Assessing the distributional impacts of carbon pricing in China's agricultural sector

Qishi Zhang[1], Bo Li[2], Jing-Yu Liu[3,4]*, Yizhi Deng[3], Runsen Zhang[5], Wenchao Wu[6], Yong Geng[3,4,7,8]

[1] China-UK Low Carbon College, Shanghai Jiao Tong University
[2] School of Economics, Peking University, P.R. China
[3] School of Environmental Science and Engineering, Shanghai Jiao Tong University
[4] Shanghai Institute of Pollution Control and Ecological Security, P. R. China
[5] Graduate School of Frontier Sciences, Tokyo University, Japan
[6] Japan International Research Center for Agricultural Sciences (JIRCAS), Japan
[7] School of International and Public Affairs, Shanghai Jiao Tong University
[8] School of Business, Shandong University

Introduction

- Non-CO2 GHG from the agricultural sector play an important role in the global warming process. Despite that, agricultural is always excluded from mitigation policies due to high cost of technology implement and concerns about food security. In the context of the imminent need to incorporate agricultural mitigation into policies, carbon pricing is a common way to incentivize emission reductions.
- On the basis of the own peculiarities of agri-food sector, many previous studies have pointed out that carbon taxes reduce life quality of households and widen the urban-rural income gap, with low-income households being more affected. (Caillavet et al., 2019; Vogt-Schilb et al., 2019)
- Currently few study has identified the long-term distributional effects of agri-food carbon tax on China's households and regions with different income. Our study fills this gap through a joint discussion of CGE model results.

Methodology

- To examine the impacts of carbon tax on segmented agricultural sectors and heterogeneous household groups, we construct a **multiregional, multisector dynamic CGE model for China**.
- The CGE model includes 31 provinces in China, each region has 68 sectors, containing 28 subdivided agri-food sectors and 40 other sectors. Agri-food sectors includes 12 primary agricultural products (wheat, rice, soybeans, maize, vegetables, fruits, pork, beef, mutton, poultry, eggs, and aquatic products) and 15 processed foods. Additionally, each region has 10 categories of heterogeneous households (five groups each in urban and rural according to income quantile).

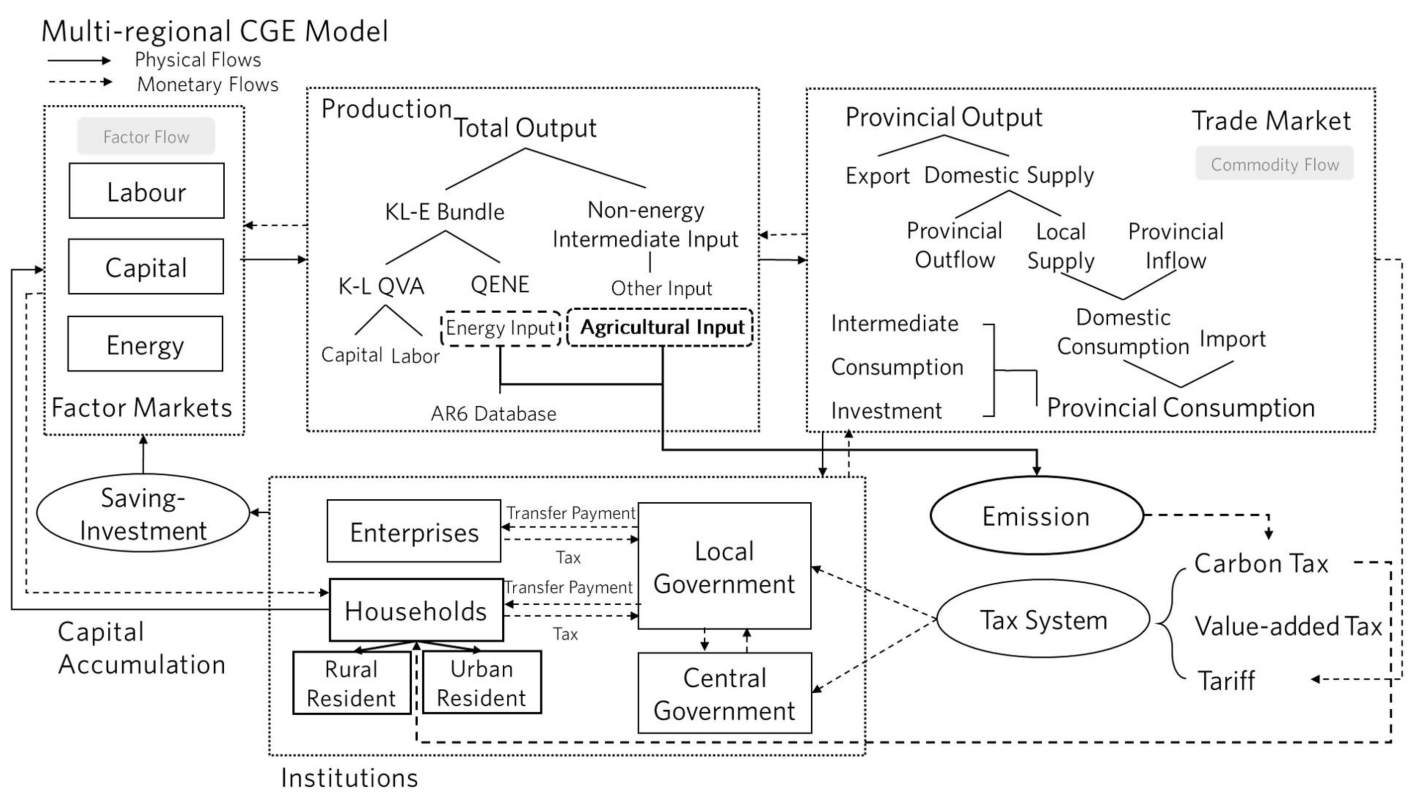

Figure 1 General framework of the developed multi-region CGE model

- Overall structure of the model refers to the basic CGE model of IFPRI and is extended according to the actual requirements. Carbon tax module, food and nutrition availability module and welfare module are added.

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- Food demand and agricultural energy input under BAU scenario are calibrated through econometric model.
- The model contains 3 scenarios: BAU, CTE and CTEA. General labor and economic growth in BAU are referenced to the SSP2 projections.

Table 1 Description of the three scenarios

Scenario	Reference tax rate	Illustration
BAU	-	Economy follows SSP2 path
CTE	AR6 referenced scenario (1.5°C)	Levying carbon tax on energy sector
CTEA	AR6 referenced scenario (1.5°C)	Levying carbon tax on both energy and agricultural sector

Results

- ***Food commodities generally face higher prices and lower consumption under agricultural carbon tax, nutrition availability loss should be concerned.*** The difference in emissions is one of the reasons for the different price changes. The income elasticity of demand made a contribution as well. Carbon tax reduce the protein and energy contained in households' food consumption, with rural residents suffering more than urban residents. Compared with energy, the impact of carbon tax on consumed protein is greater.

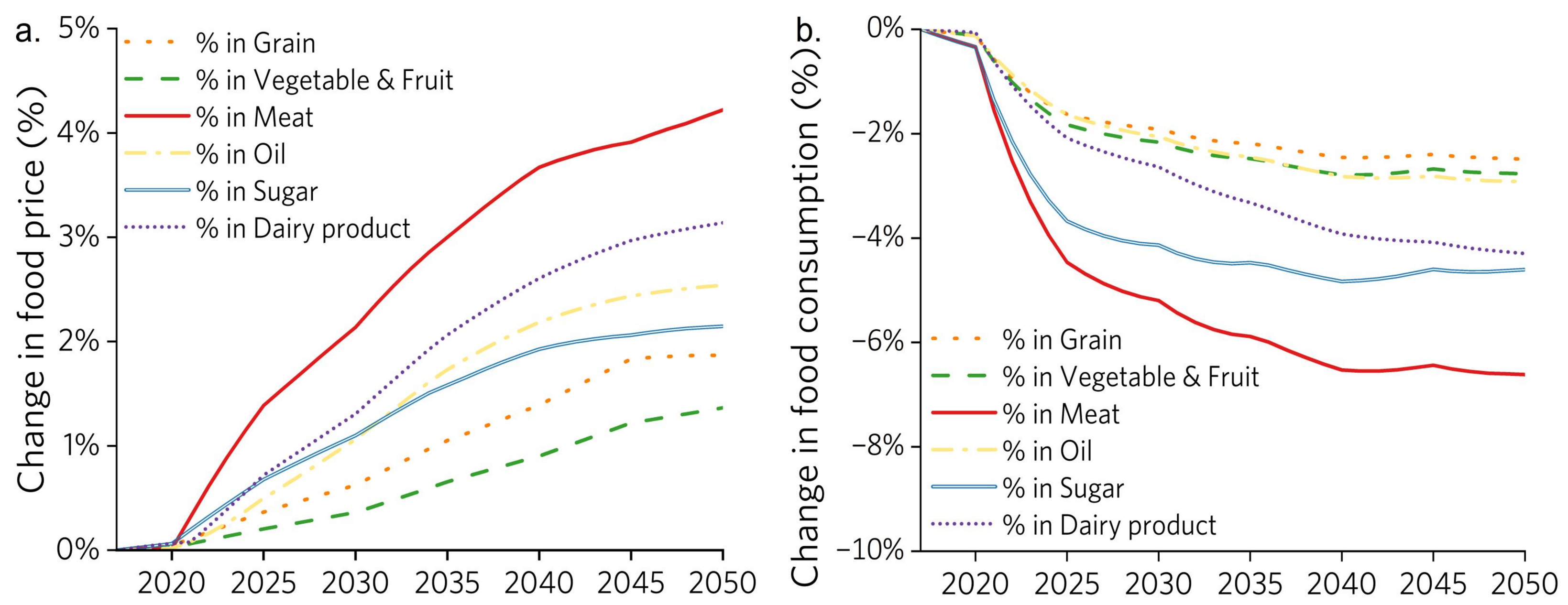

Figure 2 Food price and consumption change under an agricultural carbon tax compared with the BAU scenario

- ***Agricultural carbon tax is regressive among households, the differences between the poorest groups and other groups are particularly pronounced.*** With the imposition of agricultural carbon tax, the average welfare loss will be 2.14%-2.47% for urban residents and 2.66%-3.28% for rural residents, with rural households generally suffer higher losses than urban households. Welfare losses distributed across provinces displays similar trend.

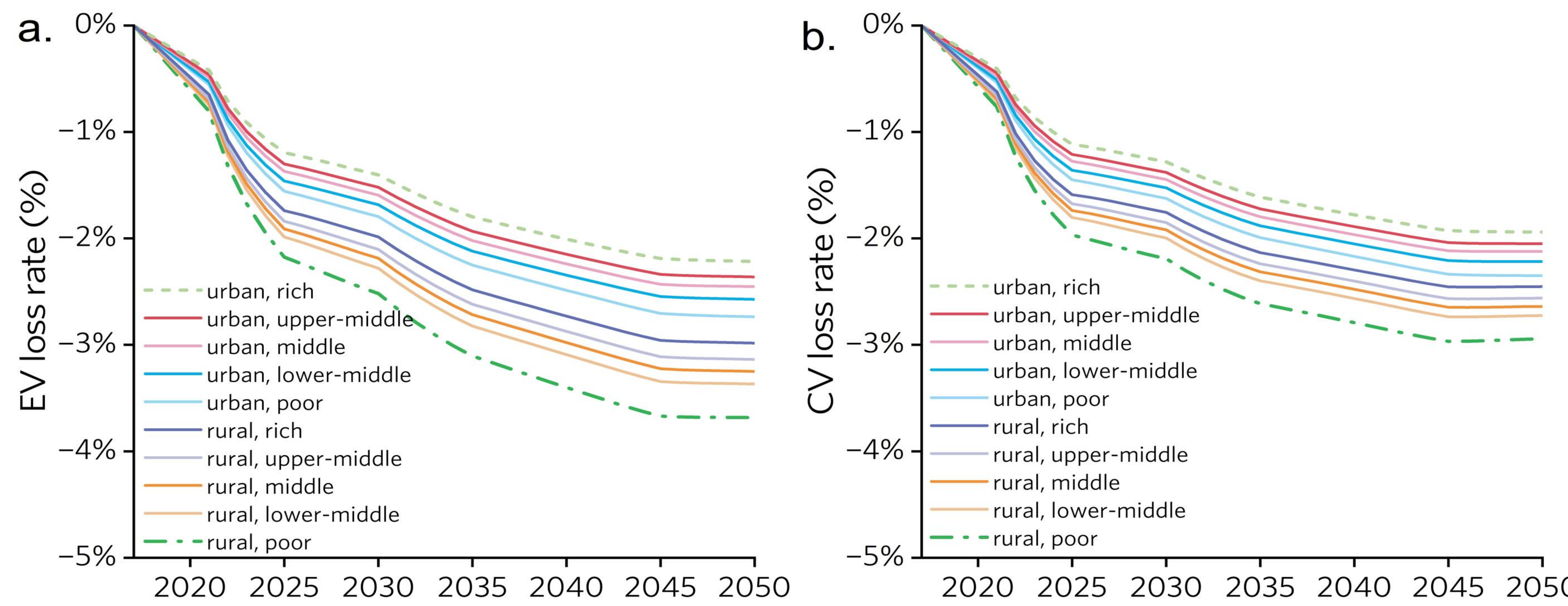

Figure 3 EV and CV loss of households under the CTEA scenario

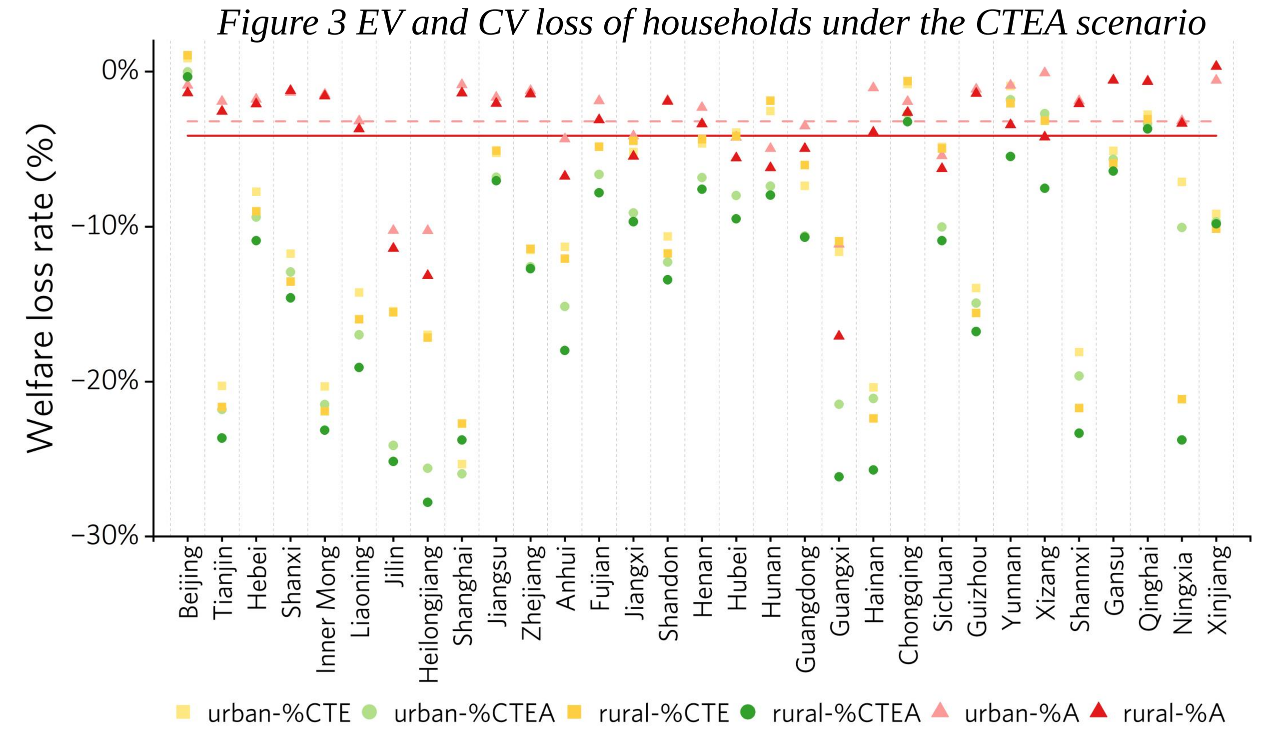

Figure 4 Welfare loss among heterogeneous households in 2050

- The Gini coefficient projected that the imposition of an agricultural carbon tax will further exacerbates income inequality. In 2050, the Gini coefficient in the CTEA scenario increases by 0.57% relative to the BAU scenario. Changes in the Gini coefficient are also heterogeneous across provinces, but the regressivity at the national level remains unchanged.

Discussion

- Combined with carbon tax, introducing additional subsidy or tax rebate towards healthy food, such as fresh fruits and vegetables, can reduce carbon emissions while aiding societal health diets.
- It is necessary for the government to remedy income gaps between different households. Strengthening land supporting policies for farmers, improving social security systems, and increasing the efficiency of financial subsidies for poor households are several effective approaches to mitigate such impact.
- It is recommended, when designing the agricultural carbon policies, to consider regional differences, by alleviating financial pressures in less developed regions via differentiated emission reduction targets, tax revenue reallocation, or provincial partnerships such as technological and financial transfers.

[1] Vogt-Schilb, A., Walsh, B., Feng, K. S., Di Capua, L., Liu, Y., Zuluaga, D., Robles, M., & Hubaceck, K. (2019). Cash transfers for pro-poor carbon taxes in Latin America and the Caribbean.
[2] Caillavet, F., Fadhuile, A., & Nichele, V. (2019). Assessing the distributional effects of carbon taxes on food: Inequalities and nutritional insights in France. Ecological Economics, 163, 20-31.