wr_R, t, r; K_H^c), c \in RC \bigcup CO \quad \text{(A 10)}$$

$$A_{po} = A_{po}^*(wr_R, wu, t, r, PXI_{po}) \quad \text{(A 11)}$$

$$K_L = K_L^*(PX_L, wr_R, t, r) \quad \text{(A 12)}$$

$$K_{po} = K_{po}^*(wr_R, wu, t, r, PXI_{po}) \quad \text{(A 13)}$$

$$K_O = K_O^*(PX_O, wr_U, wu, r) \quad \text{(A 14)}$$

$$X_{po} = X_{po}^*(wr_R, wu, t, r, PXI_{po}) \quad \text{(A 15)}$$

Income and demand

$$\prod^c = PX_H f_H(LR_H^c, A_H^c, K_H^c) - wr_R(LR_H^c + FCL^c) - tA_H^c - r(K_H^c + FCK^c), c \in RC \bigcup CO \quad \text{(A 16)}$$

$$Y^c = \begin{cases} wr_R LR^c + tA^c + rK^c + \prod^c, & c \in RC \\ wuLU^c + rK^c, & c \in UC \end{cases} \quad \text{(A 17)}$$

$$X_{PH}{}^c = \frac{a_{PH}^c (1 - mps^c) Y^c}{PQ_{PL}} - a_{PL}^c Z^c, c \in C \quad \text{(A 18a)}$$

$$X_{PL}{}^c = \frac{a_{PL}^c (1 - mps^c) Y^c}{PQ_{PL}} + \frac{PQ_{PH}}{PQ_{PL}} a_{PL}^c Z^c, c \in C \quad \text{(A 18b)}$$

$$X_O{}^c = \frac{(1 - a_{PL}^c - a_{PH}^c)}{PQ_O} (1 - mps^c) Y^c, c \in C \quad \text{(A 18c)}$$

Subject to the household budget constraint:

$$\sum_{m \in M} PQ_m \bullet X_m^c = (1 - mps^c) Y^c, c \in C$$

Savings and investment

$$S^c = mps^c * Y^c, c \in C \quad \text{(A 19)}$$

$$QINV_m = qinv_m * IADJ \quad \text{(A 20)}$$

$$FSAV + \sum_{m \in M} PQ_m * QINV_m = \sum_{c \in C} mps^c * Y^c + \prod^{CO} \quad \text{(A 21)}$$

Foreign trade

$$QQ_m = aq_m CES(QM_m, QD_m) \quad \text{(A 22)}$$

$$QX_m = at_m CET(QE_m, QD_m) \quad \text{(A 23)}$$

$$\frac{QQ_m}{QD_m} = \left(\frac{PD_m}{QM_m} * \frac{\delta_m^{\ q}}{1 - \delta_m^{\ q}}\right)^{1/(1+\sigma_m^{\ q})} \quad \text{(A 24)}$$

$$\frac{QE_m}{QD_m} = \left(\frac{PE_m}{PD_m} * \frac{1 - \delta_m^{\ t}}{\delta_m^{\ t}}\right)^{1/(\sigma_m^{\ t} - 1)} \quad \text{(A 25)}$$

$$PM_m = pwm_m * EXR \quad \text{(A 26)}$$

$$PE_m = pwe_m * EXR \quad \text{(A 27)}$$

$$PQ_m * QQ_m = PD_m * QD_m + PM_m * QM_m \quad \text{(A 28)}$$

$$PX_m * QX_m = PD_m * QD_m + PE_m * QE_m \quad \text{(A 29)}$$

$$CPI = \sum_m v_m * PQ_m \quad \text{(A 30)}$$

$$PPI = \sum_m \mu_m * PI_m \quad \text{(A 31)}$$

Equilibrium conditions

(a) *Demands equal supply for factors*

$$\sum_{i \in RI} LR_i^* + \sum_{po} LR_{po}^* + LR_U^* / T + \sum_{c \in RC \bigcup CO} FCL^c = \sum_{c \in RC} L^c \quad \text{(A 32)}$$

$$\sum_m LU_m^* = L^U \quad \text{(A 33)}$$

$$A_L^* + \sum_{c \in RC} A_H{}^{c*} + \sum_{po} A_{po}^* = \sum_{c \in C} A^c \quad \text{(A 34)}$$

$$K_L^* + \sum_{c \in RC} K_H^c + \sum_{po} K_{po}^* + K_O^* + \sum_{c \in RC \bigcup CO} FCK^c = \sum_{c \in C} K^c \quad \text{(A 35)}$$

(b) *Demands equal supply for goods*

$$\sum_c X_m^{c*} + QINV_m = QQ_m \quad \text{(A 36)}$$

$$X_{po} = QXI_{po} \quad \text{(A 37)}$$

(c) *Current account balance for ROW (in foreign currency)*

$$\sum_m PE_m * QE_m = \sum_m PM_m * QM_m + FSAV \quad \text{(A 38)}$$

Endogenous variables

wr_R , wr_U , wu , t , r	Price of factors
PX_i	Producer price of activity *i*
PXI_{po}	Producer price of intermediate product
PQ_m	Price of composite good
PD_m	Price of domestically produced good for domestic market
PE_m	Export price in domestic currency
$\prod^c$	Profit for high standards farming to agent *c*
LR_i , LU_i , A_i , K_i	Demand of factor from activity *i*
X_{po}	Demand of intermediate input from processing sector *po*
$X_m{}^{c*}$	Consumption of commodity *m* by household *c*
QX_i	Domestic production
QXI_{po}	Production of intermediate input in processing sector *po*
QQ_m	Domestic demand for composite good
QD_m	Domestic demand for domestically produced good
QE_m	Export
Y^c	Income of household *c*
YF_b^c	Factor income of household *c* from factor *b*
IADJ	Investment adjustment factor

$QINV_m$	Quantity of investment demand for commodity *m*
$FSAV$	Foreign savings (foreign currency)
CPI	Aggregate consumer price

Exogenous variables and coefficients

ϕ_i	Efficient parameter of activity *i*
$COLL^c, c \in RC \bigcup CO$	Collateral of agent *c* in high standards farming
a_m^c	Share parameter of household consumption spending on commodity *m*
pwe_m	Export price for *m* (foreign currency)
pwm_m	Import price for *m* (foreign currency)
EXR	Exchange rate (dom. Currency per unit of for. Currency)
ν_m	Weight of commodity *m* in the CPI
μ_m	Weight of commodity *m* in the PINDEX
LR^c, LU^c, A^c, K^c	Household endowment
qinvbar_m	Base-year quantity of investment demand for commodity *m*
T	Migration cost rate
mps^c	Marginal (and average) propensity to save for household *c*
FCL^c	Fixed costs in the form of rural labor
FCK^c	Fixed costs in the form of capital

Numeraire

PPI	Aggregate producer price

Functions

CES	Constant elasticity of substitution function
CD	Cobb-Douglas function
CET	Constant elasticity of transformation function

Indices and sets

i	Index for activities, $i \in I$
b	Index for intermediate sectors $b \in B = L \bigcup H$
po	Index for processing sectors $po \in PL \bigcup PH$
j	Index for factors, $j \in J$
l	Index for labor categories, $l \in L$
c	Index for agents, $c \in C \bigcup CO$
m	Index for commodities, $m \in M$
R	Set of rural activities, $R \subset I$

Table 2a. Archetype SAM of China

	Low inter.	High poor	High middle	High rich	High corp.	Low proc.	High proc.	Other com.	Rural labor	Urban labor	Land	Capital	High inter.	Poor rural	Middle rural	Rich rural	Urban	S-I	Row
Low inter.						22138.6													
High poor													70.0						
High middle													280.1						
High rich													653.5						
High corp.													159.9						
Low proc.														1950.9	5262.3	6160.0	16884.4	1781.5	761.2
High proc.														1.3	83.9	196.6	729.8	64.2	831.7
Other com.														2483.2	7598.7	12219.3	44562.7	77811.4	42412.5
Rural labor	10078.5	43.0	118.1	278.1	53.7	1304.2	68.6	29105.5											
Urban labor						3914.3	204.3	85632.3											
Land	4165.4	6.9	35.9	76.4	29.7	1461.8	76.9												
Capital	7894.8	5.0	19.9	46.4	11.4	2760.7	145.3	40037.2											
High inter.							1163.4												
Poor rural		15.2							3690.3		283.0	446.9							
Middle rural			106.2						11608.2		1355.5	1388.6							
Rich rural				252.5					25751.0		4214.5	3962.9							
Urban										89750.9		45122.3							
S-I					65.1									0.0	1513.6	15605.0	72696.3		
Row						1220.8	248.9	32312.7										10223.0	
total	22138.6	70.0	280.1	653.5	159.9	32800.3	1907.5	187087.7	41049.6	89750.9	5853.0	50920.7	1163.4	4435.4	14458.5	34181.0	134873.2	89880.0	44005.3

Source: Authors' calculation based on China's yearbooks and input/output table.

Table 2b. Matrix of average expenditure propensities for archetype China

	Low inter.	High poor	High middle	High rich	High corp.	Low proc.	High proc.	Other com.	Rural labor	Urban labor	Land	Capital	High inter.	Poor rural	Middle rural	Rich rural	Urban	S-I	Row
Low inter.						67.50													
High poor													6.02						
High middle													24.07						
High rich													56.17						
High corp.													13.74						
Low proc.														43.98	36.40	18.02	12.52	1.98	1.73
High proc.														0.03	0.58	0.58	0.54	0.07	1.89
Other com.														55.99	52.56	35.75	33.04	86.57	96.38
Rural labor	45.52	61.35	42.16	42.55	33.58	3.98	3.60	15.56											
Urban labor						11.93	10.71	45.77											
Land	18.82	9.80	12.81	11.70	18.59	4.46	4.03												
Capital	35.66	7.11	7.11	7.11	7.11	8.42	7.62	21.40											
High inter.							60.99												
Poor rural		21.74							8.99		4.83	0.88							
Middle rural			37.93						28.28		23.16	2.73							
Rich rural				38.64					62.73		72.01	7.78							
Urban										100.00		88.61							
S-I					40.73									0.00	10.47	45.65	53.90		
Row						3.72	13.05	17.27										11.37	
total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 3. Effects of world price increase ($\Delta pwe_{PH} = +25\%$)

	Capital as fixed costs (%)	Both rural labor and capital as fixed costs (%)
Aggregate effects		
Real GDP	0.08	0.08
CPI (Comparing with PPI)	-0.07	-0.07
Gini coefficient	-0.47	-0.46
Output of final goods		
Low standards food	-0.11	-0.08
High standards food	15.81	14.74
Other commodities	-0.16	-0.15
Output of high standards intermediate product		
Poor rural household	31.08	21.93
Middle-income rural household	14.50	13.48
Rich rural household	14.00	13.60
Corporate farms	12.59	12.31
Labor used in high standards intermediate product		
Poor rural household	48.22	33.51
Middle-income rural household	29.47	27.14
Rich rural household	28.90	27.96
Corporate farms	27.31	26.51
Domestic commodity price		
Low standards food	0.20	0.19
High standards food	-0.01	0.04
Other commodities	-0.20	-0.20
Factor price		
Rural labor wage	0.18	0.16
Urban labor wage	-0.29	-0.28
Land rent	1.41	1.39
Interest rate	-0.23	-0.22
Low standards intermediate product	0.26	0.25
High standards intermediate product	19.10	19.13
Poor rural household		
Profit effect	0.34	0.33
Factor income effect	0.22	0.20
Among it:		
Labor	0.15	0.13
Land	0.09	0.09
Capital	-0.02	-0.02
Consumer price effect	0.02	0.03
Total income effect	0.58	0.56
Middle-income rural household		
Profit effect	0.39	0.39
Factor income effect	0.26	0.24
Among it:		
Labor	0.15	0.13
Land	0.13	0.13
Capital	-0.02	-0.02
Consumer price effect	0.04	0.04
Total income effect	0.68	0.66
Rich rural household		
Profit effect	0.38	0.38

Factor income effect	0.28	0.27
Among it:		
Labor	0.14	0.12
Land	0.17	0.17
Capital	-0.03	-0.03
Consumer price effect	0.06	0.07
Total income effect	0.73	0.72
Urban household		
Factor income effect	-0.27	-0.26
Among it:		
Labor	-0.19	-0.19
Capital	-0.08	-0.07
Consumer price effect	0.09	0.09
Total income effect	-0.18	-0.17

Source: Authors' simulation.

Table 4. Effects of increasing preference for high standards food (%)

	$\Delta Z^{RR} = -25\%$	$\Delta Z^{U} = -25\%$
Aggregate effects		
Real GDP	-0.01	0.01
CPI (Comparing with PPI)	0.01	-0.00
Gini coefficient	-0.01	-0.01
Output of final goods		
Low standards food	-0.38	-2.15
High standards food	3.21	15.29
Other commodities	0.04	0.26
Output of high standards intermediate product		
Poor rural household	4.68	22.62
Middle-income rural household	2.95	14.04
Rich rural household	2.96	14.07
Corporate farms	2.74	13.01
Labor used in high standards intermediate product		
Poor rural household	6.54	33.85
Middle-income rural household	5.40	27.43
Rich rural household	5.55	28.16
Corporate farms	5.32	26.98
Domestic commodity price		
Low standards food	-0.09	-0.51
High standards food	3.90	17.34
Other commodities	-0.01	-0.04
Factor price		
Rural labor wage	-0.03	-0.18
Urban labor wage	0.02	0.16
Land rent	-0.33	-2.01
Interest rate	-0.07	-0.35
Low standards intermediate product	-0.10	-0.58
High standards intermediate product	3.76	18.88
Poor rural household		
Profit effect	0.06	0.34
Factor income effect	-0.05	-0.31
Among it:		
Labor	-0.02	-0.15

Land	-0.02	-0.13
Capital	-0.01	-0.03
Consumer price effect	0.04	0.24
Total income effect	0.05	0.27
Middle-income rural household		
Profit effect	0.07	0.40
Factor income effect	-0.06	-0.36
Among it:		
Labor	-0.02	-0.14
Land	-0.03	-0.19
Capital	-0.01	-0.03
Consumer price effect	0.02	0.12
Total income effect	0.03	0.15
Rich rural household		
Profit effect	0.07	0.39
Factor income effect	-0.07	-0.42
Among it:		
Labor	-0.02	-0.13
Land	-0.04	-0.25
Capital	-0.01	-0.04
Consumer price effect	-0.01	0.01
Total income effect	-0.00	-0.02
Urban household		
Factor income effect	-0.01	-0.01
Among it:		
Labor	0.01	0.11
Capital	-0.02	-0.12
Consumer price effect	-0.01	-0.04
Total income effect	-0.02	-0.05

Source: Authors' simulation.

Table 5. Effects of declining credit constraint (%)

	$\Delta C^{RP} = +50\%$	$\Delta C^{RM} = +50\%$	$\Delta C^{RR} = +50\%$	$\Delta C^{CO} = +50\%$
Aggregate effects				
Real GDP	0.01	0.03	0.06	0.02
CPI (Comparing with PPI)	0.00	0.00	0.01	0.00
Gini coefficient	-0.04	-0.12	-0.16	-0.01
Output of final goods				
Low standards food	-0.08	-0.32	-0.77	-0.22
High standards food	2.87	11.45	26.60	6.53
Other commodities	-0.01	-0.02	-0.05	-0.00
Output of high standards intermediate product				
Poor rural household	49.71	-0.70	-1.57	-0.42
Middle-income rural household	-0.13	49.28	-1.06	-0.29
Rich rural household	-0.13	-0.49	48.36	-0.30
Corporate farms	-0.13	-0.49	-1.07	49.54
Labor used in high standards intermediate product				
Poor rural household	43.83	-0.89	-1.98	-0.54
Middle-income rural household	-0.20	46.75	-1.67	-0.47

Rich rural household	-0.21	-0.78	46.48	-0.49
Corporate farms	-0.20	-0.78	-1.72	49.33
Domestic commodity price				
Low standards food	0.01	0.04	0.08	0.03
High standards food	-0.13	-0.49	-1.12	-0.30
Other commodities	-0.00	-0.01	-0.01	-0.00
Factor price				
Rural labor wage	0.03	0.05	0.13	0.01
Urban labor wage	-0.00	-0.01	-0.02	0.00
Land rent	0.03	0.22	0.36	0.19
Interest rate	-0.01	-0.04	-0.08	-0.02
Low standards intermediate product	0.01	0.05	0.10	0.03
High standards intermediate product	-0.12	-0.46	-1.05	-0.28
Poor rural household				
Profit effect	0.25	-0.01	-0.02	-0.00
Factor income effect	0.02	0.06	0.12	0.02
Among it:				
Labor	0.02	0.04	0.11	0.01
Land	0.00	0.01	0.02	0.01
Capital	-0.00	-0.00	-0.01	-0.00
Consumer price effect	-0.00	-0.02	-0.03	-0.01
Total income effect	0.26	0.03	0.07	0.00
Middle-income rural household				
Profit effect	-0.00	0.38	-0.02	-0.01
Factor income effect	0.02	0.06	0.13	0.02
Among it:				
Labor	0.02	0.04	0.10	0.01
Land	0.00	0.02	0.03	0.02
Capital	-0.00	-0.00	-0.01	-0.00
Consumer price effect	-0.00	-0.01	-0.02	-0.01
Total income effect	0.02	0.43	0.09	0.01
Rich rural household				
Profit effect	-0.00	-0.01	0.35	-0.01
Factor income effect	0.02	0.06	0.13	0.03
Among it:				
Labor	0.02	0.04	0.10	0.01
Land	0.00	0.03	0.04	0.02
Capital	-0.00	-0.00	-0.01	-0.00
Consumer price effect	-0.00	-0.01	-0.01	-0.00
Total income effect	0.02	0.05	0.47	0.02
Urban household				
Factor income effect	-0.01	-0.02	-0.04	-0.01
Among it:				
Labor	-0.00	-0.01	-0.01	0.00
Capital	-0.00	-0.01	-0.03	-0.01
Consumer price effect	-0.00	-0.00	-0.00	-0.00
Total income effect	-0.01	-0.02	-0.04	-0.01

Source: Authors' simulation.

Table 6. Source of household income (%)

	Rural labor	Urban labor	Land	Capital	Profit	Total
Poor rural	83.2		6.4	10.1	0.3	100.0
Middle-income rural	80.3		9.4	9.6	0.7	100.0
Rich rural	75.3		12.3	11.6	0.7	100.0
Urban		66.5		33.5		100.0

Source: Based on SAM in Table 1a.

Table 7. Parameters applied in the model

	Intermediate product	Final food		Other commodities
Elasticity of factor substitution	0.7	0.15 (Agg.); 0.8 (Sub-nest)		0.9
Armington elasticity of substitution	-	3.0		0.5
Elasticities of transformation	-	1.2		0.8
	Poor	Middle	Rich	Urban
Income elasticity of low standards food	0.9	0.7	0.4	0.1
	Poor-high	Middle-high	Rich-high	Corporate farms
Price elasticities of capital supply	0.7	1.0	1.3	1.6

Table 8. Literature survey: the elasticity of input factor substitution

	Klump, et al. (2007)	Piesse and Thirtle (2000)	Baffes and Vasavada (1989)	Kako (1978)	Binswanger (1974)
Elasticity of factor substitution	0.5 to 0.6	0.011 to 0.098	-0.316 to 1.091	-0.9 to 0.93	-1.622 to 2.987
for countries	U.S.	Hungary	U.S.	Japan	U.S.

Source: Ciaian et al., 2002 with additional review on China.

Table 9. Literature survey: the Armington elasticity of substitution

	Davis (1993)	Blonigen and Wilson (1999)	Gallaway et al. (2000)	Ronald-Holst et al. (1992)
Elasticity of substitution	3.41	-0.96 to 3.52	0.52 to 4.83	0.02 to 1.22
For countries	Japan	U.S.	U.S.	U.S.
Number of industries/commodities	wheat	146 industries	309 industries	22 industries

Source: Ciaian et al., 2002.

Table 10. Literature survey: the own-price elasticity of foreign demand (exports)

	Zhuang and Abbott (2007)	Tweeten (1967)	Johnson (1977)	Senhadji and Montenegro (1999)	Stern, et al. (1976)
Price elasticity of foreign demand	−0.311 to −3.974	-6.42	-6.69	short-run: -0.0 to -0.96 long-run: -0.02 to -4.72	long-run: -0.23 to -4.14
for countries	China	U.S.	U.S.	53 countries	18 countries

Source: Ciaian et al., 2002 with additional review on China.

Table 11. Literature survey: the income elasticity

	Zhuang and Abbott (2007)	Tiffin. and Tiffin .(1999)	Flood el. al (1984)	Van Driel et. al (1997)	De Crombrugghe et. al (1997),	Lluch et al. (1975)
Income elasticity	0.079 to 0.768	0.524	0.3 to 0.72	0.35, 0.65, 0.75	0.386 to 0.610	0.316 to 1.143
Number of countries	China	UK	Japan and Sweden	U.S. Netherlands	U.S. Netherlands	19

Source: Ciaian et al., 2002 with additional review on China.