Food Standards and Welfare: General Equilibrium Effects

Tao Xiang, Jikun Huang, d’Artis Kancs, Scott Rozelle and Jo Swinnen

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Abstract

We analyse the general equilibrium effects of the growth of high standard food chains on household welfare. 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 a Chinese dataset. The simulation results show that the effects on poor rural households depend on a variety of factors, including the nature of the shocks leading to the expansion of high standard sector, production technologies, trade effects, spillover effects on low standard markets, factor market constraints and labour market effects.

Keywords: China; food standards; general equilibrium analysis; rural and urban household welfare; market imperfections.

JEL classifications: C68, D58, D60, I31, L15, O13, O18, Q13, R13.

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1. Introduction

A series of recent studies has 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 by wealthy consumers for high quality, safety, health and ethical standards puts 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 factors. For example, international campaigns against child labour 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 marketing chains of many nations.2

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 meats, 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 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 to serve the higher income consumers and/or to minimise transaction costs and improve security in supply chains (Reardon et al., 2003). Fourth, the penetration of international marketing chains is more widespread than people originally thought (e.g., Gulati et al., 2007; World Bank, 2005).

However, there is substantial controversy on the welfare implications. One part of the literature claims that improved standards could have sharp negative influences on equity and poverty. Several studies argue 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

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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 (i) analyses of asymmetric information problems which may be reasons for companies or public regulators to introduce standards (Fulton and Giannakas, 2004; Gardner, 2003); (ii) studies on the role of standards in reducing consumption externalities (Copeland and Taylor, 1995; Besley and Ghatak, 2007); (iii) the role of standards in providing non-tariff trade protection (Anderson et al., 2004; Fischer and Serra, 2000); and (iv) the political economy of standards (Swinnen and Vandemoortele, 2008).
Latin America and Africa argue that small farmers were being left behind in the supermarket-driven horticultural marketing and trade (Dolan and Humphrey, 2000; Humphrey et al., 2004; Key and Runsten, 1999; Reardon et al., 2003; Weather-spoon et al., 2001). Minot and Ngigi (2004) demonstrate that modern marketing chains put intense pressure on Kenyan smallholders and Weatherspoon and Rear-don (2003) report that the rise of supermarkets in Southern Africa excluded small producers from dynamic urban markets due to quality and safety standards.

Other literature challenges these views on three grounds. First, it shows that in several cases small farmers do produce for modern supply chains. For example, Hu-ang et al. (2008) and Wang et al. (2009) showed that in China, 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 and sharp shifts in the downstream segment of the food chain towards ‘modern retailing’, almost all of the increased supply is being produced by small, relatively poor, farmers. Dries and Swinnen (2004) and Dries et al. (2009) also find that in more developed regions, as in several Eastern European countries, small farmers are the dominant suppliers in modern supply chains.

Second, small farmers also benefit in these chains because high standards induce increased vertical coordination in supply chains which improves access to credit, technology and quality inputs for poor farmers in Eastern Europe (World Bank, 2005; Swinnen, 2006). Similarly, Minten et al. (2009) 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 standard horticulture commodities to global retail chains.

Third, recent studies show that, even when rural households are excluded as small farmers because of high standards, they may still benefit importantly through the labour market, that is, from employment on larger farms (Maertens and Swinnen, 2009; Maertens et al., 2011). However, the vast majority of empirical studies analyse which farmers are supplying to the high standard market and/or the impacts on productivity or investments of supplying farms, rather than measuring poverty or welfare effects. The only studies that do so find strong poverty reducing effects of high standard exports in Senegal (Maertens and Swinnen, 2009; Maertens et al., 2011) either through product or labour markets.

An important shortcoming of much of this literature – in addition to empirical problems – is the absence of a consistent and comprehensive conceptual framework for capturing effects and interpreting the empirical findings. For example, few studies include vertical spillover effects, labour market effects, and no studies analyse general equilibrium effects such as demand and supply spillover effects on other markets, such as staple foods, which may have very important impacts on farm income in developing countries. Measuring these effects econometrically is very difficult because annual datasets usually do not contain the necessary data on high standard market and datasets from surveys targeted to measure impacts of the growth of high standard typically do not have sufficient information (either spatially or dynamically) to measure spillover effects on other markets.

A few recent studies have contributed to a theoretical framework for analysing these issues. Swinnen and Vandeplas (2009) analyse the equity and efficiency effects
of vertical coordination in high standard food chains. Vandemoortele et al. (2012) study the determinants of the emergence of high standard food chains and which producers will participate in them. However, none of these studies analyse general equilibrium effects. To address these shortcomings and to better identify the various mechanisms through which the introduction and growth of high standards can influence welfare and poverty, we use a Computable General Equilibrium (CGE) model to provide the necessary framework. Our 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 and labour market constraints. We use the model to analyse how and through which channels welfare of rural and urban households is affected.

While the CGE approach integrates markets into a single model and incorporates both market interactions, and frictions and imperfections, the approach is necessarily sensitive to assumptions, the choice of key parameter values, and the calibration of the initial equilibrium dataset (e.g. Mas-Colell et al., 1995 and Shoven and Whalley, 1992). However, it is not our intention in the paper to predict the size of the impacts of high standard food. We seek to illustrate and analyse the mechanisms through which the expansion of the high standard food sector can take place and how it affects welfare. In so doing, we identify the factors which are critical in determining the effects. Given these objectives, there is no obvious alternative to a CGE approach.

Since the resulting model is analytically intractable, we calibrate the model using a Chinese dataset. The development of a high standard food sector in China is particularly relevant for four reasons. First, even though China has sustained high growth rates for nearly 30 years and the continuously increasing income per capita has led to a structural change of Chinese diet (Gale and Huang, 2007), the food distribution system has remained laggard until very recently. However, recent years have been characterised by the rapid growth of supermarkets and some food safety scandals (Hu et al., 2004; Wang et al., 2009). This transition from a system of mainly low standard food produced by millions of small farms (Rozelle and Swinnen, 2004) to one of high standard is only just beginning and may have substantial impacts on both producers and consumers (Mo et al., 2011). Second, despite high growth rates, an increasing inequality between wealthy and poor households becomes a more and more acute issue (Ravallion, 2001). After an initially rapid reduction in poverty rates, more recently China is facing more difficulty in reducing the rural poverty (Chen and Ravallion, 2007; Riskin, 2004). Ninety percent of poverty is still rural in China (World Bank, 2009). The welfare and poverty effects associated with the expansion of a high standard food sector might therefore be very important. Third, in China, the agricultural sector alone accounted for 11.3% of GDP and almost 40% of employment in 2008 (China National Bureau of Statistics (CNBS), 2009). Including food processing, agricultural activities as a share of GDP are close to 20%. Consequently, any ‘shocks’ that impact on either agriculture or food processing have secondary economy-wide impacts. Fourth, both the agricultural commodity and factor markets are in transition. Although the commodity market is becoming more and more efficient (Huang and Rozelle, 2006), factor market 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. Theoretical Framework

2.1. Model framework

Our model follows the tradition of applied general equilibrium models pioneered by Shoven and Whalley (1992), although its precise specification is more closely related to the CGE models described in De Janvry and Sadoulet (2002), and Stifel and Thorbecke (2003). The economy consists of N types of households, M sectors and J factors. Households’ demand for consumption goods is a function of their disposable income and the vector of consumer prices. Household incomes are determined by their ownership of production factors (land, labour and capital) and the market returns to these factors.

As usual in CGE models, consumer preferences and production technologies are specified as nested constant elasticity of substitution (CES) functions. The intermediate sectors are specified to produce goods according to a CES function. Final food production combines intermediate inputs and primary factors, aggregated through a CES function with a sub-nest of a Cobb–Douglas (CD) function for different types of labour. The gross output of the other commodities sector is a CES function with a sub-nest of a CD function for labour.

Profit maximisation yields factor demands. In equilibrium, the total demand and supply of factors, goods and intermediate products balance, generating a set of prices and activity levels such that demand equals supply everywhere and no production activity makes positive (pure) profits (representing a competitive economy).

The economy is linked to the rest of the world through trade of goods and services. The substitution between the imported and the domestic goods is determined on the consumption side through a CES aggregation function (Armington, 1969), and on the production side through a constant elasticity of transformation (CET) function. The relative prices of foreign goods are determined by world market prices and the exchange rate. Changes in export and import quantities (and hence, demand and supply of foreign currency) are offset by adjustments in the foreign exchange rates.3

In order to model savings and investment, we make the following standard assumptions: (i) savings are determined by exogenous constant savings rates for households; (ii) private investment is savings-driven; and (iii) investment spending is allocated to commodities in fixed proportions.4 For simplicity and data paucity, we further assume that only final commodities are used as investment goods. Total savings equal total investments in equilibrium.

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3 This assumption is not important for the results. In fact, if savings do not enter the households’ utility function, then fixing either the exchange rate or the trade balance is similar for welfare analyses, since it prevents an arbitrary shift away from savings towards current consumption from being confused with a welfare improvement.

4 Following Dewatripont and Michel (1987), this neoclassical closure is the most common in comparative static CGE models and widely used in the literature (e.g., De Janvry and Sadoulet, 2002).
Following De Janvry and Sadoulet (2002), the nominal exchange rate is used as a numeraire. This ensures that only the relative prices matter.\textsuperscript{5} Households’ welfare is measured by real income, which is obtained by normalising nominal income by a households-specific price index. Real income is disaggregated by income source, allowing identification of the reasons for changes in income (De Janvry and Sadoulet, 2002).\textsuperscript{6} To measure inequality, we calculate the Gini coefficient.\textsuperscript{7}

2.2. Integrating standards in the model

In order to incorporate the key features of food standards and their linkages to the rest of the economy, we extend the basic CGE model in several dimensions. First, given that differentiated goods are important for studying the impact of standard expansion, we follow Banerji and Jain (2007) and introduce two types of vertically differentiated goods in the food sector\textsuperscript{8}: low standard food and high standard food. Second, to allow for differential effects in producer welfare, we explicitly model the heterogeneity of farms. Third, in order to study the impact of rural credit market imperfections, which are very important in many developing countries, we follow Harris (1984) and introduce credit constraints for rural households. Finally, in order to trace the rural–urban income effects of the high standard food expansion, an inter-regional CGE approach of Kilkenny (1993), Ando and Takanori (1997), and Kancs (2001) is adopted. Figure S1 and Table S1 in Appendix S1 in the Additional Supporting Information summarise the model structure. Additional Supporting Information may be found in the online version of this article.

\textsuperscript{5} As noted by De Janvry and Sadoulet (2002), the choice of numeraire has no impact on real income effects, but has impacts on the decomposition of real income effects, which should be borne in mind when considering the simulation results.

\textsuperscript{6} We also calculate the equivalent variation to avoid the shortcomings of using this indicator to measure welfare effects when the marginal utility of income is not constant. Our simulation results show that the difference between real income change and equivalent variation is not significant in the first scenario. However, in the second scenario, as urban households’ utility function changes, measures on welfare of urban households based on different indicators are different. In the second scenario, we will use real incomes as main indicators for decomposition of welfare effects and for calculation of Gini coefficients. As preference change itself leads to welfare change, change of welfare of urban households in the second scenario cannot be completely explained by expansion of high standard food and should be interpreted with caution.

\textsuperscript{7} We use the trapezium rule for the Gini calculation. The trapezium rule is an approximation of the definite integral of the Gini coefficient. In our case, the trapezium rule is applicable since the income distribution of representative households is not continuous (Cruz-Uribe and Neugebauer, 2002).

\textsuperscript{8} The same extensions can also be implemented in other sectors. However, for the sake of simplicity, these extensions are not presented here.
Accounting for the dual farm structure characteristic of many developing countries, there are two types of rural producers in the model: households (C) and corporate farms (CF).\(^9\) In order to study the distributional consequences between different types of consumers, we distinguish between urban and rural households, with rural households further disaggregated into several income groups. There are four types of factor inputs: rural labour (LR), urban labour (LU), capital (K) and land (A). Rural households (CR) own three types of factors: rural labour, land and capital, while urban households (CU) own only urban labour and capital. Net wages of rural workers are assumed to be lower than urban wages, even though rural workers may migrate to urban areas. The wage differences between rural and urban workers are due to different skills of different labour types and migration costs (Stifel and Thorbecke, 2003).\(^{10}\)

Five commodities are produced in the economy. Two commodities are final goods not used as intermediate inputs: low standard food (LF) and high standard food (HF). High standard food can only be produced by using high standard intermediate inputs. Two agricultural commodities are pure intermediate goods: low standard (L) and high standard (H), which are produced in rural areas and are exclusively used by their respective food processing sectors, taking place in both the rural and urban areas, to produce the final food.\(^{11}\) Agricultural intermediate goods can also be used by other commodities as intermediate inputs. The rest of commodities (O) are used as both final goods and intermediate inputs.

Household consumption, including high standard food and low standard food, is modelled by a standard linear expenditure system (LES) subject to the household budget constraint.\(^{12}\)

Factor use in the production of these commodities is affected by sector-specific investment requirements and the constraints farms face. In order to produce a high standard intermediate product, farms need to make investments. Following Harris (1984), we assume that the investments require a mixture of rural labour and capi-
tal. There is much evidence that rural households are often credit constrained and the capital investments may be prohibitive for rural households who have insufficient access to capital (Hallward-Driemeier et al., 2003; Dries and Swinnen, 2004; Dries et al., 2009; World Bank, 2005). To capture this, we assume (in the baseline model) that the supply of capital to rural households and corporate farms is inelastic and that the supplied capital is below their optimal capital use in high standard production. This assumption implies that there are positive profits in high standard agricultural production.

One could argue that this is a short-run phenomenon and that when an economy develops or when the production of high standard products grows these constraints will reduce (Swinnen and Vandeplas, 2009). There is some evidence for this, in particular in the transition countries of Eastern Europe (Dries et al., 2009; Swinnen, 2006; World Bank, 2005). To measure how changes in (the importance of) credit constraints affect the results, we perform sensitivity analyses on how changes in these assumptions affect the results – in particular we measure the effect of a more elastic supply of capital to high standard production.

In order to decompose the aggregate labour market effect into rural and urban impacts, we model the labour market as two segmented sub-markets (rural and urban labour) with different skill composition. We use iceberg migration costs to model migration between rural and urban regions, which leads to differences between wages for workers working in urban and rural regions, respectively.

All sectors have zero pure profits as in the basic CGE model except the high standard intermediate sector, where fixed investment costs are required. Rural households’ net income is the sum of their profits in high standard farming, factor incomes and profits from corporate farms. Urban households’ income is composed of factor incomes and profits from corporate farms, if any.

3. Empirical implementation

Two types of data are required for the empirical implementation of the theoretical CGE model: variables for the base year and model parameters. As usual in CGE models, the database is organised in the form of a Social Accounting Matrix (SAM) (see Table S2 in Appendix S1 in the Additional Supporting Information). Empirically, a critical issue here is to specify the share of ‘high standard’ commodities in total output, for which there are no reliable data for China. We assume that high standard production is still small (5%) and not linked to specific

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13 See for example, Barham et al. (1996) for developing countries, Swinnen and Gow (1999) for transition countries, and Ciaian and Swinnen (2009) for farmers in developed economies.

14 Hu et al. (2004) estimated that roughly 30% of food was sold through supermarkets. Large wholesale and retail companies, as defined by the Chinese Economic Yearbook (China Economy Yearbook Committee (CEYC), 2006), sold 8.7% of the total food. However, according to Wang et al. (2009), nearly all of these products came through semi-traditional supply channels and production systems.

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commodities, since we are primarily interested in understanding the direction, mechanisms and relative sizes of different sub-effects.

Our key parameters are taken from the literature, or are calibrated within the model.\textsuperscript{15} Table 1 summarises the elasticities applied in our model. Specifically, the income elasticities of low standard products are 0.8, 0.4 and 0.3 for the poorest, other rural households, and urban households, respectively (Dimaranan \textit{et al.}, 2007), reflecting the stylised fact that poor households consume a relatively larger share of staple (low standard) food compared to wealthy households (Lipton, 2001). The expenditure elasticity of the marginal utility of expenditure (the so-called Frisch (1959) parameters), are equal to $-8$, $-7$ and $-6$ for the poorest and other rural households, and urban households, respectively (Dimaranan \textit{et al.}, 2007). On the import side, for the other commodities sector we assume a relatively low aggregation elasticity between imports and domestic consumption goods (0.5), which reflects product differentiation between the domestically-produced commodities and imports of these large aggregates. For the food sectors, including both low and high standard food, we assume a higher 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 low and high standard food sectors, and lower value (0.8) for the other commodities sector (Dimaranan \textit{et al.}, 2007).

For the top-nest CES production elasticities we assume a medium value of between 0.7, 0.15 and 0.9 for intermediate, processing and the other commodities sectors, respectively (Wang and Schuh, 2002). The choice of the relatively small elasticities of substitution between intermediate input and other factors is a standard assumption in CGE models (e.g., Wang and Schuh, 2002). The elasticity of substitution among the basic factors in the sub-nest CES of the processing sectors is

\textsuperscript{15} For a review of literature on elasticities, see Ciaian (2002). For behavioural parameters in GTAP, see Dimaranan \textit{et al.} (2007). To assure robustness of the presented results, all key elasticities are subject to extensive sensitivity analysis (provided in the supplementary data).
0.8. The price elasticities of variable capital supply for the high standard intermediate activities of rural households and corporate farms are set rather moderately (0.7, 1.3 and 1.9 for the poorest, other rural households, and corporate farms, respectively).

Finally, the remaining parameters are calibrated to Chinese national accounts data for 2005 (see Appendix S1A in the Additional Supporting Information for details). The CGE model is operationalized using the General Algebraic Modeling System (GAMS) software (Brooke et al., 1988).16

In order to assess the robustness of model assumptions and parameter values, we perform extensive sensitivity analysis w.r.t. other key assumptions, such as on income elasticities of low standard products, the elasticities of transformation and substitution in the Armington equations and the substitution elasticities in production. The results, some of which are presented in this paper and more of which are presented in Appendix S1B in the Additional Supporting Information, show that our key conclusions are robust to a reasonable range of variations in the key parameters.

4. Simulations

4.1. General approach

In this CGE model, the supply and demand of all commodities, including the high standard intermediary and final products, are determined endogenously. Therefore, we have to ‘induce’ the expansion of the high standard food sector through changes in exogenous variables. We do this in several ways. In this paper we focus on two (sets of) simulations – other simulations are provided in a background document (Kancs and Xiang, 2011). First, we simulate an increase in the world price of high standard products (which is exogenous) – a scenario which we refer to as ‘export-led growth’ of high standard food. An important factor determining the welfare effects is the elasticity of transformation of the high standard food, that is, the elasticity of substitution between domestic and exported products. Therefore, we simulate the export-led growth both when the elasticity of transformation is ‘moderate’ (i.e., as in other models) and when it is high (scenarios 1A and 1B). Second, we simulate an increase in domestic consumer preferences for high standard food. By varying consumer preferences we avoid the problem of having to separate income effects from high standard expansion from direct income growth otherwise induced by increased endowments or productivity. This scenario is referred to as ‘domestic demand growth’. The two scenarios are related, because consumer demand induces import growth of high standard food with open trade. Given that trade responsiveness plays an important role, we analyse the domestic demand growth scenario with elastic imports (scenario 2A) and inelastic imports (scenario 2B).

A crucial issue in the simulations is the assumption about the technology used in the high standard food sector in China. As explained above, there are no precise data on the emerging high standard sector, because the food sector is just emerging in China, and there is no consensus on whether high standard farming is relatively labour or capital intensive compared to other activities (Bijman, 2008; Miyata et al.,

16 The source code for Simulation 1A is provided in Appendix S2 in the Additional Supporting Information, which can be found in the online version of this article.
Therefore, we first construct a baseline SAM and perform simulations by assuming the same production technology, that is, factor intensities, in high standard and low standard farming. Subsequently, we simulate how different production technologies in high standard farming affect the results. Finally, we analyse the effect of reducing credit constraints by making the supply of capital more elastic. The actual production structures for each scenario (sets of assumptions) are reported in Table S2 in Appendix S1 in the Additional Supporting Information.

In addition to these simulations, we have assessed the robustness of our results by performing sensitivity analysis w.r.t. other key assumptions, such as on income elasticities of low standard products, the elasticities of transformation and substitution in the Armington equations and the substitution elasticities in production. These sensitivity analyses and their results are presented in Appendix S1 in the Additional Supporting Information.

4.2. Scenario 1: Export-led growth

China has continuously increased its exports of agricultural products and the ratio of agricultural trade to agricultural GDP has risen steadily (Huang et al., 2000). According to Gulati et al. (2007), an outward-looking trade policy can induce the growth of high quality products, because the rise of high standard product is subject to international quality standards and safety regulations. These standards are typically considerably higher than in developing countries, such as China.

To study the potential impact of export-led emergence of high standard farming, we exogenously increase the world market price for high standard products, \( p_{wHF} \) and \( p_{wmHF} \), by 25%. The simulation results for the effect of rising international prices of high standard commodities are reported in the first column of Table 2. As a consequence of the increase in the world market price of high standard products, the domestic consumption of high standard declines (−1.6%) and that of low standard products increases (+0.02%). There is a decline in imports (−27%) and growth of exports (+58%) of high standard products. There is an increase in the domestic price of high standard products (+13.10%) and a corresponding increase in production of high standard products (+40.50%) because of growth in export demand for high standard products. Labour use on high standard farm production increases on all farms (around 39%) as do the returns to all rural production factors: 0.22% capital, and 0.78% land. As a consequence, rural household incomes increase by 0.20% and 0.17% (for poor and other households, respectively). Urban households lose (−0.17%), as their wage increase from increased employment in high standard food processing is more than offset by higher consumer prices.

The income effects are relatively small. The first reason for this is that the high standard sector is small in the model and changes have relatively limited effects on

17 In the initial simulations with the same factor intensities for low and high standard, we use the weighted average of the factor shares for all agricultural commodities in China.
18 When constructing the SAM under the assumption that high standard farming is relatively labour (capital) intensive, we change labour and capital use in the other commodities sector, so that the SAM balance is maintained.
Table 2  
Simulation results: The same technology in high standard and low standard farming  
(percentage change comparing with baseline)  

<table>
<thead>
<tr>
<th></th>
<th>Sim 1A</th>
<th>Sim 1B</th>
<th>Sim 2A</th>
<th>Sim 2B</th>
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<tr>
<td><strong>Aggregate effects</strong></td>
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<tr>
<td>Real GDP</td>
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<td>Real Gini coefficient</td>
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<td>0.04</td>
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<td>High standard food</td>
<td>−1.60</td>
<td>−2.51</td>
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<td>Other commodities</td>
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<td><strong>Output of final commodities</strong></td>
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<tr>
<td>Low standard food</td>
<td>−0.02</td>
<td>−0.04</td>
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<td>High standard food</td>
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<td><strong>Individual output of high standard intermediate product</strong></td>
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<td>Poorest rural households</td>
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<tr>
<td>Import volume</td>
<td>1.07</td>
<td>1.85</td>
<td>−0.15</td>
<td>−0.05</td>
</tr>
<tr>
<td>Export volume</td>
<td>−27.11</td>
<td>−8.72</td>
<td>18.77</td>
<td>13.53</td>
</tr>
<tr>
<td>Other commodities</td>
<td>0.16</td>
<td>0.29</td>
<td>−0.07</td>
<td>−0.05</td>
</tr>
<tr>
<td><strong>Rural labour used in high standard intermediate product</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poorest rural households</td>
<td>34.06</td>
<td>58.22</td>
<td>4.81</td>
<td>7.82</td>
</tr>
<tr>
<td>Other rural households</td>
<td>39.32</td>
<td>67.47</td>
<td>5.48</td>
<td>8.94</td>
</tr>
<tr>
<td>Corporate farms</td>
<td>39.13</td>
<td>67.20</td>
<td>5.39</td>
<td>8.83</td>
</tr>
<tr>
<td><strong>Domestic consumer price</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low standard food</td>
<td>0.35</td>
<td>0.60</td>
<td>−0.05</td>
<td>−0.01</td>
</tr>
<tr>
<td>High standard food</td>
<td>13.10</td>
<td>22.29</td>
<td>1.56</td>
<td>2.59</td>
</tr>
<tr>
<td>Other commodities</td>
<td>0.27</td>
<td>0.47</td>
<td>−0.06</td>
<td>−0.04</td>
</tr>
<tr>
<td><strong>Company food price</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low standard food</td>
<td>0.35</td>
<td>0.60</td>
<td>−0.04</td>
<td>−0.01</td>
</tr>
<tr>
<td>High standard food</td>
<td>13.32</td>
<td>22.49</td>
<td>1.89</td>
<td>3.08</td>
</tr>
<tr>
<td>Other commodities</td>
<td>0.26</td>
<td>0.44</td>
<td>−0.06</td>
<td>−0.04</td>
</tr>
<tr>
<td><strong>Farm gate price</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low standard intermediate product</td>
<td>0.38</td>
<td>0.66</td>
<td>−0.04</td>
<td>−0.01</td>
</tr>
<tr>
<td>High standard intermediate product</td>
<td>24.01</td>
<td>40.68</td>
<td>3.46</td>
<td>5.60</td>
</tr>
<tr>
<td><strong>Factor price</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural labour</td>
<td>0.35</td>
<td>0.60</td>
<td>−0.05</td>
<td>−0.02</td>
</tr>
<tr>
<td>Urban labour</td>
<td>0.20</td>
<td>0.34</td>
<td>−0.07</td>
<td>−0.05</td>
</tr>
<tr>
<td>Land</td>
<td>0.78</td>
<td>1.33</td>
<td>0.03</td>
<td>0.10</td>
</tr>
<tr>
<td>Capital</td>
<td>0.22</td>
<td>0.38</td>
<td>−0.06</td>
<td>−0.05</td>
</tr>
</tbody>
</table>
aggregate. Therefore, the effects will be larger if the high standard sector grows larger in the future.

The second reason is a relatively limited ‘pass-through’ of world market effects to the domestic market in scenario 1A. A comparison with scenario 1B shows that these effects depend strongly on the elasticity of transformation between domestic and exported products. With a higher elasticity, the increase in domestic high standard prices in scenario 1B is much larger: the price of domestic high standard food is higher (+22% instead of +13%) as is the increase in the (farmgate) price of high standard intermediate goods (+40% instead of +24%). The output response is

<table>
<thead>
<tr>
<th>Table 2 (Continued)</th>
</tr>
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<tbody>
<tr>
<td>Poorest rural households</td>
</tr>
<tr>
<td>Profit effect from high standard farming</td>
</tr>
<tr>
<td>Profit sharing from corporate farm</td>
</tr>
<tr>
<td>Factor income effect</td>
</tr>
<tr>
<td>Attributable to:</td>
</tr>
<tr>
<td>Labour</td>
</tr>
<tr>
<td>Land</td>
</tr>
<tr>
<td>Total income effect</td>
</tr>
<tr>
<td>Equivalent variation</td>
</tr>
</tbody>
</table>

| Other rural households |
| Profit effect from high standard farming | 0.12 | 0.22 | 0.02 | 0.03 |
| Profit sharing from corporate farm | 0.01 | 0.01 | 0.00 | 0.00 |
| Factor income effect | 0.04 | 0.08 | 0.01 | 0.01 |
| Attributable to: |
| Labour | 0.02 | 0.04 | 0.00 | 0.01 |
| Land | 0.05 | 0.09 | 0.01 | 0.01 |
| Capital | -0.03 | -0.05 | -0.00 | -0.01 |
| Total income effect | 0.17 | 0.30 | 0.03 | 0.04 |
| Equivalent variation | 0.19 | 0.33 | 0.03 | 0.05 |

| Urban households |
| Profit sharing from corporate farm | 0.00 | 0.00 | 0.00 | 0.00 |
| Factor income effect | -0.17 | -0.29 | -0.02 | -0.03 |
| Attributable to: |
| Labour | -0.12 | -0.21 | -0.01 | -0.02 |
| Capital | -0.05 | -0.08 | -0.01 | -0.01 |
| Total income effect | -0.17 | -0.29 | -0.02 | -0.03 |
| Equivalent variation | -0.16 | -0.27 | -0.02 | -0.03 |

Source: Authors’ simulation. Notes: Sim 1A: World price of high standard food increases by 25% (Δp_{w PH} = +25%, Δp_{wm PH} = +25%); Elasticity of transformation of high standard food is normal (σ^r_{PH} = 1.2).
Sim 1B: World price of high standard food increases by 25% (Δp_{w PH} = +25%, Δp_{wm PH} = +25%); Elasticity of transformation of high standard food is large (σ^r_{PH} = 20).
Sim 2A: Urban households’ preference for low high standard food increases by 25% (Δf_{U PH} = +25%); Import is elastic (σ^q_{PH} = 3).
Sim 2B: Urban households’ preference for low high standard food increases by 25% (Δf_{U PH} = +25%); Import is inelastic (σ^q_{PH} = 0.1).

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stronger both for high standard food (+64% instead of +40%) and high standard farm products (more than 28% compared to less than 21% on all farms). High standard labour use on farms increases considerably more (by more than 58%) and the income effects for poor rural households are almost twice as high: +0.35% compared to +0.20%.

The aggregate effects on growth and inequality are reflected in changes in GDP and in the Gini coefficient. Real GDP declines by −0.04% to −0.06%. The growth in rural incomes with increasing international high standard prices is more than offset by urban consumer losses in terms of total growth. However, inequality reduces: the Gini coefficient declines by −0.31% to −0.54%. With (richer) urban consumers losing and (poorer) rural households gaining, the income gap between both reduces.

4.3. Scenario 2: Domestic demand growth

We now simulate the effect of a change in consumer preferences for high standard products. Such change may come gradually or with shocks. The demand for high standards food will normally increase gradually with rising incomes (Gale and Huang, 2007). However, in developing countries markets are often exposed to shocks, such as the scandal in the dairy sector of China in 2008 (Xinhua Net, 2008; Mo et al., 2011). Such shocks could trigger sharp shifts in preferences.

Scenario 2A simulates the effect of increasing consumer preferences for high standard food by exogenously increasing the minimum consumption of high standard food of urban households. As shown in Table 2, the reported results are rather different from the export-led growth scenario. Now the substitution between low and high standard food leads to an increase in high standard food consumption (+13.4%) but a decline in low standard food consumption (−0.01%). Most of this increased consumption comes from increased imports of high standard food (+18.8%). Domestic production of high standard food (+6.4%) and high standard intermediate products (+2.8% to +3.1%) increase less, while low standard production decreases. Because of the high share of low standard production, this reduces nominal returns to all rural factors: labour (−0.05%) and capital (−0.06%), except land (+0.03%). Because the individual CPIs for rural households decrease more (with falling low standard food prices), the real effects on returns to factors are positive (+0.01% for both poorest and other rural households). And the profit effects are also positive (+0.02% for both). As a result, the real incomes of all rural households increase. Notice that the household income changes reported in Table 2 reflect the real income effects which are measured by household-specific CPIs. For example, while the factor price of rural labour declines by 0.05% in simulation 2A, the factor income from labour for the poorest household increases by 0.01% because their CPI decreases more than the wage rate, as low standard food prices (which make up a large share of their expenditures) decline by 0.05%. This is less the case for richer households which spend more on high standard food whose price increases by 1.6%.

Again these results are strongly influenced by the trade effects. This can be seen from comparing the results with scenario 2B where we simulate the same exogenous change in preferences but with less elastic imports. In this case, the domestic producers benefit more from the increased demand for high standard food by domestic consumers as more of the increased demand comes from domestic production and because the price of low standard farm products falls less because of lower substitu-
The increase in the domestic high standard food prices is almost twice as high (+2.6% compared to +1.6%) and the fall in low standard food price is much less (−0.01% compared to −0.05%) as there is less substitution by consumers. Rural households, including the poor, benefit considerably more: their incomes increase from 0.03% to 0.05% (almost double).

The income effects of urban consumers and the aggregate effects need to be interpreted with care. By exogenously imposing an increase in the share of the high standard food of urban consumers we introduce a distortion in the consumption.
pattern (moving the consumption bundle away from the optimum choice). This in itself will make consumers worse off. These negative effects are compounded by the price and trade effects discussed above. The simulation results indicate that there is no net impact on real GDP as the fall in urban consumer incomes is exactly offset by the gains in rural producer incomes at the aggregate level. This also leads to a reduction in inequality (the Gini coefficient declines by around 0.05%): with (richer) urban consumers losing and (poorer) rural households gaining, the income gap between both reduces. Again, these results need to be interpreted with care because of the exogenously imposed change in consumption preferences.

4.4. Sensitivity analyses

Figures 1–3 summarise a series of sensitivity analyses. Figure 1 shows the effect of differences in technology use in high standard farming, for the export-led growth (scenario 1). It shows that under the export-led scenario rural households will benefit more (less) if the technology used in high standard farming is more (less) labour intensive (see Table S3 in Appendix S1 in the Additional Supporting Information for more details). This effect is strongest for the poorest as is reflected in the different curves for poorer and other rural households. As the poor’s main production factor is their family labour, they will benefit more the more this factor is used in the high standard production, and vice versa. The same result holds under the domestic growth scenario: rural households (and especially the poorest) will gain more (less) with more (less) labour intensive high standard farming technologies (see Figure S2 in Appendix S1 in the Additional Supporting Information).

Figure 2 illustrates the impact of credit constraints, where the capital supply elasticity, used here to reflect credit constraints, is shown on the horizontal axis. We analyse how real income changes if credit is more easily accessible for all the farms (hence credit constraints are relaxed for all farms simultaneously). Figure 2 shows that income effects for rural households may be different for the poorest and the other (somewhat better off) rural households. The ‘other’ rural households, who have more access to non-labour assets, benefit from reduced credit constraints. In contrast, the poorest rural households may actually lose from the reduction of credit constraints for all farms. The reason is that they face stronger competition from other rural households and corporate farms who benefit relatively more from capital cost reductions after credit constraints for all of them are relaxed. Hence, the impact on rural households depends not only on general changes in credit market constraints (e.g., by falling interest rates) but also by the relative effects across the different farm types.

Figure 3 illustrates the effects of investment requirements for high standard farmers, with the fixed costs (an indicator for investment requirements) on the horizontal axis. Not surprisingly, our simulations show that in particular the poorest farmers are negatively affected by higher investment costs.

In summary, these sensitivity analyses are consistent with intuition: poor farms whose main assets are labour are most likely to gain if the high standard products can be produced with labour intensive technologies and less likely if the investment requirements are higher. The impact of capital market constraints depends on the distribution of these constraints across farms.

Finally, Figures S3–S6 in Appendix S1 in the Additional Supporting Information show the results of further sensitivity analyses and robustness tests for various elas-
ticities. The simulations and sensitivity analyses are consistent with intuition. In summary, the sensitivity analyses show that our key conclusions are robust to alternative model specifications and a plausible range of parameter values.

5. Conclusion and Discussion

In this paper we analyse how the expansion of high standard food production might affect structural production changes, the incomes of different types of rural and urban households, and rural poverty and equity using a structural CGE model with market imperfections. We explicitly model credit market constraints and their consequences for poverty and equity. In addition, we explicitly model households’ preferences for high standard food. We use 2005 data from China to calibrate the model and perform two simulations: the effect of an increase in the world price of high standard food and an increase in urban households’ preference for high standard food.

This paper is the first to show the complex set of factors that determine growth and equity effects of high standard growth. First, the simulation results show that poor rural households will expand their production of high standard product with the increase of world price for high standard food, leading to a reduction of poverty and of inequality. Second, expansion of the high standard sector resulting from domestic preference changes increases real incomes of poor rural households, and decreases inequality. Third, the size of the effects depends significantly on the elasticity of trade, on the technology used in high standard production, and on the required investment costs and factor market imperfections.

Poor households will benefit less if consumers can easily switch to high standard imports because of two different mechanisms: first, they benefit less from producing high standard for the increase in domestic high standard demand and, second, they lose because of a stronger substitution and a larger decline in demand for (domestic) low standard production which they primarily produce.
A reduction in credit constraints induces an increase in high standard farming and rural households will gain more. If the technology used in high standard farming is more labour intensive it will benefit the poor more, and vice versa.

Fourth, the spillover effects of high standard demand growth on other product markets (in this in particular low standard markets) is important. Since poor rural households depend importantly on high standard production they may benefit or lose from spillover effects. As we have shown, the effects depend, among others, on where high standard demand comes from and on substitution between imports and domestic products.

Our model, as any CGE approach, is subject to the weaknesses and constraints associated with the many assumptions that have to be made in the development of the equations and their calibration with the data. In addition, to get a more complete understanding, our findings in this paper need to be combined with insights from partial equilibrium models on the role of factors which we did not include in our analysis, such as the role of scale economies, spillover effects, technology transfer, skill heterogeneity, various transaction costs, vertical coordination, contracting, etc (see, for example, Vandemoortele et al., 2012; Swinnen and Vandeplas, 2009).

Despite these shortcomings, we believe that our paper makes an important contribution as it is the first to formally show how the overall welfare effects of standards on poor rural households are determined by many factors and a variety of mechanisms throughout the economy. Numerous empirical studies have ignored several of these mechanisms and our study implies that the results of these studies need to be interpreted within the specific circumstances that they analyse, and particularly taking into account the mechanisms that they ignore. Overlooking some of these effects may lead to biased, and sometimes wrong, policy conclusions.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Model Structure, Data and Additional Sensitivity Analyses.
Figure S1. Model Structure.
Figure S2. Domestic demand growth with elastic import under different technologies.
Figure S3. Export-led expansion with different income elasticities.
Figure S4. Export-led expansion with different Armington elasticities.
Figure S5. Domestic demand growth with different substitution elasticities.
Figure S6. Domestic demand growth with different elasticities of transformation.
Table S1. The Model.
Table S2. Archetype SAM of China when the same technology is used in high standard and low standard farming.
Table S3. Export-led expansion under different technologies.

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