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Simulation Analysis of Adjusting domestic Trade Costs in China to Enhance Residents' Food Consumption

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Abstract

This study employs national Computable General Equilibrium (CGE) model to simulate the impacts of reducing domestic agricultural trade costs on agricultural production, household income, food prices, macroeconomic conditions, as well as food consumption and dietary quality of urban and rural residents. We find that in comparison to trade costs associated with agricultural imports and exports, the reduction of domestic agricultural trade costs is more conducive to expanding food production and cultivation areas, reducing food prices, and improving the dietary conditions of both urban and rural residents in China. Moreover, it stimulates the growth of agricultural, agro-processing, and agrifood system GDP. In terms of specific foods, the reduction in domestic agricultural product trade costs will lower the prices of various food items, decrease the consumption of rice and wheat, and increase the consumption of other types of food. This study provides theoretical and empirical foundations for achieving the dual objectives of revitalizing the national unified market and promoting the transformation of the agrifood system to enhance nutritional welfare within the framework of the new development paradigm, thereby offering valuable insights for informing governmental trade policy decisions. In the future, efforts should focus on intensifying the construction of infrastructure for perishable fresh agricultural products, reducing transportation distances, lowering transport costs, and establishing a "unified national market" in the agricultural sector to enhance the sustainability and resilience of China's agrifood system.

Keywords: trade costs; dietary quality; general equilibrium model; domestic circulation

JEL Codes: Q18, N7, F17, C68

1. Introduction

With the disappearance of the factor price dividend, the slowdown of world economic growth, and the deterioration of the international political and public opinion environment, China's foreign trade has encountered serious challenges (Shi and Zhang, 2021). Since 2018, the trade friction between China and the United States has been escalating. The outbreak of the COVID-19 pandemic in 2020 accelerates the transformation of the world economic landscape. The Russian-Ukrainian conflict intensifies in 2022, resulting in geopolitical tensions as well. Against this background, in March 2020, the CPC Central Committee and the State Council issued the Opinions on Accelerating the Construction of a Nationally Unified Large Market (the Opinions), and the Outline of the Fourteenth Five-Year Plan for the National Economic pointed out that it was necessary to give full play to the role of the main body of the domestic big cycle and promote the new development pattern of domestic and international dual cycles. Based om this, the center of gravity of China's economic cycle has shifted from an international orientation to a domestic one (He and Yang, 2021). Although China's domestic market is not fully integrated at present, there is no denying the existence of large-scale advantages and development potential. Constructing a new development pattern is conducive to reshaping the competitive advantages of large countries, upgrading the modernization level of industrial chains, and realizing the coordinated development of regional economies (Liu and Kong, 2021).

China has made great progress in reducing hunger in recent decades, and the diets of Chinese residents are becoming more diverse, shifting from a predominantly cereal intake to a greater intake of fruits, vegetables, meat, eggs, dairy products, and seafood, but Chinese residents still face dietary imbalances (FAO, 2022). First, the consumption of fast foods high in salt, sugar and fat has led to numerous health problems. Per capita consumption of ultra-processed foods among Chinese adults (aged 20 years or older) quadrupled in 2011 compared to 1997, which is closely associated with an increased risk of overweight (Li and Shi, 2021). Second, meat consumption has grown significantly among Chinese residents. In the 1960s, China consumed less than 8kg of meat per capita per year, this figure rose to around 20kg in the 1980s, and in 2018 it reached around 62kg per capita. China's meat consumption accounts for 28% of the world's total meat consumption, including 14% of pork consumption (Seth et al., 2023). Third, Chinese population has a high intake of edible oils and salt, while the intake of whole grains, dark vegetables, fruits, dairy, fish, shrimp and pulses is generally insufficient (Chinese Nutrition Society, 2021).

In the context of the domestic circulation, how to build a "national unified market" in the agricultural sector, promote the development of inter-provincial trade in agricultural products, and safeguard the nutritional health of the population has become a key issue in the transformation of the current agrifood system. This study focuses on the simulation of countermeasures to improve the dietary situation of Chinese residents in the context of the domestic circulation, with a view to combining the new development pattern with China's agrifood system. This study explores how to achieve the dual goals of revitalising the unified national market and improving the dietary situation of Chinese residents, as well as promoting the transformation of the agrifood system. It should be noted that the national unified market is to a large extent an issue of "high-level socialist market economic system", and its policy orientation is to accelerate the establishment of national unified market system rules, break local protection and market segmentation, open up key blockages that restrict economic circulation, and promote the smooth flow of commodity factor resources on a wider scale. Thus, the construction of a national unified market covers a wide range of areas which from policy regulation to commodity circulation. However, the discussion of the national unified market and domestic circulation in this study focuses on the commodity level, and is mainly in the agricultural field. We discuss the issue of domestic trade costs of agricultural products. Although it does not fully reflect the entire content of the national unified market and domestic circulation, it can be regarded as a partial substitution. On the whole, the above issues will not prevent us from studying the national unified market and the domestic circulation, and can provide theoretical and policy thinking to a certain extent.

Current research on agricultural trade costs is relatively abundant. Duval et al. (2012) measure the trade costs of agricultural products in Asian and Pacific Rim countries and studied their influencing factors. Xu et al. (2012) focus on agricultural trade between China and other countries and measure the trade costs of China's major agricultural products using an improved gravity model, which shows that the average trade costs of China's major agricultural products (rice, wheat, soybeans, and fruits, etc.) declined year by year from 1996 to 2009. Jia and Qin (2013) analyze the trend of China's grain trade costs and its impact on trade growth, which also obtains the conclusion that China's grain trade costs are basically in a downward trend. Ma (2014) measures the bilateral agricultural trade costs between China and 39 major trading partners since 1992 based on the modified gravity model, and the results show that China's agricultural trade costs have generally shown a downward trend. Jia et al. (2017) take the lead in studying the impact of trade costs on the growth of China's agricultural trade across regions by constructing a two-sector CGE model, they find that there is a significant regional difference in China's agricultural trade costs and this difference is generally on a downward trend, which is an earlier study on China's inter-regional agricultural trade.

In addition to the literature on the "agricultural trade costs", the literature on the integration of trade and dietary health issues is also instructive. Thow (2009) points out that developing countries are undergoing a nutrition transition, and trade policy has been highlighted as a potential preventive pathway in relation to nutrition. From the existing literature, there is a more complex relationship between trade policies and diet. On the one hand, these policies contribute to the nutrition transition to some extent. Hawkes et al. (2015) find that trade liberalization facilitates cross-border trade in food and services, which can contribute to the nutrition intake of the population through increasing the quantity and type of food products. Ravuvu et al. (2017) argue that trade agreements play an increasingly important role in shaping national food environments, food availability and nutritional quality. On the other hand, trade policies also have a negative impact on the domestic dietary environment. The availability and affordability of processed foods, meat and dairy products tend to improve with lower tariffs, leading to increased salt, fat and sugar intake (Hawkes, 2008). Zhou and Zhang (2020) provide methodological innovations, they apply the

Global Trade Analysis Model (GTAP) to simulate different trade liberalization policy scenarios, and find that trade liberalization impacts on the food consumption structure of Chinese residents through the income effect, substitution effect, and competition effect. They point out that the expansion of imports is able to effectively alleviate the growth in the demand for food consumption of Chinese residents in contradiction with the domestic effective supply of It is pointed out that import expansion can effectively alleviate the imbalance between the growth in demand for food consumption and the effective domestic supply and improve the welfare of Chinese residents.

However, the trade policy discussed in the above literature mainly focuses on trade liberalization as measured by tariffs, very few studies have focused on trade costs, especially trade costs between regions within countries. In order to make up for the shortcomings of existing studies, this paper intends to use the data of the 2018 National Input-Output Table published by the National Bureau of Statistics (NBS) to compile the Social Accounting Matrix (SAM) and subdivide the SAM into 88 sectors according to the data of production value and cost-benefit, then construct a general equilibrium model (CGE) based on it. Different policy scenarios are simulated to assess the impacts of declining agricultural trade costs on China's agricultural production, household income, food prices, macroeconomic conditions, as well as food consumption and dietary quality of Chinese urban and rural residents.

The research value of this paper is mainly reflected in the following points. First, this study applies of a more scientific method to compile the 2018 national-level social accounting matrix by using data such as the production value and cost-benefit. Second, on the basis of China's dynamic CGE model, it is the first time to construct China's general equilibrium (CGE) model distinguishing between domestic and foreign trade. Third, we connect domestic agricultural trade costs with residents' dietary health concerns, establishing links between China's CGE model and micro-level household survey data of rural and urban residents. This not only explores the impact of trade costs on agricultural production and the macro-economy but also includes their effects on residents' food consumption quantity, food consumption structure, income, dietary quality, and food prices. This broadens the research boundaries for the transformation of China's agricultural and food system under the new development pattern, aiming at providing timely and effective decision-making references for government trade policy formulation.

2. Analysis of Agricultural Transportation Costs

Trade costs are an important indicator reflecting the degree of domestic economic integration. There are two main sources of domestic trade costs in China: transportation costs between regions and local protectionism. Transportation costs primarily depend on the level of infrastructure development. Compared to mature market economies, China's transportation infrastructure started developing relatively late, resulting in lower network density. Additionally, transportation costs are also related to the operation and management system of infrastructure. Domestic transportation costs are not entirely natural barriers (Huang, 2011; Duan et al., 2023).

Local protectionism represents a concealed form of transnational tariff and non-tariff barriers in domestic trade. Local governments across China tend to protect industries within their jurisdiction from competitive pressures through various means. However, measuring local protectionism is not easy. Therefore, this paper primarily calculates observable variables as important components of domestic trade costs ——transportation costs. And we use transportation costs of agricultural products as a significant proxy variable for domestic agricultural trade costs in China. Among these, the data of transportation costs is sourced from the CEIC database[1]. From Figure 1, it can be observed that China's transportation costs increased from 0.5 trillion yuan in 1991 to 17.8 trillion yuan in 2022. Among these, agricultural transportation costs increased from 0.3 trillion yuan to 5.3 trillion yuan. In 2022, the total industry transportation costs were 34 times that of 1991, and agricultural transportation costs were 16 times that of 1991. This indicates the significant role of logistics transportation in the national economy, which cannot be overlooked. Due to the seasonal characteristics and short shelf life of agricultural products, they impose

[1] Data is sourced from the CEIC database's indicator of total logistics costs, which refers to the total social logistics costs incurred in various aspects of the national economy during the reporting period. Specifically, it includes expenses incurred in various logistics activities such as transportation, storage, loading and unloading, packaging, circulation processing, distribution, and information processing; loss of goods during logistics; interest expenses incurred due to capital occupation in logistics activities; management expenses incurred in logistics activities, etc. The data is obtained through the following path: CEIC database (https://insights.ceicdata.com.cn/) - China Economic Database - Transportation and Storage Industry - Logistics Industry - Total Logistics Costs for Agricultural Products. The original source of this data is the China Federation of Logistics and Purchasing.

higher requirements on transportation, warehousing, and other links. As shown in Figure 1, the proportion of agricultural transportation costs in the total industry transportation costs decreased from 62.8% in 1991 to 29.8% in 2022. Although the proportion of agricultural transportation costs in the total industry transportation costs has decreased, the current freight rates for Chinese agricultural products remain high. It's worth noting the potential impacts of higher transportation costs on residents' dietary habits, how to reduce transportation costs, and whether residents' diets can be improved after cost reduction. These are all issues worthy of attention.

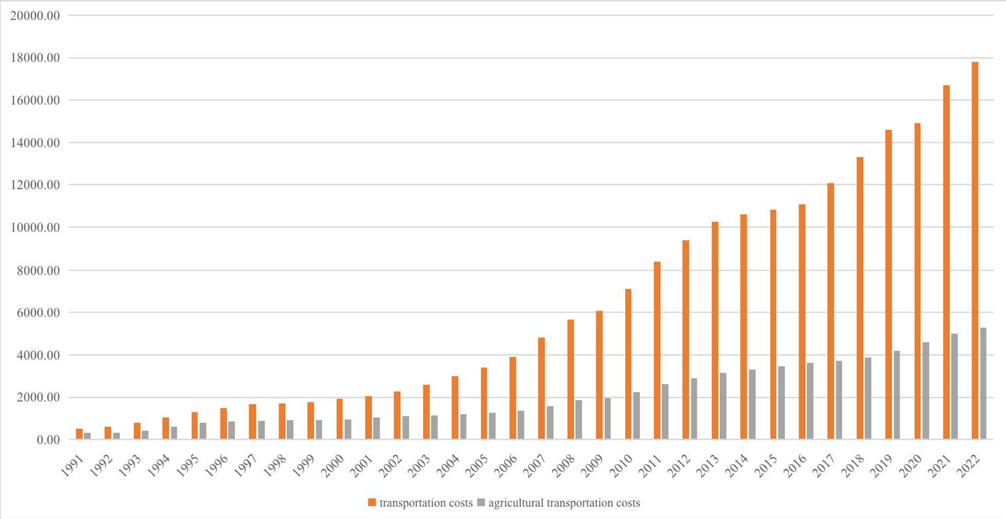
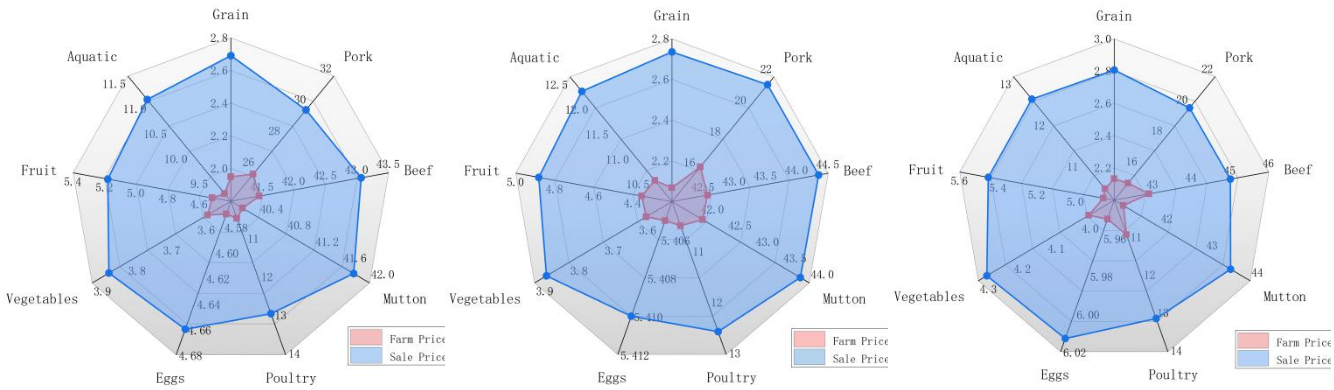


Figure 1 Transportation costs in China from 1991 to 2022 (unit: ten billion yuan)

To further illustrate the transportation costs of agricultural products, this paper proceeds to observe and study the differences between farm price and sale price. The price differences of various food from 2020 to 2022 are represented in the form of radar charts. The farm price data primarily come from the "China Agricultural Product Price Survey Yearbook," while the sale price data are obtained using Python, crawled and calculated from the China Price Information Network. It can be observed that there are remarkable differences between farm price and sale price, with some foods having prices at the destination nearly double those at the farm.



(a) 2020 (b) 2021 (c) 2022

Figure 2 Difference between farm price and sale price in 2020-2022 (unit: yuan)

Furthermore, upon calculating the proportion of the price difference to the farm price, we find that for grains, this proportion is the highest. This may be attributed to the clear delineation of primary grain-producing regions, main sales regions, and production-sales equilibrium regions in China. To ensure a sustained and stable supply of grains, domestic grain trade in China is extensive and abundant. Due to the inherently high farm price of beef and mutton, the overall proportion of the price difference to the farm price is relatively small. Conversely, for pork, chicken, and aquatic products, this proportion is relatively larger. The proportion for eggs, vegetables, and fruits is relatively smaller, possibly because these food items primarily circulate within provinces.

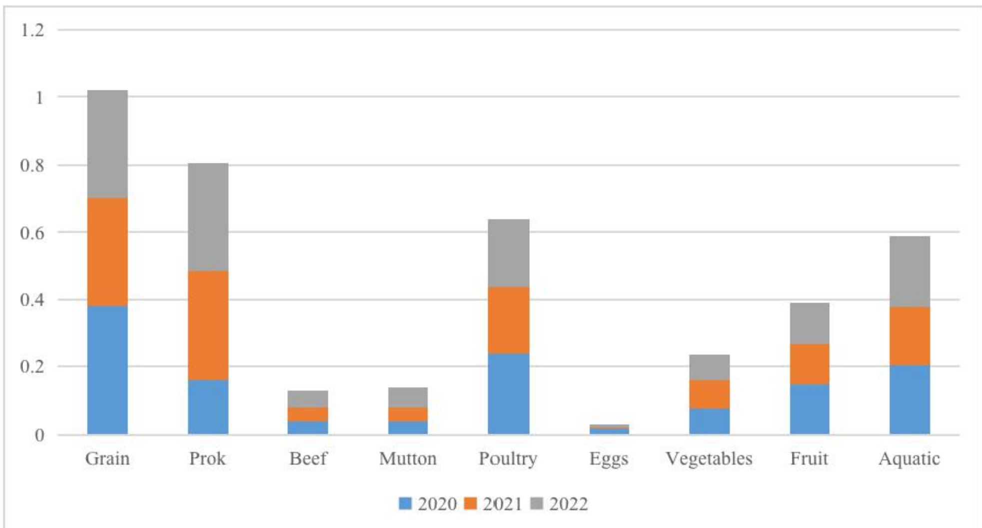


Figure 3 Proportion of price difference to the farm price in 2020-2022 (%)

3. Theoretical basis and data sources

3.1. Basic economic theory analysis

Starting from economic theory, this study presents a theoretical analysis of changes in producer and consumer prices under scenarios such as with trade costs, or without trade costs. This establishes a theoretical foundation for further investigating the price mechanism's influence on household food consumption due to trade costs. In Figures 4, D represents the consumer demand curve, S^* represents the market supply curve under the condition of no trade costs, and S_0 represents the market supply curve under the condition of trade costs. By comparing S^* and S_0, it can be seen that the trade cost is $P_1 - P_2$, where P_1 is the consumer price and P_2 is the producer price. Furthermore, assuming that trade costs decrease, it can also be understood as the government increases subsidies to the trade sectors. As trade costs decrease, the market supply curve shifts from S_0 to S_1, and consumer prices decrease from P_1 to P_3. The price decrease increases consumer demand from Q_1 to Q_2, and the equilibrium point shifts from A to C below the right; The increase in demand drives producer prices to rise from P_2 to P_4, and the price increase leads to an increase in supply for producers. Production increases from Q_1 to Q_2, and the equilibrium point shifts from B to D in the upper right direction.

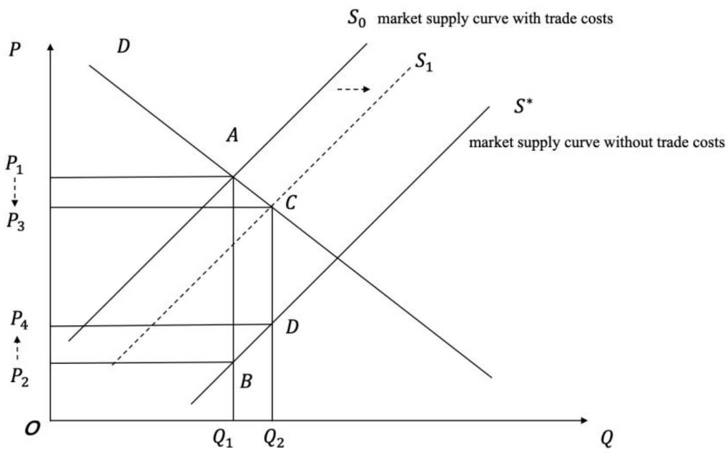


Figure 4 The impact of trade costs on prices

3.2. General equilibrium models (CGE)

Promoting the transformation of the agrifood system to achieve the multi-objectives of high quality, high efficiency, nutritional, low-carbon, resilience and inclusiveness requires multi-disciplinary and comprehensive research. The China Agricultural University - AgriFood System model (CAU-AFS) was developed by the College of Global Food Policy of China Agricultural University. This model has a huge modelling system. The core models include China Dynamic General Equilibrium Model (DGEM), 31-province Partial Equilibrium Model (PEM), China Agricultural Industry Model (CASM), and Belt and Road International Trade Partial Equilibrium Model (BRITEM). The structure of the model is shown in figure 5.

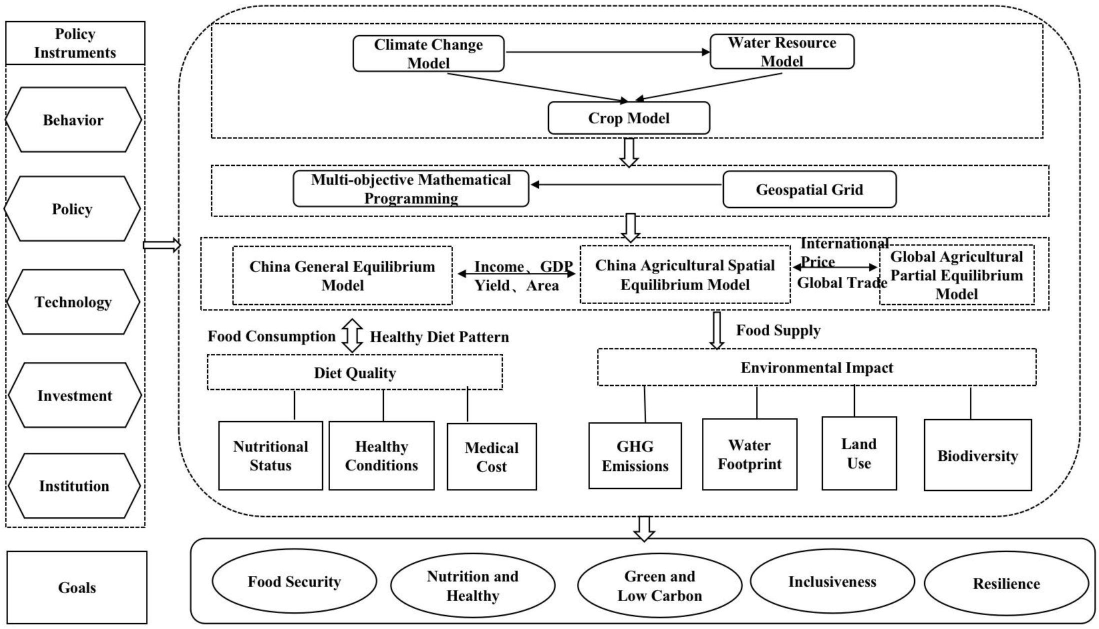


Figure 5 CAU-AFS model structure

Source: China and Global Food Policy Report 2022.

CGE model is an economic system model, which consists of multiple sectors, factors, economic agents and markets, covering all aspects of production, consumption and trade, describes the market equilibrium of the economy and society, establishes the relationship between different production sectors, and captures the complex linkages and interactions in the economic system. CGE has been widely used in various fields of research, and is an important policy simulation and analysis tool (Zhang et al., 2013).

China's dynamic CGE model is the core model of the CAU-AFS modelling system, which is a Chinese model constructed using Chinese data and based on the Rural Investment And Policy Analysis (RIAPA) model developed by the International Food Policy Research Institute (IIPRI). The RIAPA model adds the Agricultural Investment Data Analysis Module (AIDA) on top of the ordinary general equilibrium model, which can analyze the impact of investment on the agricultural industry, economic growth, farmers' income and dietary status. Compared with the farm micro model, the SAM multiplier method, and the multi-market partial equilibrium model, the advantage of the Chinese dynamic CGE model is that it endogenizes the residents' income in the economic system, which can facilitate the study of the impact of economic activities on economic growth and residents' income. This model inherits the advantages of the RIAPA model while making several innovative improvements. First, China's dynamic CGE model carries out a more detailed division of the agricultural sector, including 23 agricultural sectors, 14 food processing sectors, as well as other industries and services sectors, a total of 88 sectors. In order to comprehensively reflect the linkages between the entire agrifood system industry chain. Second, a macro-micro linkage mechanism is established to divide residents into 40 groups according to urban and rural areas and incomes, and the simulation results of China's dynamic CGE model are transferred to micro-individuals, which are used to simulate and analyze the differences in the impacts of various policies on different groups of residents, including the changes in incomes and dietary quality. Third, the China Dynamic CGE Model improves the nutritional diet module, which makes it possible to analyze both under-nutrition and over-nutrition in the population and the quality of the overall diet, and to study the impact of various policies on food consumption and diet quality in different population groups. These improvements enable the CAU-AFS model to be widely used in multi-objective policy simulation analyses, including food security, population income increase, nutritional health, and protection of the environment. It provides a scientific basis for the government to comprehensively weigh multi-objective decision-making (China and Global Food Policy Report, 2022; Lofgren, 2001; Xu et al. 2012; Zhang & Diao, 2020).

The dynamic CGE model can further track trends in economic structure. In the dynamic CGE model, residents' incomes increase with economic growth, and residents' consumption patterns change with income growth. In addition, residents' expenditures change with demographic change. Savings are transformed into investment, further expanding the demand for goods and services. As population changes, per capita income grows, and investment increases, the demand structure of the economy and the structure of production change accordingly. This general equilibrium structure also allows us to analyze the contribution of a given exogenous trend change to macro economy, residents' incomes, and product consumption as well as production through product and factor markets. By assuming a market economy, the CGE model solves for the equilibrium of supply and demand in multiple factor and product markets in an economic system, mediated by changes in relative prices. This study refers to Diao et al. (2012), where a series of mathematical equations are used to explain the behavioral responses of economic agents.

(1) Consumer behaviour functions

The representative consumers maximize their welfare facing a budget constraint. Using a Stone-Geary utility function, the consumer problem can be presented mathematically as follows:

$$Max_i U_h = \Pi_i \ (c_{hi} - \gamma_{hi})^{\beta_{hi}} \tag{1}$$

$$s.t. \sum_i P_i c_{hi} = (1 - s_h)(1 - yt_h) Y_h \tag{2}$$

where $c_{h,i}$ is the commodity consumption level, and $\gamma_{h,i}$ is the minimum commodity consumption level, and $\beta_{h,i}$ is the primary budget share of the commodity. In the budget constraint equation, the price of the commodity purchased by the consumer, the savings rate, the personal income tax and household savings are taken as exogenous variables and the demand function obtained by maximising the above utility function is applied to the consumption problem in the CGE model:

In the utility function $c_{h,i}$ is the level of consumption for good *i* by household *h*, which are rural and urban in our case, $\gamma_{h,i}$ is the subsistence level of consumption for good *i* by household *h*, $\beta_{h,i}$ is the marginal budget share for good *i* by household *h*. In the budget constraint function, p_i is the price for good *i* faced by consumers, s_h the saving rate of household *h*, yt_h an income tax rate, and y_h household *h*'s total income.

The demand functions that are derived from maximizing the above utility function are explicitly defined in the CGE models, which are known as linear expenditure system (LES) in the CGE model:

$$c_{hi} = \frac{\beta_{hi}[(1-s_h)(1-yt_h)Y_h - \Sigma_j P_j \gamma_{hj}}{P_i} + \gamma_{hi} \tag{3}$$

(2) The production equation

The producers are defined at the production sector level, and production functions are constant returns to scale in technology. Accordingly, a CES production function is defined for each sector as follows:

$$X_i = \Lambda_i (\sum_f a_{if} \cdot V_{if}^{-\rho_i})^{-\frac{1}{\rho_i}}, f \in F \tag{4}$$

Where X_i is the output of sector *i*, Λ_i a shift parameter reflecting total factor productivity (TFP) of sector *i*, α_i the parameter for factor *f* (land, labor, and capital) employed in the production of commodity *i*, $V_{i,f}$ the factor demand, and ρ a parameter to capture the substitution relationship between factors, which transfers the elasticity of substitution in the following way: $\sigma_i = \frac{\rho_i}{1+\rho_i}$ and σ_i is the elasticity of substitution between factor inputs.

Following the neoclassical general equilibrium theory for producers' behavior of profit maximization, the rearranged first order condition of maximizing profits subjecting to the technology defined in (2) provides a system of factor demand functions that are explicitly defined in the CGE model as follows:

$$V_{if} = \Lambda_i^{-\frac{\rho_i}{1+\rho_i}} \cdot X_i \left(\alpha_{if} \cdot \frac{PV_i}{W_f}\right)^{\frac{1}{1+\rho_i}} \quad (5)$$

Equation (2) shows how the demand for a single factor *V* will fall when its cost *W* rises relative to the combined price *PV* of all other factors. It is important to note that in the CGE model, it is the relative price change that matters rather than the absolute price change. If *PV* and *W* increase or decrease at similar rates, then factor demand will not be affected (factor demand will increase proportionately with changes in output *X*).

The intermediate input function takes the form of the Leontief equation, in which the various intermediate inputs required for each product are determined according to fixed input-output coefficients:

$$PP_i = PV_i + \sum_j P_j\, io_{ji} \quad (6)$$

(3) Factor market equilibrium and population income

The factor market equilibrium condition holds in the presence of full employment and factor mobility in the domestic economy:

$$\Sigma_i v_{fi} = V_f \quad (7)$$

China's dynamic CGE model assumes that all factors are owned by residents, so that residents' income *Y* is determined by the following factors:

$$Y_h = \Sigma_f \delta_{hf} (1 - ft_f)\, w_f V_f + y^h_{row} \quad (8)$$

where δ_{hf} is the matrix of distribution coefficients from factor income to residential income, ft_f is the factor tax rate, y^h_{row} is an exogenous variable which represents net foreign income received by households.

3.3. SAM table decomposition and data description

The core data of the general equilibrium model (CGE) is the Social Accounting Matrix (SAM), which is a matrix representation of the transactions among the accounts of the national economy, reflecting the economic linkages among the various agents of the socio-economy over a certain period of time. It provides the CGE model with a comprehensive database (Pyatt, 1985). SAM can be compiled based on different research questions with flexibility. Due to the wide range of data sources, in order to solve the situation that the error will not be balanced in the process of compilation, this study refers to Robinson et al. (2001), utilizing the cross-entropy method for balancing. SAM's Activity and Merchandise Account data are primarily derived from Input-Output Tables (IO Tables). The national level SAM uses the 2018 IO tables for sector 149. First, we subdivide the total account of "agriculture, forestry and fishery products and services" according to the proportion of output value of the five sectors, namely, agriculture, forestry, animal husbandry, fishery and services. Then, we utilize the national IO tables of the 149 sectors in 2018 to compile the SAM, and decompose the corresponding rows and columns using the input-output relationships of the five sectors. Further, in order to analyze the impact of changes in domestic agricultural trade costs on the dietary health of the population, this study decomposes the agricultural sector using data on the production value and cost-benefit of crops, and classifies "agriculture" into rice, wheat, maize, other grains, soybeans, peanuts, rapeseed, cotton, sugarcane, sugar beets, fruit, vegetables, tobacco, and other crops, while the Livestock Products sector is also disaggregated into six sectors, including pork, beef, mutton, poultry, eggs, and dairy. The final SAM totaled 88 sectors, including 23 agricultural sectors, 15 food processing sectors, 26 industrial sectors, and 24 service sectors (China and Global Food Policy Report, 2022).

The proportions involved in the decomposition process are mainly calculated by the CASM model, which was based on the following data sources: production data are obtained from the China Rural Statistical Yearbook, food consumption data are obtained from the China Statistical Yearbook, data on the eating out are converted by the proportion of external consumption (Sheng et al., 2021).

The function for feeding consumption is as follows:

$$\sum_i Feed_{i,j} * QX_i \tag{9}$$

Where i is the type of livestock product, j is the type of crop, QX_i is the output of livestock products. They are from the China Rural Statistics Yearbook. $Feed_{i,j}$ is the quantity of feed grains of type j required per unit of livestock product from China Feed Industry Yearbook. Seed consumption data are from the China Rural Statistics Yearbook. Processing consumption is from the National Cereals and Oils Center database and the China Food Industry Yearbook. Domestic producer prices are from the China Agricultural Product Price Survey Yearbook. Gross production output data are from the 2018 China Rural Statistical Yearbook. Cost-benefit data are from the China Cost-Benefit Survey Compendium. Import and export data are from the Key Agricultural Products Market Information Platform.

3.4. Disaggregation of domestic and foreign trade

In order to focus on domestic trade, this study distinguishes between domestic and foreign trade for the first time on the basis of China's dynamic CGE model. In the original model, imports and exports include both "domestic" and "foreign", while the modified model decomposes imports and exports into "domestic imports and exports" and "foreign imports and exports". We first calculate the balance of production and sales from the available data on production and consumption, then express the balance of production and sales in terms of imports, exports, inter-provincial transfers out and extra-provincial transfers in:

Balance of production and sales = production - consumption = exports - imports + inter-provincial transfers out - extra-provincial transfers in (10)

Further, by using the production and marketing balance data and the import and export data, we can determine whether each province is a net outflow province or a net inflow province in the domestic agricultural trade:

Inter-provincial transfers out - extra-provincial transfers in = balance of production and sales - exports + imports (11)

Consistent with the decomposition of the SAM table described in the previous section, the methods of decomposing the trade are as follows:

First, the total account of "agriculture, forestry and fishery products and services" is subdivided according to the proportion of output value of the five sectors of agriculture, forestry, animal husbandry, fishery and services in 2018, and the input-output relationship of the five sectors in the national table of 149 sectors in 2018 is decomposed into the corresponding rows and columns:

$$T_{i,j} = TAGRI_j * SHR_{i,j} = TAGRI_j * \frac{T^0_{i,j}}{TAGRI^0_j} \tag{12}$$

Where i denotes sub-industry i and j denotes trade type j. Here, sub-industries include agriculture, forestry, animal husbandry, fishery and services, and trade types include imports, exports, inter-provincial transfers out and extra-provincial transfers in. Taking agricultural imports as an example, $T_{i,j}$ is the value of agricultural imports, $TAGRI_j$ is the total value of agriculture, forestry, animal husbandry and fishery imports. The data is sourced from the national-level Input-Output (IO) table for the year 2018. $SHR_{i,j}$ denotes the share of agricultural imports, $T^0_{i,j}$ is the value volume of agricultural imports calculated through the CASM model, $TAGRI^0_j$ is the total import value of agriculture, forestry, animal husbandry and fishery calculated through the CASM model. The import and export value volume data in the CASM model come from the Key Agricultural Markets Information Platform. The inter-provincial transfers out and extra-provincial transfers in value volume are calculated by multiplying the inter-provincial net outward transfer volume (inter-provincial transfers out - extra-provincial transfers in) and the extra-provincial net inward transfer volume (extra-provincial transfers in - inter-provincial transfers out) multiplied by domestic producer prices.

Based on this, "agriculture" is further divided into 14 crop sectors such as rice, wheat, maize, other grains, soybeans, peanuts, rapeseed, cotton, sugarcane, sugar beets, fruit, vegetables, tobacco, and other crops:

$$T_{i,j} = TCROP_j * SHR_{i,j} = TCROP_j * \frac{T^0_{i,j}}{TCROP^0_j} \tag{13}$$

Where *i* denotes the category of plantation agricultural products, and *j* denotes the category of trade types, where the plantation agricultural products include the above 14 categories, and the trade types are the same as above. Taking the inter-provincial transfer of rice as an example. $T_{i,j}$ is the value volume of inter-provincial transfer out of rice, $TCROP_j$ denotes the total net inter-provincial transfer value of the plantation industry, and the data comes from the SAM table obtained from the decomposition of the IO table using the GAMS software. $SHR_{i,j}$ denotes the share of inter-provincial transfers out of rice, $T^0_{i,j}$ is the value of net inter-provincial transfers out of rice obtained through the CASM model, $TCROP^0_j$ denotes the total value of net inter-provincial transfers out of all products in the plantation sector calculated through the CASM model.

Finally, the livestock product sectors were disaggregated using the value of production and cost-benefit data for livestock products, which became six sectors, including pork, beef, mutton, poultry, eggs, and dairy sectors:

$$T_{i,j} = TLVST_j * SHR_{i,j} = TLVST_j * \frac{T^0_{i,j}}{TLVST^0_j} \tag{14}$$

Where *i* indicates the category of animal husbandry products and *j* indicates the category of trade types, here animal husbandry products include the above six categories, and the trade types are the same as above. Taking pork out-of-province transfer in as an example. $T_{i,j}$ is the value volume of pork transferring in from outside the province, $TLVST_j$ denotes the total value of net out-of-province transfers in for the livestock industry, and the data comes from the SAM table obtained from the decomposition of the IO table using the GAMS software. $SHR_{i,j}$ denotes the share of pork out-of-province transfers in, $T^0_{i,j}$ is the value of net out-of-province transfers in of pork calculated through the CASM model, $TLVST^0_j$ denotes the total value of net out-of-province transfers in of all products in the animal husbandry sector calculated through the CASM model.

4. Simulation of countermeasures to improve the dietary situation of the Chinese population in the context of the domestic general circulation

4.1. Research methodology

This study uses the China Agricultural University's Agrifood System (CAU-AFS) model. This is an interdisciplinary model that not only can predict future changes in agricultural and food systems, but also can be used for policy simulation analysis. It can simulate the combined impact of various policies and external shocks on the agricultural and food system, including the impacts on food security, economic efficiency, nutritional health, resources, and the environment. Currently, the base year for the CAU-AFS model is 2018. According to future population and labor force growth, urbanization rates, and technology progress (using 2018 as the base year), the situation in 2030 is projected recursively and is regarded as the business-as-usual (BAU) scenario.

4.2. Simulation programme design

The data on domestic transportation costs in the CEIC database shows that in 2022, the total transportation cost of agricultural trade in China was 5.3 trillion yuan, accounting for 33.96% of the agricultural output value of the same year. The transportation industry has a significant impact on economic development. Reducing transportation costs for agricultural trade plays an important role in agricultural production, household income, food prices, food consumption quantity, dietary quality, and macroeconomic factors. Based on the classification and composition of China's agricultural trade costs, combined with the latest situation of China's agricultural market operation, this paper adopts a counter-factual method to set up three different policy simulation schemes: The first scheme simulates the policy effect of only reducing domestic agricultural trade costs under the premise that the costs of agricultural import and export trade remain unchanged. The second scheme simulates the policy effect of only reducing agricultural import trade costs under the premise that domestic trade costs and export trade costs of agricultural products remain unchanged. The third scheme simulates the policy effect of only reducing the cost of exporting agricultural products under the premise that domestic trade costs and import trade costs of agricultural products remain unchanged. Since the base year of the model is 2018, the total transportation cost of agricultural products in China was 3.9 trillion yuan in 2018. It is assumed that through channels such as strengthening the construction of transportation infrastructure, improving cold chain transportation services, enhancing regional production specialization, strengthening regional cooperation, reducing market barriers, and optimizing the operation and management mode of transportation and warehousing links, the domestic agricultural trade costs in China will decrease annually at rates of 1%, 5%, and 10%, respectively, and likewise for agricultural import and export trade costs. Therefore, high, medium, and low scenarios are set for each simulation scheme, and the specific contents of the simulation scenarios are shown in Table 1.

Table 1

Scenarios design

Scenarios	Medium scenario	Low scenario	High scenario
Scenario 1: Reducing domestic agricultural trade costs	1% reduction in the domestic agricultural trade costs, all else being equal	5% reduction in the domestic agricultural trade costs,all else being equal	10% reduction in the domestic agricultural trade costs, all else being equal
Scenario 2: Reducing trade costs of agricultural imports	1% reduction in trade costs of agricultural imports, all else being equal	5% reduction in trade costs of agricultural imports, all else being equal	10% reduction in trade costs of agricultural imports, all else being equal
Scenario 3: Reducing trade costs of agricultural exports	1% reduction in trade costs of agricultural exports, all else being equal	5% reduction in trade costs of agricultural exports, all else being equal	10% reduction in trade costs of agricultural exports, all else being equal

4.3. Analysis of simulation results

(1) Impact on agricultural production

In the scenarios with reduced domestic agricultural trade costs, both food production and food acreage show an upward trend. Under the low, medium and high scenarios with 1%, 5% and 10% reduction in domestic agricultural trade costs, food production rises by 0.91%, 3.80% and 6.11% in 2030, and the food acreage expands by 0.23%, 0.95% and 1.52%, respectively. Food production and food acreage in 2060 increase more under the low and medium scenarios compared with that in 2030, but the food production decreases by 1.57% from 2030 under the high scenario. Food production and food acreage show a decreasing trend under the scenario of reducing trade costs of agricultural imports, and food acreage remains unchanged in 2060 under all three scenarios. Under the scenario with reduced trade costs for agricultural exports, both food production and food acreage show an increasing trend, but the impact of reduced trade costs for agricultural exports is smaller compared to the scenario with reduced domestic agricultural trade costs.

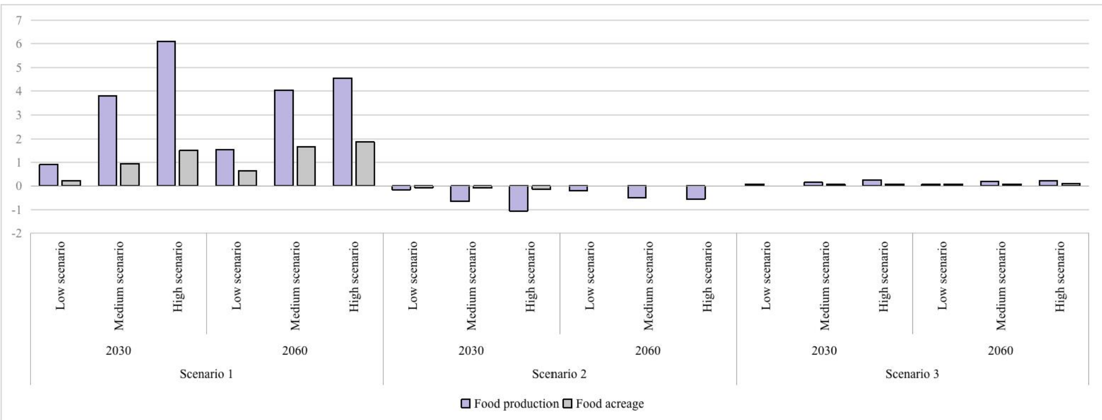


Figure 6 Impact of reducing agricultural trade costs on agricultural production (%)

(2) Impact on household income, food prices, and food consumption of urban and rural residents

The reduction in the domestic agricultural trade costs can be interpreted as an increase in government subsidies for agricultural trade, which brings down consumer food prices. Reducing trade costs of agricultural imports will bring about a decrease in domestic food prices, and a reduce in the trade costs of agricultural exports will have the opposite effect on domestic food prices. The reduction of domestic agricultural trade costs and trade costs of agricultural imports will bring about the reduction of urban and rural residents' income. The reduction of trade costs of agricultural exports on residents' income is not obvious. Reductions in the agricultural trade costs lead to an increase in residents’ food consumption.

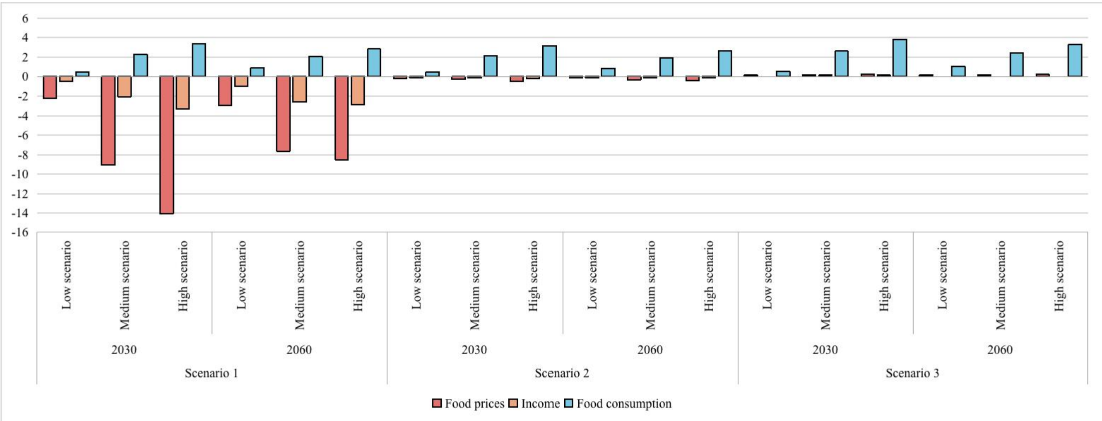


Figure 7 Impact of reducing agricultural trade costs on household income, food prices, and food consumption of urban and rural residents (%)

(3) Macroeconomic implications

A decline in the domestic agricultural trade costs would lead to a decline in total domestic GDP, which would fall by 0.06%-0.41% and 0.18%-0.46% in 2030 and 2060, respectively. The decline in the domestic agricultural trade costs provides a positive boost to agricultural GDP, agro-processing industry GDP, and agrifood system GDP, with the largest positive impact on agro-processing industry GDP. It is worth noting that under the high scenario, the growth rates of agricultural GDP, agro-processing industry GDP, and agrifood system GDP in 2060 are smaller than those in 2030, suggesting that the growth of agricultural, agro-processing industry, and agrifood system GDP brought about by the decline in the domestic agricultural trade costs at a rate of 10% per year reaches an inflection point between 2030 and 2060. Reducing trade costs of agricultural imports and exports affect total domestic GDP, agricultural GDP, and agro-processing industry GDP in opposite directions.

Reducing agricultural trade costs lead to an increase in agrifood system GDP, decreasing domestic agricultural trade costs contribute the most.

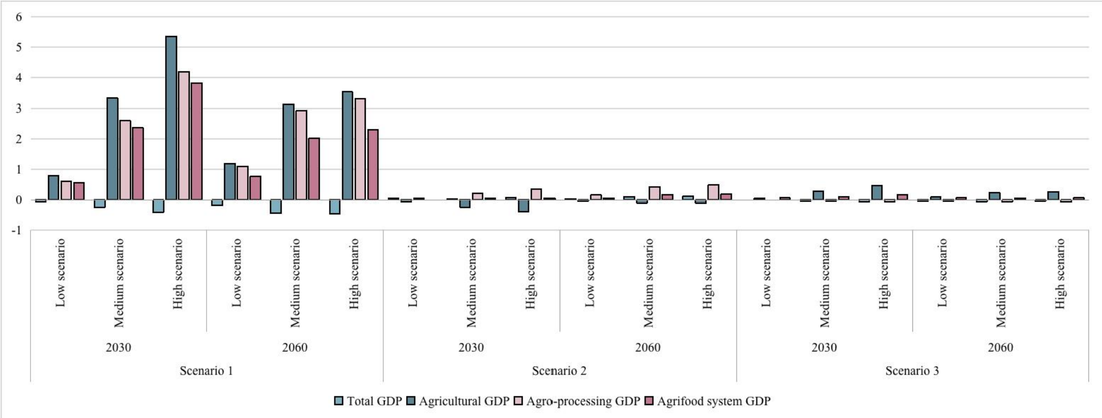


Figure 8 Impact of reducing agricultural trade costs on macroeconomic (%)

(4) Impact on the dietary quality of urban and rural residents

In this study, we used DBI-16 to evaluate the dietary quality level of Chinese urban and rural residents, which contains three indicators, namely diet quality distance (DQD), high bound score (HBS) and low bound score (LBS). Compared with internationally used dietary quality indicators, DBI-16 is based on the "Dietary Guidelines for Chinese Residents 2016" and the Balanced Diet Pagoda for Chinese Residents, and it is more in line with the actual dietary intake and nutritional status of Chinese residents. In addition, DBI-16 can more intuitively reflect the imbalance of intake in the dietary structure, of which the DQD indicators can comprehensively reflect the overall dietary balance level, the HBS and LBS indicators can reflect the level of dietary over-intake and under-intake. Depending on the specific food subgroups, the scores of the DBI-16 indicators could be classified into the following ranges: a score of 0 indicates excellent, a score lower than 20% of the total score is considered as more appropriate, a score in the range of 20%-40% is considered as low, a score in the range of 40%-60% is considered as moderate, and a score higher than 60% is considered as high. From the results in Figure 9, it can be found that the decline in the domestic agricultural trade costs as well as the import and export trade costs will improve the dietary quality of urban and rural residents, including the improvement of the level of dietary over consumption, dietary under consumption and the overall balance of the diet, among which the decline in the domestic agricultural trade costs has the most obvious effect on the improvement of the dietary quality of urban and rural residents.

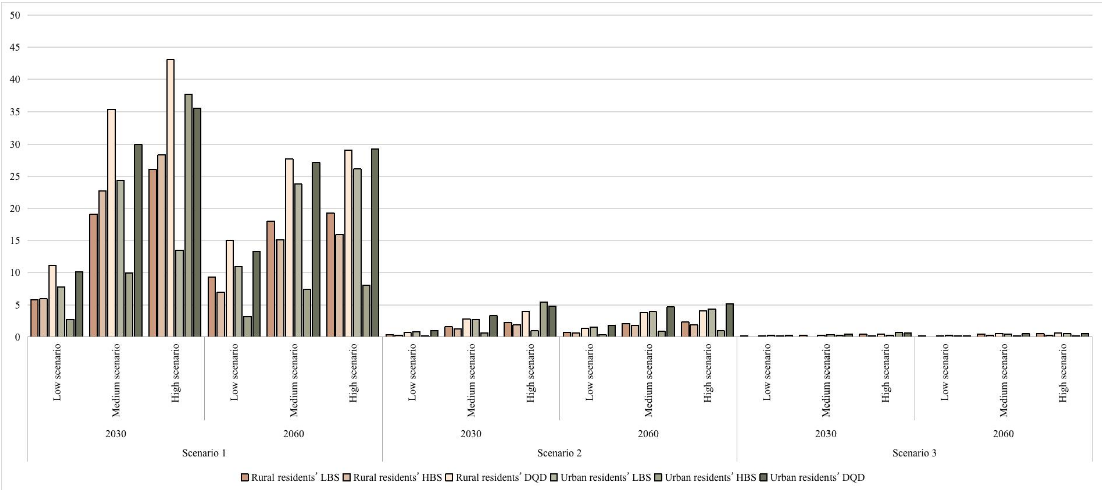


Figure 9 Impact of reducing agricultural trade costs on residents' dietary quality (%)

We further divided urban and rural residents into 5 groups according to income level, and the last group, namely the dietary quality level of urban and rural low-income residents in China, was evaluated using DBI-16. Comparing the results of Figure 10 and Figure 9, it can be found that the reduction of domestic agricultural trade costs have a more obvious effect on the improvement of dietary quality of urban and rural low-income residents than that of all residents. However, the decrease of import and export trade costs has no more significant effect on the dietary quality of urban and rural low-income residents than that of all residents. This may be due to the long chain of import and export trade costs affecting the dietary quality of urban and rural low-income groups. Relatively speaking, the domestic agricultural trade costs have a more obvious effect on the improvement of dietary quality of urban and rural residents, and the transmission path is more direct. Moreover, the improvement effect shows the characteristics of income heterogeneity, that is, it has a more significant effect on the improvement of dietary quality of urban and rural low-income groups.

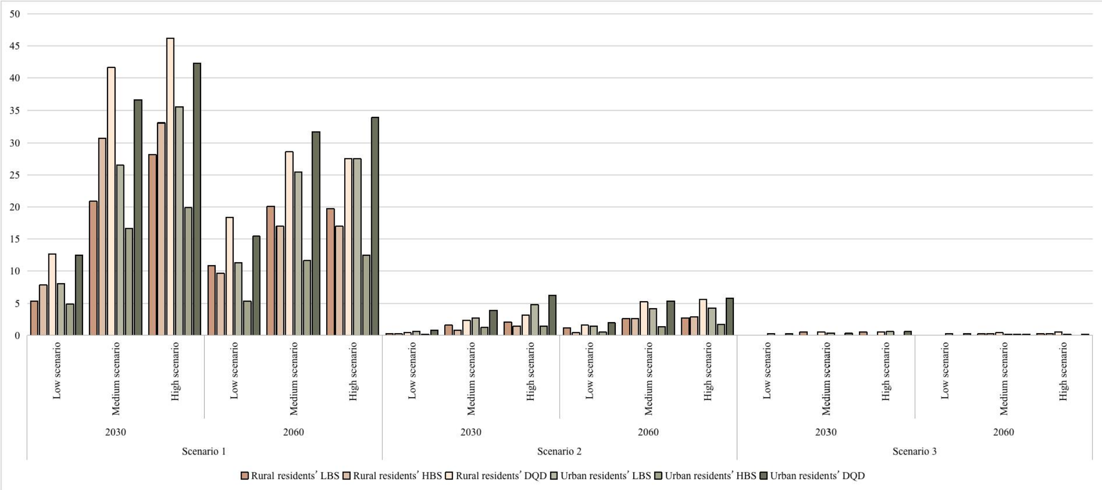


Figure 10 Impact of reducing agricultural trade costs on low-income group residents' dietary quality (%)

In order to better analyze the impact of the three simulation scenarios on the change of residents' dietary structure, this paper conducted a simulation analysis at the product level. The food types involved include: rice, wheat, maize, fruit, vegetables, pork, beef, mutton, poultry, eggs, milk and aquatic products. The results in Figure 11 show that the decrease of domestic agricultural trade costs and import trade cost of agricultural products will reduce the prices of various kinds of food, and the decrease of export trade costs of agricultural products will reduce the prices of vegetables, mutton, poultry and aquatic products to a certain extent, and promote the rise of other food prices.

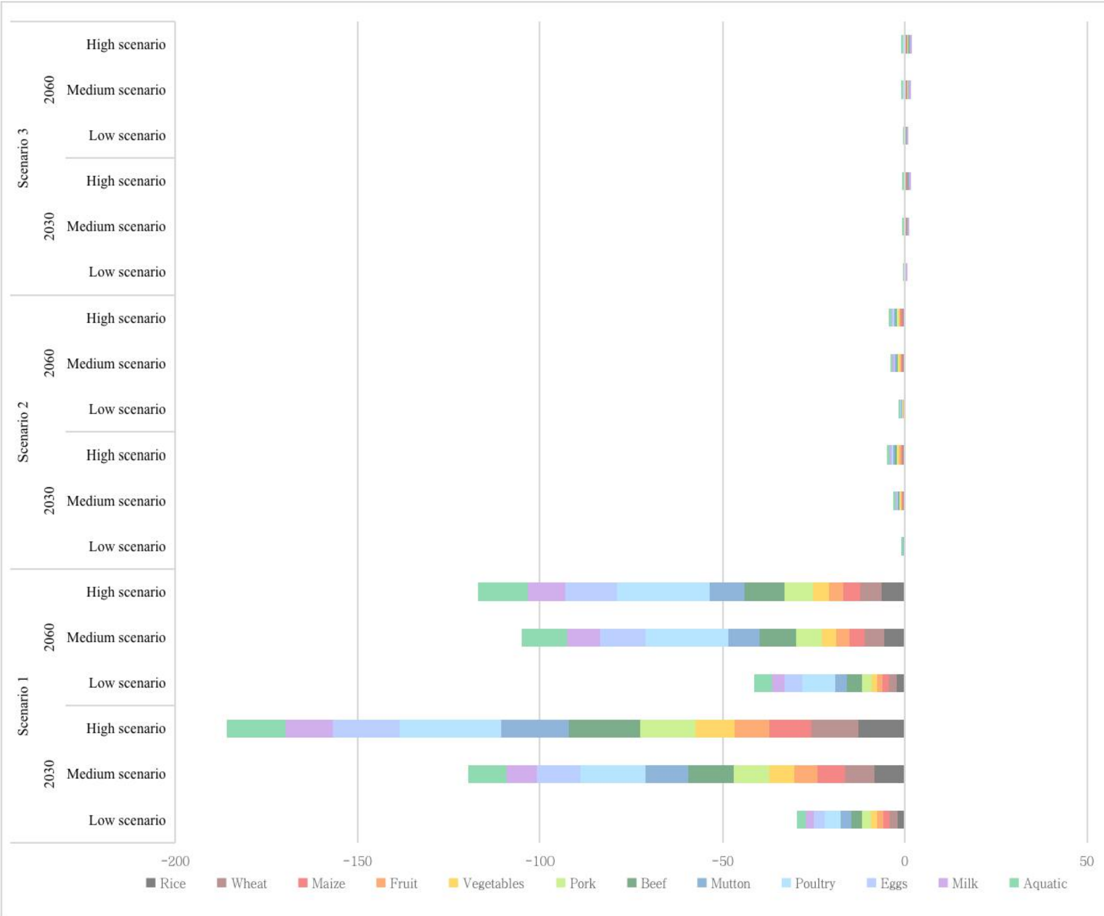


Figure 11 Impact of reducing agricultural trade costs on food prices (%)

In terms of the consumption quantity of various kinds of food, the decrease of domestic agricultural trade costs and import trade costs of agricultural products will reduce the consumption quantity of rice and wheat, and increase the consumption of other foods, and the impact of domestic agricultural trade costs on the consumption quantity of food is more significant. The decrease of the export costs of agricultural products has no obvious influence on the quantity of food consumption.

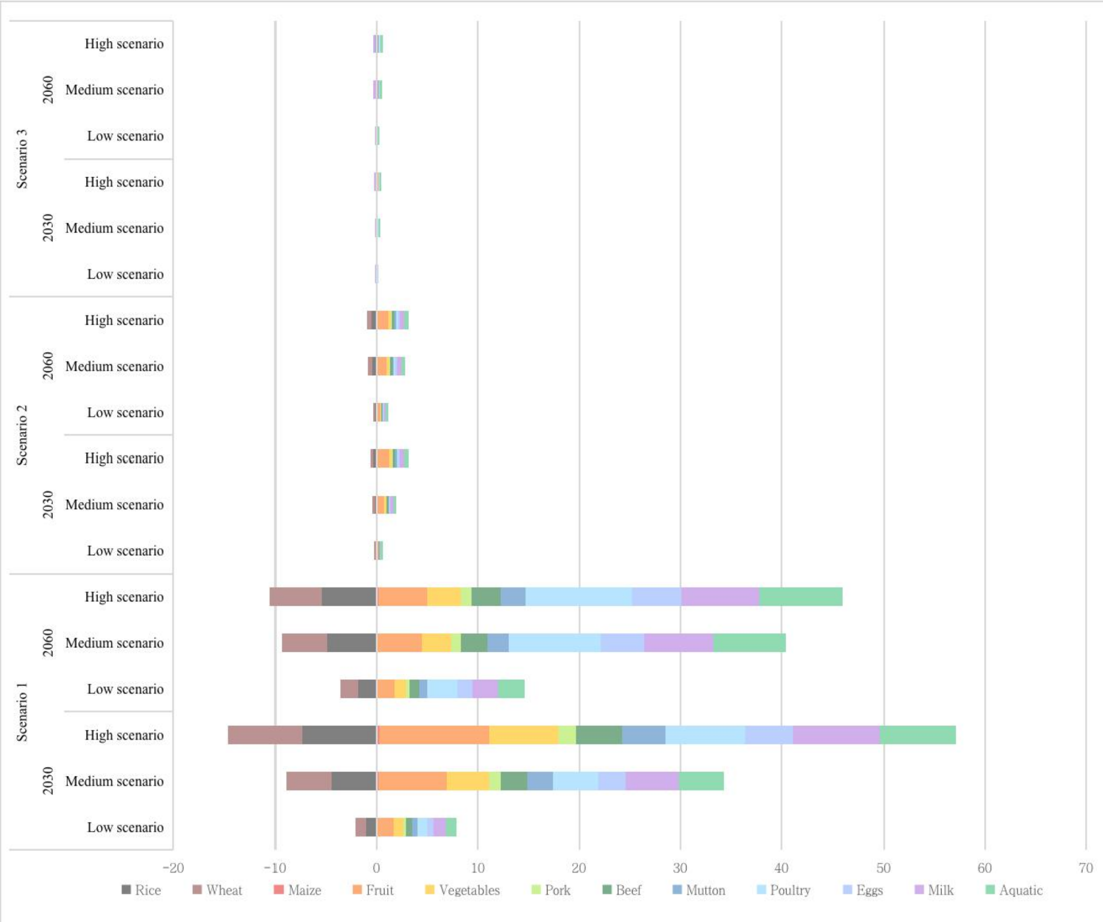


Figure 12 Impact of reducing agricultural trade costs on food consumption (%)

5. Conclusions

The purpose of this study is to explore the impact of the decline in China's domestic agricultural trade costs on agricultural production, household income, food prices, macroeconomic conditions, as well as food consumption and dietary quality of urban and rural residents in the context of domestic circulation. The results of this study show that: First, compared with the adjustment of agricultural import and export trade costs, changes in domestic agricultural trade costs have a more pronounced impact on domestic agricultural production. A decline in domestic agricultural trade costs leads to an increase in food production and an expansion of food acreage as well. Second, a decline in domestic agricultural trade costs and trade costs of agricultural exports leads to an increase in domestic food prices in 2030 and 2060, and the decline in the trade costs of agricultural imports will bring about a fall in domestic food prices.

The decline in the domestic agricultural trade costs will bring about a decrease in residents’ income, while the change in the trade costs of agricultural imports and exports will not have a significant impact on residents’ income. Decrease in agricultural trade costs will bring about an increase in food consumption. Third, the decrease in domestic agricultural trade costs will help to stimulate the growth of agricultural GDP, agro-processing GDP as well as the agrifood system GDP, but it will bring about a decrease in the total GDP to a certain extent. Decreases in both domestic and import/export agricultural trade costs promote growth in agrifood system GDP, with decreases in domestic agricultural trade costs having the most significant effect on agrifood system GDP. Fourthly, a reduction in both domestic and import/export agricultural trade costs will improve the dietary quality of urban and rural residents, including the improvement of dietary over-intake, dietary under-intake, and the overall balance of diets, with a reduction in domestic agricultural trade costs having the most obvious effect on the improvement. Fifthly, in terms of specific food prices, the reduction in domestic agricultural product trade costs and agricultural product import trade costs will lower the prices of various food items. The decrease in agricultural product export trade costs will to some extent reduce the prices of vegetables, mutton, poultry, and aquatic products, while promoting price increases for other food items. Regarding food consumption quantities, the reduction in domestic agricultural product trade costs and agricultural product import trade costs will decrease the consumption of rice and wheat while increasing the consumption of other food items, with the impact of the reduction in domestic agricultural product trade costs on food consumption quantities being more significant. The decrease in agricultural product export trade costs has a less noticeable effect on the consumption quantities of various food items.

This study not only provides an economic perspective to understand the "unified national market in agriculture", but also has clear theoretical and policy implications for its conclusions. First, this study uses a more scientific method to compile a social accounting matrix of China and constructs a Chinese general equilibrium (CGE) model that distinguishes between inter-provincial and foreign trade on the basis of

China's dynamic CGE model for the first time. Second, Linkages were established between the China CGE model and the micro household survey data to simulate the impact of the reduction in domestic agricultural trade costs and agricultural import-export trade costs on agricultural production, residents' food consumption quantity, food consumption structure, income, food prices, and macro-economy. Further, this study forecast the changes in Chinese agricultural production and various socio-economic indicators in 2030 and 2060 under the scenario of agricultural trade cost adjustment. This can provide timely and effective decision-making references for the formulation of government trade policies. Finally, By linking the percentage changes of various food consumption of urban and rural residents in each income group from the results of the China CGE model with the food consumption by income group from the household survey data, a number of indicators under the effects of various scenarios were re-estimated. The Chinese high bound score (HBS), low bound score (LBS), and the dietary quality distance (DQD) indicators are among these indicators and their changes reflect the effects of various policies on the dietary quality of different household groups. This study discusses the impact of the adjustment of the agricultural trade costs on the dietary quality of Chinese urban and rural residents, and provides a theoretical basis for how to realize the dual objectives of revitalizing the national unified market, improving the dietary status of Chinese residents, and promoting the transformation of the agrifood system, which supports the exploration of the direction and path of the transformation of agrifood system under the goal of high-quality development of the national economy.

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Appendix

Table A-1 Impact of reducing agricultural trade costs on agricultural production (%)

Scenarios	Agricultural production	2030			2060		
		Low scenario	Medium scenario	High scenario	Low scenario	Medium scenario	High scenario
Scenario 1	Food production	0.91	3.80	6.11	1.53	4.04	4.54
	Food acreage	0.23	0.95	1.52	0.63	1.66	1.87
Scenario 2	Food production	-0.16	-0.66	-1.06	-0.19	-0.50	-0.57
	Food acreage	-0.02	-0.08	-0.14	0.00	0.00	0.00
Scenario 3	Food production	0.03	0.15	0.25	0.07	0.19	0.21
	Food acreage	0.00	0.02	0.03	0.03	0.08	0.09

Table A-2 Impact of reducing agricultural trade costs on household income, food prices, and food consumption of urban and rural residents (%)

Scenarios	Household income, food prices, and food consumption of urban and rural residents	2030			2060		
		Low scenario	Medium scenario	High scenario	Low scenario	Medium scenario	High scenario
Scenario 1	Food prices	-2.25	-9.07	-14.09	-3.01	-7.64	-8.50
	Income	-0.51	-2.08	-3.26	-1.03	-2.63	-2.91
	Food consumption	0.47	2.28	3.36	0.90	2.05	2.83
Scenario 2	Food prices	-0.07	-0.30	-0.48	-0.14	-0.37	-0.42
	Income	-0.01	-0.04	-0.06	-0.01	-0.01	-0.01
	Food consumption	0.44	2.15	3.15	0.84	1.91	2.66
Scenario 3	Food prices	0.01	0.06	0.09	0.03	0.07	0.08
	Income	0.00	0.01	0.01	0.00	0.00	0.00
	Food consumption	0.53	2.61	3.84	1.05	2.40	3.30

Table A-3 Impact of reducing agricultural trade costs on macroeconomic (%)

Scenarios	Macroeconomic	2030			2060		
		Low scenario	Medium scenario	High scenario	Low scenario	Medium scenario	High scenario
Scenario 1	Total GDP	-0.06	-0.25	-0.41	-0.18	-0.44	-0.46

	Agricultural GDP	0.79	3.33	5.36	1.19	3.13	3.53
	Agro-processing GDP	0.62	2.61	4.19	1.11	2.93	3.30
	Agrifood system GDP	0.56	2.37	3.82	0.77	2.03	2.30
Scenario 2	Total GDP	0.01	0.04	0.07	0.04	0.10	0.12
	Agricultural GDP	-0.06	-0.24	-0.39	-0.04	-0.10	-0.11
	Agro-processing GDP	0.05	0.22	0.36	0.16	0.43	0.49
	Agrifood system GDP	0.00	0.01	0.02	0.06	0.17	0.19
Scenario 3	Total GDP	0.00	-0.01	-0.02	-0.01	-0.03	-0.04
	Agricultural GDP	0.06	0.28	0.47	0.09	0.24	0.27
	Agro-processing GDP	-0.00	-0.01	-0.02	-0.01	-0.03	-0.03
	Agrifood system GDP	0.03	0.11	0.17	0.03	0.06	0.07

Table A-4 Impact of reducing agricultural trade costs on residents' dietary quality (%)

Scenarios	Dietary quality	Changing situation	2030			2060		
			Low scenario	Medium scenario	High scenario	Low scenario	Medium scenario	High scenario
Scenario 1	Rural residents' LBS	Better	5.75	19.1	26.08	9.29	18.02	19.28
		Not change	93.81	79.59	71.98	90.01	80.38	79.04
		Worse	0.45	1.31	1.94	0.71	1.6	1.68
	Rural residents' HBS	Better	5.93	22.74	28.38	6.93	15.08	15.92
		Not change	93.63	76.08	69.67	92.21	83.16	82.27
		Worse	0.45	1.18	1.94	0.87	1.76	1.81
	Rural residents' DQD	Better	11.12	35.36	43.07	15.01	27.73	29.04
		Not change	88.64	63.43	55.14	84.23	70.75	69.33
		Worse	0.24	1.21	1.78	0.76	1.52	1.63
	Urban residents' LBS	Better	7.75	24.37	13.52	10.92	23.78	26.15
		Not change	91.84	74.58	84.49	88.55	75.16	72.67
		Worse	0.4	1.05	1.99	0.53	1.07	1.18
	Urban residents' HBS	Better	2.73	9.92	37.72	3.18	7.43	8.04
		Not change	97.03	88.97	61.36	96.06	90.79	89.9
		Worse	0.24	1.11	0.92	0.76	1.78	2.05
	Urban residents' DQD	Better	10.11	29.93	35.54	13.28	27.15	29.28
		Not change	89.66	69.5	19.87	86.29	71.7	69.47
		Worse	0.23	0.57	42.33	0.44	1.15	1.24
Scenario 2	Rural residents' LBS	Better	0.37	1.57	2.23	0.73	2.1	2.31
		Not change	99.63	98.37	97.64	99.19	97.66	97.46
		Worse	0	0.06	0.13	0.08	0.24	0.24
	Rural residents' HBS	Better	0.29	1.23	1.92	0.63	1.76	1.84
		Not change	99.66	98.66	97.74	99.34	98.03	97.92
		Worse	0.05	0.1	0.34	0.03	0.21	0.24

	Rural residents' DQD	Better	0.66	2.78	3.99	1.36	3.78	4.07
		Not change	99.32	97.17	95.93	98.48	95.88	95.59
		Worse	0.03	0.05	0.08	0.16	0.34	0.34
	Urban residents' LBS	Better	0.81	2.71	0.95	1.5	3.93	4.33
		Not change	99.18	97.16	98.85	98.47	95.90	95.46
		Worse	0.02	0.13	0.19	0.03	0.18	0.21
	Urban residents' HBS	Better	0.16	0.65	5.39	0.34	0.84	0.94
		Not change	99.79	99.26	94.48	99.52	98.93	98.82
		Worse	0.05	0.1	0.13	0.15	0.23	0.24
	Urban residents' DQD	Better	0.95	3.3	4.77	1.83	4.68	5.17
		Not change	99.03	96.62	1.45	98.13	95.14	94.64
		Worse	0.02	0.08	6.22	0.05	0.18	0.19
Scenario 3	Rural residents' LBS	Better	0.05	0.29	0.39	0.16	0.47	0.52
		Not change	99.95	99.71	99.61	99.84	99.53	99.48
		Worse	0	0	0	0	0	0
	Rural residents' HBS	Better	0	0	0.03	0	0.08	0.08
		Not change	100	100	99.97	100	99.87	99.87
		Worse	0	0	0	0	0.05	0.05
	Rural residents' DQD	Better	0.05	0.29	0.42	0.16	0.55	0.60
		Not change	99.95	99.71	99.55	99.84	99.45	99.4
		Worse	0	0	0.03	0	0	0
	Urban residents' LBS	Better	0.08	0.36	0.10	0.13	0.47	0.52
		Not change	99.92	99.64	99.89	99.85	99.47	99.42
		Worse	0	0	0.02	0.02	0.06	0.06
	Urban residents' HBS	Better	0.02	0.1	0.71	0.03	0.03	0.03
		Not change	99.97	99.89	99.27	99.95	99.94	99.94
		Worse	0.02	0.02	0.02	0.02	0.03	0.03
	Urban residents' DQD	Better	0.1	0.45	0.57	0.16	0.5	0.55
		Not change	99.9	99.53	0.00	99.82	99.47	99.4
		Worse	0	0.02	0.57	0.02	0.03	0.05

Table A-5 Impact of reducing agricultural trade costs on low-income group residents' dietary quality

(%)

Scenarios	Dietary quality	Changing situation	2030			2060		
			Low scenario	Medium scenario	High scenario	Low scenario	Medium scenario	High scenario
Scenario 1	Rural residents' LBS	Better	5.35	20.89	28.20	10.84	20.1	19.71
		Not change	94.26	77.55	69.58	87.73	76.76	77.15
		Worse	0.39	1.56	2.22	1.44	3.13	3.13
	Rural residents' HBS	Better	7.83	30.68	33.03	9.66	16.97	16.97

		Not change	91.51	68.02	64.62	89.16	80.94	80.68
		Worse	0.65	1.31	2.35	1.17	2.09	2.35
	Rural residents' DQD	Better	12.66	41.64	46.21	18.41	28.59	27.55
		Not change	86.95	56.79	51.83	80.16	69.06	70.10
		Worse	0.39	1.57	1.96	1.44	2.35	2.35
	Urban residents' LBS	Better	8.08	26.49	35.54	11.31	25.44	27.54
		Not change	91.36	72.05	62.12	87.96	72.94	70.76
		Worse	0.57	1.45	2.34	0.73	1.62	1.7
	Urban residents' HBS	Better	4.85	16.64	19.87	5.33	11.63	12.52
		Not change	95.07	81.91	77.95	94.10	86.67	85.7
		Worse	0.08	1.45	2.18	0.57	1.7	1.78
	Urban residents' DQD	Better	12.52	36.59	42.33	15.43	31.74	33.84
		Not change	87.32	63	57.11	84.17	66.96	64.78
		Worse	0.16	0.41	0.57	0.4	1.3	1.37
Scenario 2	Rural residents' LBS	Better	0.26	1.57	2.09	1.17	2.61	2.74
		Not change	99.74	98.43	97.91	98.83	97	96.87
		Worse	0	0	0	0	0.39	0.39
	Rural residents' HBS	Better	0.13	0.78	1.44	0.39	2.61	2.87
		Not change	99.87	99.09	98.04	99.61	97.13	96.87
		Worse	0	0.13	0.52	0	0.26	0.26
	Rural residents' DQD	Better	0.39	2.35	3.13	1.57	5.22	5.61
		Not change	99.61	97.52	96.61	98.3	94.39	93.99
		Worse	0	0.13	0.26	0.13	0.39	0.39
	Urban residents' LBS	Better	0.65	2.67	4.77	1.45	4.12	4.28
		Not change	99.35	97.09	94.91	98.55	95.8	95.64
		Worse	0	0.24	0.32	0	0.08	0.08
	Urban residents' HBS	Better	0.16	1.21	1.45	0.48	1.37	1.70
		Not change	99.84	98.79	98.47	99.35	98.47	98.06
		Worse	0	0	0.08	0.16	0.16	0.24
	Urban residents' DQD	Better	0.81	3.88	6.22	1.94	5.33	5.82
		Not change	99.11	96.12	93.78	98.06	94.51	94.02
		Worse	0.08	0	0	0	0.16	0.16
Scenario 3	Rural residents' LBS	Better	0	0.52	0.52	0	0.13	0.26
		Not change	100	99.48	99.48	100	99.87	99.74
		Worse	0	0	0	0	0	0
	Rural residents' HBS	Better	0	0	0.00	0	0.26	0.26
		Not change	100	100	100	100	99.74	99.74
		Worse	0	0	0	0	0	0
	Rural residents' DQD	Better	0	0.52	0.52	0	0.39	0.52
		Not change	100	99.48	99.35	100	99.61	99.48
		Worse	0	0	0.13	0	0	0

	Urban residents' LBS	Better	0.08	0.32	0.57	0.08	0.16	0.16
		Not change	99.92	99.68	99.43	99.92	99.84	99.84
		Worse	0	0	0	0	0	0
	Urban residents' HBS	Better	0	0	0.00	0	99.84	0.00
		Not change	100	100	100	99.92	0.16	99.84
		Worse	0	0	0	0.08	0	0.16
	Urban residents' DQD	Better	0.08	0.32	0.57	0.08	0.16	0.16
		Not change	99.92	99.6	99.35	99.92	99.84	99.84
		Worse	0	0.08	0.08	0	0	0

Table A-6 Impact of reducing agricultural trade costs on food consumption and prices (%)

Scenarios	Food variety	Dietary quality	2030			2060		
			Low scenario	Medium scenario	High scenario	Low scenario	Medium scenario	High scenario
Scenario 1	Rice	Food consumption	-1.04	-4.48	-7.33	-1.84	-4.85	-5.44
		Food prices	-2.06	-8.28	-12.85	-2.27	-5.68	-6.30
	Wheat	Food consumption	-1.03	-4.42	-7.23	-1.72	-4.52	-5.07
		Food prices	-2.05	-8.25	-12.79	-2.18	-5.46	-6.05
	Maize	Food consumption	0.04	0.17	0.28	0.05	0.12	0.14
		Food prices	-1.86	-7.46	-11.54	-1.65	-4.09	-4.51
	Fruit	Food consumption	1.60	6.75	10.85	1.68	4.32	4.84
		Food prices	-1.57	-6.28	-9.67	-1.43	-3.55	-3.91
	Vegetables	Food consumption	0.99	4.20	6.78	1.14	2.95	3.30
		Food prices	-1.72	-6.86	-10.58	-1.64	-4.08	-4.51
	Pork	Food consumption	0.25	1.09	1.80	0.36	0.95	1.07
		Food prices	-2.43	-9.78	-15.21	-2.73	-6.93	-7.70
	Beef	Food consumption	0.60	2.67	4.53	0.95	2.59	2.93
		Food prices	-3.10	-12.51	-19.50	-3.93	-10.01	-11.15
	Mutton	Food consumption	0.57	2.53	4.25	0.80	2.15	2.43
		Food prices	-2.93	-11.82	-18.39	-3.39	-8.62	-9.59
	Poultry	Food consumption	0.94	4.44	7.93	2.98	9.05	10.49
		Food prices	-4.41	-17.90	-28.00	-8.84	-22.72	-25.40
	Eggs	Food consumption	0.62	2.77	4.67	1.53	4.27	4.86
		Food prices	-2.88	-11.64	-18.17	-4.89	-12.53	-13.98
	Milk	Food consumption	1.20	5.18	8.50	2.52	6.85	7.75
		Food prices	-2.07	-8.34	-12.96	-3.53	-9.00	-10.03
	Aquatic	Food consumption	1.03	4.51	7.52	2.57	7.16	8.14
		Food prices	-2.59	-10.45	-16.27	-4.83	-12.34	-13.76
Scenario 2	Rice	Food consumption	-0.05	-0.20	-0.33	-0.17	-0.44	-0.50
		Food prices	-0.05	-0.21	-0.34	-0.13	-0.34	-0.38

	Wheat	Food consumption	-0.05	-0.19	-0.31	-0.15	-0.41	-0.46
		Food prices	-0.05	-0.22	-0.35	-0.13	-0.35	-0.39
	Maize	Food consumption	0.00	0.01	0.01	0.00	0.01	0.02
		Food prices	-0.06	-0.24	-0.39	-0.14	-0.36	-0.40
	Fruit	Food consumption	0.17	0.74	1.21	0.36	0.97	1.09
		Food prices	-0.07	-0.29	-0.48	-0.13	-0.34	-0.38
	Vegetables	Food consumption	0.04	0.18	0.30	0.09	0.26	0.29
		Food prices	-0.06	-0.26	-0.43	-0.11	-0.30	-0.33
	Pork	Food consumption	0.01	0.03	0.06	0.02	0.05	0.06
		Food prices	-0.06	-0.23	-0.38	-0.11	-0.29	-0.32
	Beef	Food consumption	0.04	0.16	0.27	0.09	0.26	0.29
		Food prices	-0.06	-0.27	-0.44	-0.13	-0.34	-0.38
	Mutton	Food consumption	0.02	0.10	0.17	0.06	0.16	0.19
		Food prices	-0.06	-0.24	-0.39	-0.11	-0.30	-0.33
	Poultry	Food consumption	0.02	0.08	0.13	0.06	0.17	0.19
		Food prices	-0.04	-0.15	-0.25	-0.08	-0.22	-0.24
	Eggs	Food consumption	0.01	0.06	0.09	0.04	0.12	0.14
		Food prices	-0.05	-0.19	-0.31	-0.10	-0.25	-0.28
	Milk	Food consumption	0.07	0.30	0.49	0.16	0.43	0.49
		Food prices	-0.05	-0.23	-0.38	-0.11	-0.28	-0.32
	Aquatic	Food consumption	0.06	0.24	0.40	0.14	0.37	0.42
		Food prices	-0.05	-0.21	-0.34	-0.09	-0.25	-0.27
Scenario 3	Rice	Food consumption	0.01	0.03	0.06	0.03	0.09	0.11
		Food prices	0.02	0.11	0.18	0.07	0.18	0.21
	Wheat	Food consumption	0.01	0.04	0.06	0.03	0.09	0.10
		Food prices	0.03	0.11	0.19	0.07	0.18	0.21
	Maize	Food consumption	0.00	0.00	0.00	0.00	0.00	0.00
		Food prices	0.03	0.13	0.21	0.07	0.20	0.22
	Fruit	Food consumption	0.00	0.02	0.03	-0.02	-0.05	-0.06
		Food prices	0.00	0.00	0.00	0.03	0.08	0.09
	Vegetables	Food consumption	0.01	0.04	0.07	0.00	0.00	-0.01
		Food prices	-0.02	-0.08	-0.13	0.01	0.03	0.03
	Pork	Food consumption	0.00	-0.01	-0.01	0.00	-0.01	-0.02
		Food prices	0.02	0.10	0.16	0.06	0.15	0.17
	Beef	Food consumption	0.00	-0.01	-0.02	-0.01	-0.03	-0.03
		Food prices	0.03	0.11	0.19	0.06	0.16	0.19
	Mutton	Food consumption	0.00	-0.01	-0.02	-0.01	-0.03	-0.03
		Food prices	0.02	0.10	0.17	0.06	0.16	0.18
	Poultry	Food consumption	0.01	0.03	0.05	0.05	0.13	0.15
		Food prices	-0.03	-0.14	-0.24	-0.15	-0.44	-0.50
	Eggs	Food consumption	0.00	0.00	0.00	0.00	0.00	0.01

		Food prices	0.00	0.01	0.02	0.00	0.00	0.00
	Milk	Food consumption	-0.01	-0.03	-0.06	-0.02	-0.07	-0.07
		Food prices	0.02	0.10	0.16	0.05	0.13	0.15
	Aquatic	Food consumption	0.00	0.02	0.03	0.04	0.10	0.11
		Food prices	-0.01	-0.04	-0.07	-0.08	-0.21	-0.23