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

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Abstract

We develop a general equilibrium households model to analyze the effects of high standards food chains taking seriously into account market imperfections. To measure structural production changes and welfare effects on rural and urban households, our model has two types of agents, five kinds of products and four types of factors. We calibrate the model using dataset from China and do simulations through three ways: increasing world price of high standards food, increasing urban households' preference for high standards food, and relaxing credit constraints on high standards food production. The simulation results show that how poor households are affected depends on the nature of the shocks leading to the expansion of high standards sector and the market imperfections, and whether the poor can gain through the labor market if they are excluded from high standards farming.

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1 INTRODUCTION

A series of recent studies have identified the spread of 'high standards' 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 recent years it has been 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.[1]

Although high standards emerged initially in rich countries, they now affect poorer countries through several channels. First, standards in richer countries are also imposed on imports and consequently have an impact on producers and traders in exporting nations (Jaffee and Henson, 2004; Unnevehr, 2000). Second, global supply chains are playing an increasingly important role in world food markets and the growth of these vertically coordinated marketing channels is facilitated by increasing standards (Swinnen, 2007). 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 food quality and safety in this sector wherever they are doing business (Dolan and

[1] 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 (Copeland and Taylor, 1995; Besley and Ghatak, 2007); 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).

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 or to minimize transaction costs in supply chains (Reardon et al., 2003).

Early studies argued that the penetration of international marketing chains was much more widespread than people originally thought (e.g., Gulati et al., 2007; World Bank, 2005) and predicted that the implications of these developments would be vast: a new development paradigm was emerging (Reardon and Timmer, 2005).

Importantly, the early literature also posited that the rise of standards could have sharp negative influences on equity and poverty. Several of the studies argued that 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 this process (Farina and Reardon, 2000). 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 a study on 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. 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, 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) and Dries, et al. (2009) find that high standards lead to increased vertical coordination in supply chains which improves access to credit, technology and quality inputs for poor, farmers in Eastern Europe. Minten et al. (2007) and Maertens and Swinnen (2009) also find increased vertical coordination in newly emerging supply chains between buyers and farms 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 literature – in addition to empirical problems – is the absence of consistent and comprehensive conceptual framework for interpreting the empirical findings. Related to this, very few of the empirical studies actually measure 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 studies that actually examine poverty effect are Maertens and Swinnen (2009) and Maertens et al. (2008). They find strong poverty reducing 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.

The objective of this paper is to develop a general equilibrium model to measure the process through which high standards production and consumption affects development.

The model has both a low standard and high standard supply chain and we explicitly integrate key characteristics of many developing and emerging economies, such as capital constrains and labor market imperfections.[2] We use the model to analyze how and through which channels welfare of rural and urban households is affected.

The development of high standards food sector in China is particularly relevant for three reasons. First, even though China has sustained high growth rates for nearly thirty years and the continuously increasing income per capita leads to structural change of Chinese diet (Gale and Huang, 2007), the food distribution system remained laggard until very recently. However, recent years are characterized by the fast rising supermarkets (Hu et al., 2004; Wang et al., 2007). Yet 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 is only now starting and will undoubtedly have huge impact on both producers and consumers. Second, despite high growth rates, an increasing inequality between wealthy and poor households becomes a more and more acute issue (Ravallion, 2001). After the initially fast decrease of poverty rate, in the last decade China faces more difficulties in reducing the rural poverty (Chen and Ravallion, 2007; Riskin, 2004). The welfare and poverty effects associated with the expansion of high standards food sector are therefore very important. 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), factor markets imperfections remain important. Therefore, China provides a very interesting case for research on the interaction between the food system transition and the acute equity and poverty problem under conditions of market imperfections.

[2] The technical reason for taking into account market imperfections is that the implicitly assumed higher profitability in high standards food sector can only exist under the condition of market imperfections according to the view of Industrial Organization. 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. 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.

2 THEORETICAL FRAMEWORK

The underlying theoretical framework is based on the general equilibrium approach to households models addressing development issues (e.g., de Janvry and Sadoulet, 2002; Stifel and Thorbecke, 2003). We extend the underlying approach to integrate low and high standards food and also account for market imperfections. Figure 1 and Table 1 summarize the model structure.

There are two kinds of agents: households (*C*) and corporate farms (*CF*).[3] In order to study the distributional consequences of standards, we distinguish urban and rural households, and rural households are further separated into several groups. There are four types of factor inputs: rural labor (LR), urban labor (LU), capital (K) and land (A), with rural households (*CR*) owning three types of them: rural labor, land and capital, while urban households (*CU*) owning urban labor and capital.

Five commodities are produced in the economy, with three final goods: low standards food (*LF*) and high standards food (*HF*) and other commodities (*O*)[4]. There are two types of agricultural intermediate products: low standards (*L*) and high standards (*H*), which are exclusively used by their respective food processing sectors to produce the respective final food. Given that the main focus of the paper is on food standards, we also don't include intermediate goods in other sectors.[5] All sectors have zero profit except the high standards intermediate sector, where all rural households and corporate farms are initially engaging and

[3] To avoid confusion between notations for households and high standards, we use capital '*C*' and '*H*' to indicate households and high standards respectively. Later, to differentiate with activity set, noted as '*I'*, we use '*O'* as the notation for the industrial sector. We use '*LF*'/'*HF*' and '*L*'/'*H*' for low/high standards final food and low/high standards intermediate products respectively.

[4] 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).

[5] 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.

earn positive profits because credit constraints limit their production capacity to satisfy the equilibrium market demand if the market were under perfect competition and lead to positive profit.

We assume a partially open economy, i.e., all final goods are traded with the rest of the world (*ROW*) while intermediate goods and factors are domestically used. For simplicity, we do not include government and taxes in the model.

2.1 Production and factor market imperfections

All the production technologies are based on nested constant elasticity of substitution (*CES*) functions with possible sub-nests in the form of Cobb-Douglas (*CD*) functions. The intermediate sectors produce goods according to a *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 (other than intermediate inputs), aggregated through a *CES* function with a sub-nest of a *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 a *CD* function for labor. The factor demand from these activities is derived from the production functions except in the following situations:

First, in order to produce high standards intermediate product, farms face some fixed investment cost to satisfy the standards requirement (Farina and Reardon, 2000; Maertens and Swinnen, 2009). Following Harris (1984) and without loss of generality, we assume that these fixed costs are a mixture of rural labor (φ) and capital (ψ), mostly compatible to the reality.

Second, rural households are often credit constrained (See, e.g., Barham et al., 1996; Hallward-Driemeier et al., 2003; Swinnen and Gow, 1999). We assume that, because of rural credit market imperfections, rural households and corporate farms face credit constraints in their production for the high standards intermediate product market. To model this we assume

that the supply of capital in the high standards intermediate sector (K_H^c) for the engaging households and corporate farms are constrained as follows:[6]

(1) $K_H^c = \kappa^c r^{\varepsilon^c}, c \in CR \bigcup CF$

where κ^c is the collateral, r the price of capital, and ε^c the capital supply elasticity.

Third, to model the labor market, we use stylized facts from 'typical' developing economy. Net wages of workers in rural region are generally lower than wages of workers in urban region, even when rural workers migrate to urban areas. This can be explained by different skills of different labor types or by transaction costs of migration (Stifel and Thorbecke, 2003). To account for this, we model the labor market as two separate sub-markets with different skill labor (rural and urban labor), and migrating from rural to urban region is subject to iceberg transaction costs, τ, with $0 < \tau < 1$. Thus, $wr_U = wr_R / \tau$, where wr_U and wr_R are the wages for rural workers working in urban and rural regions respectively. Finally, as usual in CGE modeling, we assume that leisure is not an argument of the worker's utility function so that labor is supplied inelastically.

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) $\prod^c = PX_H f_H(LR_H^c, A_H^c, K_H^c) - wr_R(LR_H^c + \varphi^c) - tA_H^c - r(K_H^c + \psi^c), c \in CR \bigcup CF$

Profit of corporate farms are transferred to involved factors proportionally according to their value shares in production.[7] Rural households' net income (Y^c) is the sum of its profit in high standards farming, factor incomes and profit sharing from corporate farms while the

[6] We only cite the most critical equations in our model while keep the set of all equations in Table 1.

[7] The actual distribution of profits among factors depends on the bargaining power of factor owners (Swinnen et al., 2009). In fact, because the profit is not a big amount comparing with the overall factor incomes, our assumption will have no significant impact on the empirical results except in simulation 3C, where profit of corporate farms increase sharply.

urban households' income is only composed of factor incomes and profit sharing:

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

where γ^c is the endogenous share parameter of transferred profit from corporate farms.

Households' demand for consumption goods is a function of their disposable income and the vector of consumer prices. We assume that high standards food is a luxury good compared to low standards food products. Accordingly, households consumption is described by the following system:[8]

$$(4a)\quad X_{HF}{}^c = \frac{a_{HF}^c (1 - mps^c) Y^c}{PQ_{LF}} - a_{LF}^c \zeta^c, c \in C$$

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

$$(4c)\quad X_O{}^c = \frac{(1 - a_{LF}^c - a_{HF}^c)}{PQ_O} (1 - mps^c) Y^c, c \in C$$

subject to the households 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 households consumption function, mps^c the saving rate for households and ζ^c a parameter determining the degree of preference for low standards food. A smaller ζ^c means a larger preference for high standards food.

2.3 Foreign trade and savings/investment

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 captured by the

[8] 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)

substitutability between imported and domestic goods on the consumption side through a *CES* aggregation function (Armington substitution function), and on the production side through a constant elasticity of transformation (*CET*) function. The relative prices of foreign goods are determined by international prices and the exchange rate.

In order to model savings and investment, we make the following three widely used assumptions: (1) savings are determined by exogenous constant rates for households; (2) private investment is savings driven; and (3) investment spending is allocated to commodities in fixed proportions.[9] For simplicity and data paucity, we further assume that only the final commodities are used as investment goods, while intermediate commodities not. Total savings have to equal total investments.

2.4 Equilibrium conditions and other price equations

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.[10]

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) $CPI = \sum_m \nu_m * PQ_m$

[9] 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).

[10] 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) $PPI = \sum_m \mu_m * PI_m$

The *PPI* is normalized so that the comparative statics are meaningful.[11]

3 MEASURING THE WELFARE EFFECTS

To determine the welfare effects of expansion of the high standards sector, we have to measure the welfare change of individual households. We measure households welfare (W^c) by real income, which is nominal income (Y^c) normalized by households-specific price index (P^c):[12]

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

The model allows us to analyze two types of effects: nominal income effects and consumption price effects. Income effects can be disaggregated into a profit effect, a profit sharing effect and a factor income effect for rural households while urban households only experience a change in profit sharing and factor incomes. The factor income effect can be further disaggregated into income effects of specific factors.

By including different types of rural households in our model we can measure welfare effects for representative households. To draw implications on poverty, we assume that the within group income distributions do not change.[13]

To measure inequality we calculate a Gini coefficient using the trapezium rule:

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

[11] 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.

[12] The way applied here is consistent with de Janvry and Sadoulet (2002).

[13] 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)

where N^c and Y^c are the cumulated proportions of population and income respectively.

4 EMPIRICAL IMPLEMENTATION

We calibrate the model to 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. The CGE model is operationalised using the General Algebraic Modelling System (GAMS) software (Brooke et al., 1988).[14] The model is calibrated so as to reproduce 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 commodity prices and factor prices, except wage of rural labor working in urban region, are initially equal to unity.[15] 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 distributional shares of labor income, land income, capital income, profit and investment, reflect the values observed in the data base.

Second, elasticities are drawn from the relevant literature shown in Table 6. Appendix B provides detailed overview of all relevant elasticities with references to their sources and Table 5 summarizes elasiticities applied in our model. At first, 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 households respectively. Such structure is compatible with the literature and the stylized facts that poor households consume a relatively larger share of staple (low standards) food compared to wealthy households (Lipton, 2001). On the import side, a relatively low

[14] The source code is available from the authors upon request.
[15] 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).

aggregation elasticity between imports and domestic consumption goods is assumed (elasticity of 0.5) for the other commodities sector, which 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). Thirdly, 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. Finally, 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 (e.g., Wang and Schuh, 2002). The elasticity of substitution among basic 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 intermediate activities 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

High standards food is typically the food produced according to good practices for outcomes and processes. They are the higher end of the differentiable food such as vegetables and follow some special institutional arrangements to guarantee the high standards. There are no precise data on the high standards sector because it is just an emerging sector in China. Since it is widely accepted that high standards farming is relatively labor intensive compared with other activities especially in developing countries with rich labor endowment (Bijman,

2008; Miyata, et al., 2007; Weinberger and Lumpkin, 2007),[16] first we construct a SAM and do simulations, assuming labor intensive production technology in high standards farming. Then we deal with capital intensive production technology in high standards farming to show the robustness of our results. Since the profit rate of contract farming is larger than that of non-contract farming from the sample data of Miyata et al. (2007), the difference (11.2%) is treated as the positive profit for the middle-income households in our case. And we proxy the input/output of high standards intermediate product by the weighted average of high value products including tobacco, tea, peanut, sugar cane, beet and apple, which as a whole occupies 9.3% of the total farming land. As small households often have smaller profit rates and higher labor intensity in high standards farming (Birthal et al., 2005), we structurally set different profit rates and input/output ratios for rural households and corporate farms. When constructing the SAM under assumption of capital intensive technology in high standards farming, we reverse capital and labor use structurally so that the SAM keeps balance. The actual production structures for each situations can be found in Table 2.

We distinguish urban and rural households and the rural households are separated into three groups by their income level: poor, middle-income and rich rural households. Poor rural households defined in our model do not necessarily correspond to the official definitions of poverty level, as there are probably people who are included in the poor rural households group but not poor by the defined threshold of poverty. In fact, 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 officially defined poor people.

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

[16] From the literature on contract farming, one reason for the inclusion of small holders is that they have relatively better endowment of labor to cater to the requirement of higher standards farming (Bijman, 2008).

change other variables which induce increases in demand and supply of high standards food. We simulate the expansion of high standards food by (1) increasing the world price for high standards food, (2) increasing households preferences for high standards food, and (3) relaxing credit constraints in high standards farming. Table 3 report the simulation results. Previewing our simulations results, we find that poor rural households may benefit in all three high standards food growth scenarios. Since labor intensive production in high standards farming is more possible especially for labor-rich countries, like China, we first describe the results under assumption of labor intensive technology from section 5.1 to 5.3. Then in section 5.4, we compare the results under different assumptions of technology.

5.1 An increase in the world price for high standards 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. To study the potential impact of these developments, we exogenously increase the world market price, pwe_{HF} , by 25%. The simulation results are reported in the first column of Table 3a.

The output of high standards and low standards food increase by 10.60% and 0.10% respectively, while the output of other commodities decrease by -0.14%, because of the high standards sector's competition for factors. All producers of high standards food produce more but with different rates, because they use factors in different proportions. The high standards output of poor rural households increases by 10.90%. These benefits for poor rural households can be explained as follows: The higher price for high standards food directly results in higher profit and income for rural households. The increasing income leads to more consumption, and hence a higher price, of their preferred low standards food (+0.12%). The

prices of factors used intensively in these two sectors increase with different ratios (+0.07% and +1.09% for rural labor and land respectively). The land rent increases more because the larger low standards sector is more land-intensive comparing with the high standards sector. The households, which use relatively more the less expensive factor in the production of high standards intermediate product, i.e., poor rural households using more rural labor in the present case, has a comparative advantage and expands its output more.[17]

The real incomes of poor, middle-income and rich rural households increase by 0.54%, 0.64% and 0.67%, respectively, resulting mainly from increasing profits in high standards farming and increasing factor incomes. In contrast, urban households income decreases (-0.13%), because the gain from the lower price index is smaller than the loss from factor income.[18] Hence, our simulation results suggest that poverty will decrease because all rural households benefit. The Gini coefficient decreases by 0.41%, implying that the overall inequality would decrease.

In summary, a price induced expansion in the high standards food sector would benefit all rural households in China because all rural households increase their productions and hence profits of high standards intermediate product. Another critical issue making poor rural households relatively better off and urban households relatively worse off is the initial factor endowments, i.e., rural households benefit because they own relatively more factors that are employed in the expanding high standards food sector.

5.2 An increase of preferences for high standards food

The preference for high standards food increases often gradually with increasing income (Gale and Huang, 2007) while sometimes sharply when there happens some special event like the scandal in the dairy sector of China (Xinhua Net, 2008). In this section we assess welfare

[17] The welfare effects seem to be small. This is because the high standards sector is a small part of agricultural sector, and hence a minor part in the whole economy.

[18] The reason, why their price index decreases, lies in their relative changes to the normalized PPI, which is directly impacted by the change of the world price. Because the PPI increases more, the price index of urban households declines relatively even though their nominal index may increase.

effects of changes in urban households preferences, i.e., decreasing the preference parameter, ζ^{CU}, by 25%. The simulation results are reported in the second column of Table 3a.

Outputs of high standards food and other commodities increase by 10.63% and 0.25% respectively while output of low standards food decreases by 1.84%. All farmers producing high standards intermediate product increase their output, especially poor and middle-income rural households (+11.13% for each), indicating that, above all, poor rural households would benefit from relatively higher demand for high standards food.

The real income of poor, middle-income and rich rural households increase by 0.43% 0.30% and 0.09%, respectively. This is caused mainly by the increasing profit (+0.33%, +0.40% and +0.39%) and decreasing price indices, which covers the negative effects of decreasing factor income (-0.23%, -0.29% and -0.36%). Profits increase because the price of high standards intermediate product increases by 19.37% while the intensively used factor prices decrease. Since the representative poor households benefit from this change, the poverty decreases. As a result relative income for urban households decreases (-0.06%), inequality decreases (Gini coefficient decreases by 0.08%).

In summary, preference changes are anti-poverty and pro-equity. As expected, urban households lose from these changes because they do not produce the high standards food.

5.3 Increases of farm access to credit

In China credit constraints are likely to constrain rural households from entering into (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, the Chinese government has decided to take steps to help rural households get easier access to finance (CCCPC, 2008). In this section we assess the possible welfare effects of relaxing credit constraints for rural households and corporate farms, which we model as a 50% increase in the collateral value, κ^c. We perform three sets of simulations by relaxing credit

constraints for poor and rich rural households, and corporate farms respectively. The simulation results are reported in the last three columns of Table 3a.

The first set of simulation results, when the collateral of poor rural households increases by 50%, is shown by the third column of Table 3a. The profit of poor rural households increases, contributing 0.12% to the total income increase. Lower credit constraints lead to a larger production of high standards intermediate products for poor rural households (+49.88%). The real income of poor rural households increases by 0.13%, which is caused mainly by increasing profits in the high standards intermediate sector. Given that poor rural households gain from better access to credit, poverty decreases. The Gini coefficient decreases by 0.02% indicating that the inequality decreases too.

The forth column of Table 3a reports simulation results, when the collateral of the rich rural households increases by 50%. The real income of poor and middle-income rural households increases by 0.02% and 0.03%, respectively, caused by the increasing factor income (+0.06% and +0.07% respectively), which covers the negative effects of decreasing profits in the high standards farming (-0.02% for both) and negative price effects (-0.02% and -0.01% respectively). Profits decrease because the price of high standards intermediate product decreases by 1.09%, resulting from the relaxed credit constraint, while prices of most factors except capital increase, because of increased competition for factors from the rich rural households. The price effect for poor and middle-income rural households is negative (the aggregate consumption price increases), because rural households have a high share of low standards food than high standards food in their consumption basket. 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 households, the rural poverty decreases. In contrast, rich rural households benefit (+0.19%) and urban households lose (-0.02%). The Gini coefficient decreases by 0.07%, implying that

the inequality decreases.

The last column shows the results of increasing collateral of corporate farms by 50%. This process leads to a decline of poor rural households output by 0.18%. However, the real income of poor, middle-income and rich rural households increases slightly (+0.03% for each of them), mainly by the increasing profit sharing from corporate farms (+0.02% ,+0.02% and +0.01% respectively) and factor income of rural labor (+0.01% for each), 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 0.02%, implying that the inequality decreases.

In summary, the effects of asymmetrically relaxing credit constraints for different types of rural households and corporate farms are exclusive if targeted to other agents instead of poor rural households. Nevertheless, they benefit all rural households because of spillover effects through the labor market. These results contradict most previous literature, which usually argue that poor rural households will lose because they are excluded from the high standards sector after the entry of large farms, represented by rich rural households and corporate farms in our model. When factor income is the main source of income and the high standards sector is small, the overall effect of large (corporate) farm entry may be positive. This simulated effect is consistent with findings by Maertens and Swinnen (2009).

5.4 Comparison with capital intensive technology in high standards farming

For simulations with world price and preference changes, the results are similar. Rural households still gain in real incomes but benefit less. For example, when world price for high standards food increases, under labor intensive technology, the real income of poor rural households increases by 0.54%, while increasing by 0.51% under capital intensive technology.

However, for the other three pairs of simulations, results have more significant difference.

Especially when we relax credit constraint of rich rural households, poor rural households can gain positive real income effect because factor income increase cover the loss of profit from high standards farming under labor intensive technology, but gain negative real income effect (-0.01%) because positive factor income effect (+0.02%) is not so strong to cover negative profit and consumer price effects (-0.02% respectively) under capital intensive technology. Hence, in the latter case, poverty increases. And even though poor rural households may lose somehow, Gini coefficient decreases (-0.04%) under this simulation because rural households benefit generally comparing with urban households (-0.00%).

Therefore, even though high standards sector may utilize capital intensive technology in some cases, poor rural households can benefit under several conditions. However, since poor rural households can get less from factor market, they may lose if other players in high standards market have more advantageous conditions.

5.5 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 robust to alternative assumptions on income elasticities of low standards products ($\sigma_{LF}{}^{RP} \in (1.35,\ 0.9,\ 0.45)$ for poor rural, and structural modification of elasticities for the other households).

Second, alternative choices of the elasiticities of transformation ($\sigma_{LF}{}^{t} \in (0.6,\ 1.2,\ 1.8)$, $\sigma_{HF}{}^{t} \in (0.6,\ 1.2,\ 1.8)$ and $\sigma_{O}{}^{t} \in (0.4,\ 0.8,\ 1.2)$) and the elasticities of substitution ($\sigma_{LF}{}^{q} \in (1.5,\ 3.0,\ 4.5)$, $\sigma_{HF}{}^{q} \in (1.5,\ 3.0,\ 4.5)$ 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 then have some impacts on the simulations of preference changes. The reason why the simulation results of preference change are sensitive to different assumptions of elasticities in trade lies in the fact that 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 then have 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 using a CGE model with several kinds of market imperfections such as credit constraints and transaction costs. We explicitly model credit constraints and its consequences for poverty and equity. In addition, we model households'

preferences for high standards food with a Stone-Geary utility function to explicitly model and simulate the demand for high standards food.

We use the dataset of China 2005 to calibrate our model and perform three simulations: the effect of an increase in the world price of high standards food, an increase urban households' preference for high standards food, and a reduction in credit constraints. First, the simulation results show that poor rural households will expand their production of high standards product with the increase of world price for high standards food. In this way an expansion in the high standards food sector leads to a reduction of poverty and of inequality. Second, expansion of high standards sector resulting from preference changes also increases real incomes of poor and middle-income rural households, and also reduces poverty and inequality. Third, a reduction in credit constraints induces an increase in high standards farming. This benefits all farms. However, if the improvement in credit access is limited to larger and richer farms, these households will gain more, while other rural households gain less, but they still gain through factor market effects (in particular labor). This result demonstrate a more general conclusion on the role of factor markets. Especially the labor market may play an important role in the sence that even when excluded from the high standards sector because of credit constraints, households can get higher wages from the labor market if the labor market is efficient to relocate the excluded labor.However if the transaction costs in the labor market are high that labor cannot relocate to more beneficial labor markets, they may become unemployed labor without farming as income source of subsistence. Therefore, the efficiency of labor markets is an important issue.

Finally, our paper shows the importance of taking into account all the relevant effects. The simulation results have shown that the general equilibrium effects are different from the partial equilibrium effects. The overall welfare effects of standards on poor rural households are determined by the tradeoff of all the relevant effects. Overlooking some effects may

arrive at biased, and sometimes wrong, policies. 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.

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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.[19]

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. As we have stated that the concept of standards includes so many aspects that 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.[20] 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 contribution rates of traditional staple goods, i.e., wheat, maize and rice, as proxies to calculate the contribution rates. Since the combination of the three crops has a share of more than 60% of the whole farming land in the sampled crops in the yearbook (CMA, 2006), it is regarded as a robust proxy for low standards food. From the sample data of Miyata et al.

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

[20] We can have several unsatisfying alternative proxies based on different definition of high standards food, 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..

(2007), the profit rate of contract farming is 11.2% higher than non-contract farming, which is regarded as the positive profit for the middle-income household in our case since other sectors are assumed as having zero profits. We proxy the input/output of high standards intermediate product by the weighted average of high value products including tobacco, tea, peanut, sugar cane, beet and apple, which as a whole occupies 9.3% of the total farming land. As small households often have smaller profit rates and higher labor intensity in high standards farming (Birthal et al., 2005), we structurally set different profit rates and input/output ratios for households and corporate farms. When constructing the SAM under assumption of capital intensive technology in high standards farming, we reverse capital and labor use structurally so that the SAM keeps balance.

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 Households 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 households 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

shares in input/output table.

The division of income between rural[21] and urban households is based on the income per capita and ratio of population. 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 households and urban households 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 households income structures are concerned, the yearbook only divides income data into four parts: Income from wages and salaries, from households 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 households 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 activities, like transportation, we use its total amount as proxy to farming operations since we can't differentiate them. As for urban households, its income from wages and salaries is

[21] 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)

treated as income from labor. And the incomes from households operations and from properties are added up to income from capital.[22]

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[23] 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[24]

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 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

[22] 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.
[23] 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.
[24] This method is referred to St-Hilaire and Whalley (1983).

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 households 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 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 6. The median of the estimates ranges from 0.2 to 1.1. Table 5 (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 7, and Table 5 (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 8, and Table 5 (row 4) gives values applied in the model.

A survey of income elasticities of food demand is given in Table 9. 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.[25] 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 5 (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 5 (row 8) gives values applied in the model.

[25] 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

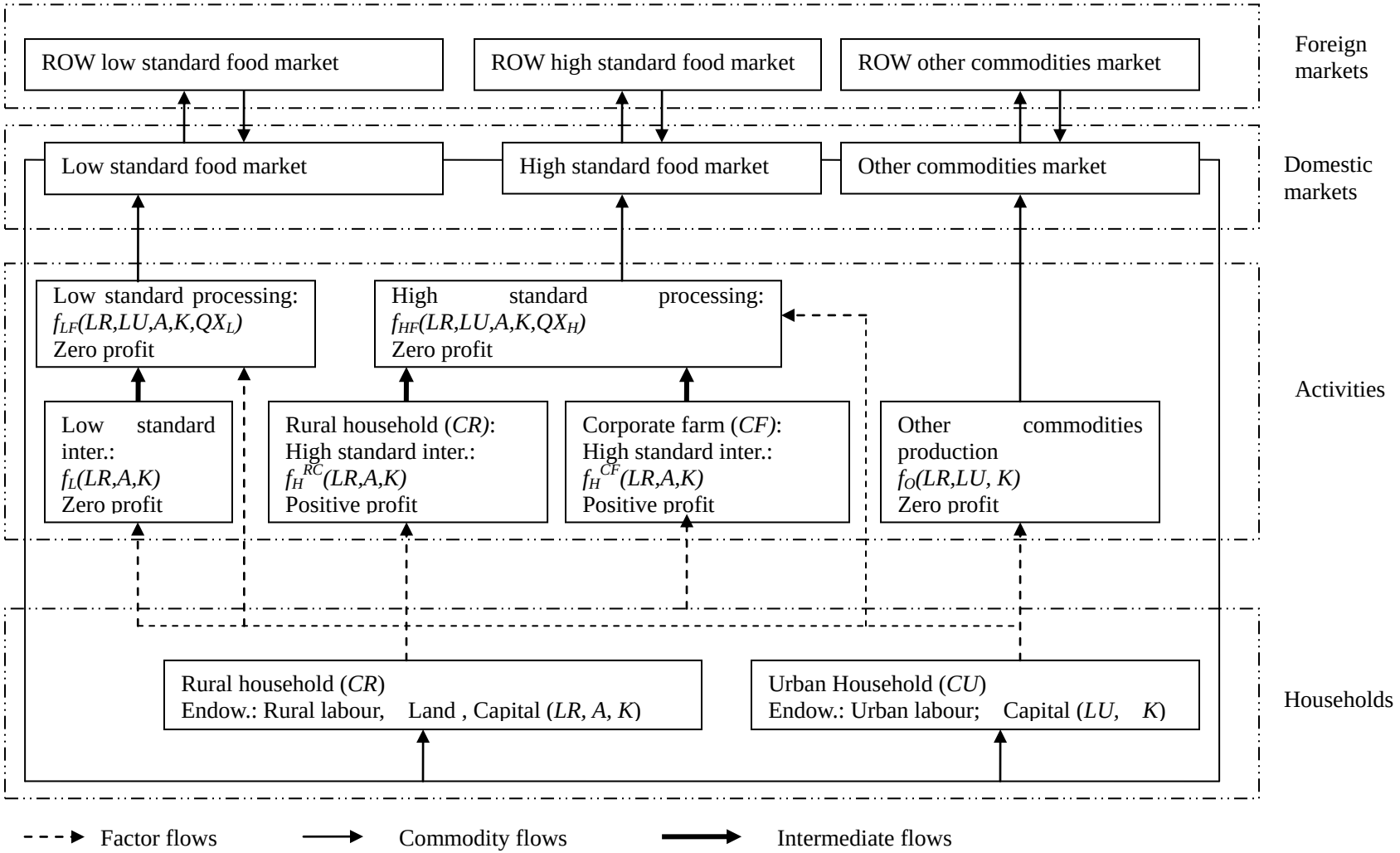

Table 1 The Model

Production and factor demand

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

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

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

$$K_H^c = \kappa^c r^{\varepsilon^c}, c \in CR \cup CF \quad \text{(A 4)}$$

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

$$LR_H^c = LR_H^{c*}(PX_H, wr_R, t; K_H^c), c \in CR \cup CF \quad \text{(A 6)}$$

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

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

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

$$A_H^c = A_H^{c*}(PX_H, wr_R, t, r; K_H^c), c \in CR \cup CF \quad \text{(A 10)}$$

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

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

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

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

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

Income and demand

$$\prod^c = PX_H f_H(LR_H^c, A_H^c, K_H^c) - wr_R(LR_H^c + \varphi^c) - tA_H^c - r(K_H^c + \psi^c), c \in CR \cup CF \quad \text{(A 16)}$$

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

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

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

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

Subject to the households budget constraint:

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

Savings and investment

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

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

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

Foreign trade

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

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

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

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

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

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

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

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

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

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

Equilibrium conditions

(a) *Demands equal supply for factors*

$$\sum_{i \in RI} LR_i^* + \sum_{po} LR_{po}^* + LR_U^* / \tau + \sum_{c \in CR \cup CF} \varphi^c = \sum_{c \in CR} L^c \quad \text{(A 32)}$$

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

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

$$K_L^* + \sum_{c \in CR \cup CF} K_H^c + \sum_{po} K_{po}^* + K_O^* + \sum_{c \in CR \cup CF} \psi^c = \sum_{c \in C} K^c \quad \text{(A 35)}$$

(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*
γ^c	Endogenous share parameters of transferred profit from corporate farms
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 households *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 households *c*

YF_b^c	Factor income of households *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* for different level of nests
$\kappa^c, c \in CR \bigcup CF$	Collateral of agent *c* in high standards farming
a_m^c	Share parameter of households 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)
v_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	Households endowment
τ	Migration cost rate
mps^c	Marginal (and average) propensity to save for households *c*
φ^c	Fixed costs in the form of rural labor
ψ^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 2. Archetype SAM of China

a. Labor intensive technology in high standards farming

	Low inter.	High poor	High middle	High rich	High corp.	Low proc.	High proc.	Other com.	Rural labor	Urban labor	Land	Capital	LaborRCFP	LandCFP	Capital CFP	cfpro	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.																		2473.5	7512.6	12044.0	44566.5	77807.0	42412.5
Rural labor	7912.1	32.0	113.8	232.9	57.0	1304.2	68.6	31329.0															
Urban labor						2924.4	204.3	86622.2															
Land	3220.5	6.2	25.0	58.3	14.3	2451.7	76.9																
Capital	11006.0	27.5	109.9	256.4	62.7	2760.7	145.3	36552.2															
LaborRCFP																11.0							
LandCFP																2.8							
CapitalCFP																12.1							
cfpro					25.9																		
High inter.							1163.4																
Poor rural		4.3							3690.3		283.0	446.9	1.0	0.1	0.1								
Middle rural			31.4						11608.2		1355.5	1388.6	3.1	0.6	0.3								
Rich rural				105.9					25751.0		4214.5	3962.9	6.9	2.0	0.9								
Urban										89750.9		45122.3		0.0	10.7								
S-I																		0.0	1528.9	15643.5	72703.2		
ROW						1220.8	248.9	32312.7														10223.0	
total	22138.6	70.0	280.1	653.5	159.9	32800.3	1907.5	186816.1	41049.6	89750.9	5853.0	50920.7	11.0	2.8	12.1	25.9	1163.4	4425.8	14387.8	34044.1	134883.9	89875.6	44005.3

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

b. Average expenditure propensities with labor intensive technology in high standards farming

	Low inter.	High poor	High middle	High rich	High corp.	Low proc.	High proc.	Other com.	Rural labor	Urban labor	Land	Capital	LaborRCFP	LandCFP	Capital CFP	cfpro	High inter.	Poor rural	Middle rural	Rich rural	Urban	S-I	ROW
Low inter.						67.5																	
High poor																	6.0						
High middle																	24.1						
High rich																	56.2						
High corp.																	13.7						
Low proc.																		44.1	36.6	18.1	12.5	2.0	1.7
High proc.																		0.0	0.6	0.6	0.5	0.1	1.9
Other com.																		55.9	52.2	35.4	33.0	86.6	96.4
Rural labor	35.7	45.6	40.6	35.6	35.6	4.0	3.6	16.8															
Urban labor						8.9	10.7	46.4															
Land	14.5	8.9	8.9	8.9	8.9	7.5	4.0	0.0															
Capital	49.7	39.2	39.2	39.2	39.2	8.4	7.6	19.6															
LaborRCFP																42.5							
LandCFP																10.6							
CapitalCFP																46.8							
cfpro					16.2																		
High inter.							61.0																
Poor rural		6.2							9.0		4.8	0.9	9.0	4.8	0.9								
Middle rural			11.2						28.3		23.2	2.7	28.3	23.2	2.7								
Rich rural				16.2					62.7		72.0	7.8	62.7	72.0	7.8								
Urban										100.0		88.6			88.6								
S-I																		0.0	10.6	46.0	53.9		
ROW						3.7	13.0	17.3														11.4	
total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

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

c. Capital intensive technology in high standards farming

	Low inter.	High poor	High middle	High rich	High corp.	Low proc.	High proc.	Other com.	Rural labor	Urban labor	Land	Capital	LaborRCFP	LandCFP	Capital CFP	cfpro	High inter.	Poor rural	Middle rural	Rich rural	Urban	S-I	ROW
Low inter.						22138.6																	
High poor																	70.0						
High middle																	280.1						
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Other com.																		2473.5	7512.6	12044.0	44566.5	77807.0	42412.5
Rural labor	7912.1	28.5	99.8	200.2	49.0	1304.2	68.6	31387.2															
Urban labor						2924.4	204.3	86622.2															
Land	3220.5	6.2	25.0	58.3	14.3	2451.7	76.9																
Capital	11006.0	31.0	123.9	289.1	70.7	2760.7	145.3	36494.0															
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Rich rural				105.9					25751.0		4214.5	3962.9	6.9	2.0	0.9								
Urban										89750.9		45122.3			10.7								
S-I																		0.0	1528.9	15643.5	72703.2		
ROW						1220.8	248.9	32312.7														10223.0	
total	22138.6	70.0	280.1	653.5	159.9	32800.3	1907.5	186816.1	41049.6	89750.9	5853.0	50920.7	11.0	2.8	12.1	25.9	1163.4	4425.8	14387.8	34044.1	134883.9	89875.6	44005.3

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

d. Average expenditure propensities with capital intensive technology in high standards farming

	Low inter.	High poor	High middle	High rich	High corp.	Low proc.	High proc.	Other com.	Rural labor	Urban labor	Land	Capital	LaborRCFP	LandCFP	Capital CFP	cfpro	High inter.	Poor rural	Middle rural	Rich rural	Urban	S-I	ROW
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High rich																	56.2						
High corp.																	13.7						
Low proc.																		44.1	36.6	18.1	12.5	2.0	1.7
High proc.																		0.0	0.6	0.6	0.5	0.1	1.9
Other com.																		55.9	52.2	35.4	33.0	86.6	96.4
Rural labor	35.7	40.6	35.6	30.6	30.6	4.0	3.6	16.8															
Urban labor						8.9	10.7	46.4															
Land	14.5	8.9	8.9	8.9	8.9	7.5	4.0	0.0															
Capital	49.7	44.2	44.2	44.2	44.2	8.4	7.6	19.5															
LaborRCFP																42.5							
LandCFP																10.6							
CapitalCFP																46.8							
cfpro					16.2																		
High inter.							61.0																
Poor rural		6.2							9.0	0.0	4.8	0.9	9.0	4.8	0.9								
Middle rural			11.2						28.3	0.0	23.2	2.7	28.3	23.2	2.7								
Rich rural				16.2					62.7	0.0	72.0	7.8	62.7	72.0	7.8								
Urban										100.0		88.6			88.6								
S-I																		0.0	10.6	46.0	53.9		
ROW						3.7	13.0	17.3														11.4	
total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

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

Table 3. Simulation results (Percentage change)

a. Labor intensive technology in high standards farming

	Simu 1: $\Delta pwe_{PH} = +25\%$	Simu 2: $\Delta Z^{U} = -25\%$	Simu 3A: $\Delta COL^{RP} = +50\%$	Simu 3B: $\Delta COL^{RR} = +50\%$	Simu 3C: $\Delta COL^{CF} = +50\%$
Aggregate effects					
Real GDP	0.09	0.02	0.00	0.03	0.01
CPI (Comparing with numeraire PPI)	-0.08	-0.02	0.00	0.00	0.00
Gini coefficient	-0.41	-0.08	-0.02	-0.07	-0.02
Output of final commodities					
Low standards food	0.10	-1.84	-0.09	-0.82	-0.20
High standards food	10.60	10.63	2.93	27.27	6.69
Other commodities	-0.14	0.25	-0.01	-0.09	-0.02
Individual output of high standards intermediate product					
Poor rural households	10.90	11.13	49.88	-0.69	-0.18
Middle-income rural households	11.01	11.13	-0.08	-0.69	-0.18
Rich rural households	9.26	9.22	-0.07	49.16	-0.15
Corporate farms	9.27	9.13	-0.07	-0.54	49.78
Rural labor used in high standards intermediate product					
Poor rural households	21.53	21.74	41.98	-1.20	-0.31
Middle-income rural households	24.50	24.64	-0.16	-1.36	-0.35
Rich rural households	23.14	23.11	-0.15	47.02	-0.33
Corporate farms	23.25	23.10	-0.15	-1.26	48.63
Domestic commodity price					
Low standards food	0.12	-0.59	0.01	0.06	0.01
High standards food	0.21	17.72	-0.13	-1.19	-0.30
Other commodities	-0.18	-0.02	-0.00	-0.00	-0.00
Factor price					
Rural labor	0.07	-0.05	0.01	0.06	0.02
Urban labor	-0.27	0.19	-0.01	-0.06	-0.01
Land	1.09	-2.15	0.01	0.09	0.03
Capital	-0.15	-0.49	0.00	0.06	0.01
Low standards intermediate product	0.11	-0.58	0.01	0.07	0.02
High standards intermediate product	19.29	19.37	-0.12	-1.09	-0.28
Poor rural households					
Profit effect	0.32	0.33	0.12	-0.02	-0.00
Profit sharing from corporate farm	0.06	0.06	-0.00	-0.00	0.02
Factor income effect	0.12	-0.23	0.01	0.06	0.02
Among it:					
Labor	0.06	-0.04	0.01	0.05	0.01
Land	0.07	-0.14	0.00	0.01	0.00
Capital	-0.02	-0.05	0.00	0.01	0.00
Consumer price effect	0.05	0.27	-0.00	-0.02	-0.01
Total income effect	0.54	0.43	0.13	0.02	0.03
Middle-income rural households					
Profit effect	0.39	0.40	-0.00	-0.02	-0.01
Profit sharing from corporate farm	0.04	0.04	-0.00	-0.00	0.02
Factor income effect	0.15	-0.29	0.01	0.07	0.02
Among it:					

Labor	0.06	-0.04	0.01	0.05	0.01
Land	0.10	-0.20	0.00	0.01	0.00
Capital	-0.01	-0.05	0.00	0.01	0.00
Consumer price effect	0.05	0.14	-0.00	-0.01	-0.00
Total income effect	0.64	0.30	0.01	0.03	0.03
Rich rural households					
Profit effect	0.39	0.39	-0.00	0.13	-0.01
Profit sharing from corporate farm	0.04	0.04	-0.00	-0.00	0.01
Factor income effect	0.17	-0.36	0.01	0.07	0.02
Among it:					
Labor	0.06	-0.04	0.01	0.05	0.01
Land	0.13	-0.27	0.00	0.01	0.00
Capital	-0.02	-0.06	0.00	0.01	0.00
Consumer price effect	0.08	0.02	-0.00	-0.00	-0.00
Total income effect	0.67	0.09	0.01	0.19	0.03
Urban households					
Profit sharing from corporate farm	0.01	0.01	-0.00	-0.00	0.00
Factor income effect	-0.23	-0.04	-0.00	-0.02	-0.00
Among it:					
Labor	-0.18	0.13	-0.00	-0.04	-0.01
Capital	-0.05	-0.16	0.00	0.02	0.00
Consumer price effect	0.09	-0.03	0.00	0.00	0.00
Total income effect	-0.13	-0.06	-0.00	-0.02	0.00

Source: Authors' simulation.

b. Capital intensive technology in high standards farming

	Simu 1: $\Delta pwe_{PH} = +25\%$	Simu 2: $\Delta Z^{U} = -25\%$	Simu 3A: $\Delta COL^{RP} = +50\%$	Simu 3B: $\Delta COL^{RR} = +50\%$	Simu 3C: $\Delta COL^{CF} = +50\%$
Aggregate effects					
Real GDP	0.09	0.02	0.00	0.03	0.01
CPI (Comparing with numeraire PPI)	-0.08	-0.01	0.00	0.00	0.00
Gini coefficient	-0.39	-0.06	-0.01	-0.04	-0.01
Output of final commodities					
Low standards food	0.14	-1.77	-0.09	-0.83	-0.21
High standards food	8.76	8.79	2.95	27.50	6.74
Other commodities	-0.13	0.26	-0.01	-0.09	-0.02
Individual output of high standards intermediate product					
Poor rural households	8.88	9.11	49.91	-0.52	-0.14
Middle-income rural households	8.97	9.09	-0.06	-0.50	-0.13
Rich rural households	7.50	7.47	-0.05	49.43	-0.10
Corporate farms	7.52	7.38	-0.05	-0.36	49.85
Rural labor used in high standards intermediate product					
Poor rural households	19.18	19.45	41.05	-1.06	-0.27
Middle-income rural households	22.18	22.40	-0.14	-1.20	-0.31
Rich rural households	21.15	21.21	-0.13	47.08	-0.29
Corporate farms	21.26	21.20	-0.13	-1.10	48.55
Domestic commodity price					
Low standards food	0.12	-0.59	0.01	0.06	0.01

High standards food	0.29	17.86	-0.13	-1.20	-0.30
Other commodities	-0.18	-0.02	-0.00	-0.00	-0.00
Factor price					
Rural labor	0.03	-0.09	0.01	0.02	0.01
Urban labor	-0.26	0.19	-0.01	-0.06	-0.01
Land	1.06	-2.14	0.01	0.09	0.03
Capital	-0.13	-0.47	0.01	0.10	0.02
Low standards intermediate product	0.10	-0.58	0.01	0.07	0.02
High standards intermediate product	19.35	19.56	-0.12	-1.10	-0.28
Poor rural households					
Profit effect	0.32	0.33	0.12	-0.02	-0.00
Profit sharing from corporate farm	0.05	0.06	-0.00	-0.00	0.02
Factor income effect	0.08	-0.26	0.01	0.03	0.01
Among it:					
Labor	0.03	-0.08	0.00	0.02	0.01
Land	0.07	-0.14	0.00	0.01	0.00
Capital	-0.01	-0.05	0.00	0.01	0.00
Consumer price effect	0.05	0.27	-0.00	-0.02	-0.01
Total income effect	0.51	0.40	0.13	-0.01	0.02
Middle-income rural households					
Profit effect	0.39	0.41	-0.00	-0.02	-0.01
Profit sharing from corporate farm	0.04	0.04	-0.00	-0.00	0.02
Factor income effect	0.12	-0.32	0.01	0.04	0.01
Among it:					
Labor	0.03	-0.07	0.00	0.02	0.01
Land	0.10	-0.20	0.00	0.01	0.00
Capital	-0.01	-0.05	0.00	0.01	0.00
Consumer price effect	0.06	0.14	-0.00	-0.01	-0.00
Total income effect	0.60	0.26	0.00	-0.00	0.02
Rich rural households					
Profit effect	0.38	0.40	-0.00	0.13	-0.01
Profit sharing from corporate farm	0.03	0.03	-0.00	-0.00	0.01
Factor income effect	0.14	-0.39	0.01	0.04	0.01
Among it:					
Labor	0.03	-0.07	0.00	0.02	0.01
Land	0.13	-0.26	0.00	0.01	0.00
Capital	-0.02	-0.05	0.00	0.01	0.00
Consumer price effect	0.08	0.02	-0.00	-0.00	-0.00
Total income effect	0.64	0.06	0.00	0.17	0.02
Urban households					
Profit sharing from corporate farm	0.01	0.01	-0.00	-0.00	0.01
Factor income effect	-0.22	-0.03	-0.00	-0.00	-0.00
Among it:					
Labor	-0.17	0.13	-0.00	-0.04	-0.01
Capital	-0.04	-0.16	0.00	0.03	0.01
Consumer price effect	0.09	-0.03	0.00	0.00	0.00
Total income effect	-0.11	-0.05	-0.00	-0.00	0.00

Source: Authors' simulation.

Table 4. Source of households income (%)

	Rural labor	Urban labor	Land	Capital	Profit	Profit sharing from CF	Total
Poor rural	83.38		6.39	10.10	0.10	0.03	100.00
Middle-income rural	80.68		9.42	9.65	0.22	0.03	100.00
Rich rural	75.64		12.38	11.64	0.31	0.03	100.00
Urban		66.54		33.45		0.01	100.00

Source: Based on SAM in Table 2a.

Table 5. 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 6. Elasticity estimation in the Literature

a. 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.

b. 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.

c. 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.

d. 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.