The spillover effect of consumption transformation contributes to the deceleration of China's CO_2 emission growth

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Introduction

- **Background**: China's ambition to achieve the emission peak without undermining economic growth presents the necessity of decarbonization roadmaps covering the comprehensive socioeconomic factors as China's economy entering the new phrase.
- **Research gaps**: (1) The impact of low carbon consumption from the consumption pattern transformation remain unclear under the new normal. (2) The spatial spillover characteristics of these drivers haven't been captured due to less account of the high heterogeneity between China's regions and emission transfers in recent researches. (3) When dealing with more than 3 factors, the spatial SDA models proposed currently will yield the deviation in the decomposition of the cross terms and influence the identification of the potential effect of factors.
- **Research questions**: What is the effect of the driving factors on China's emission change under the new normal? How could these factors influence the emission in terms of their own spatial characteristics?

Methodology

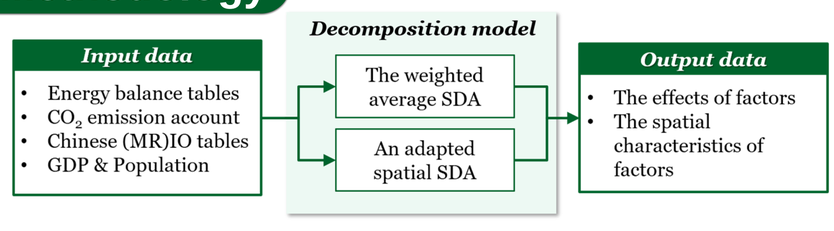

Figure 1 presents the structure of this research. We calculate China's sectoral emissions by energy types since 2000 and estimate the emission in 2018 based on the newest energy consumption data. As for the cross terms, we select the weighted average SDA at the aggregate level and combine it with the spatial SDA at the regional level, so that our method can depict the spatial spillover of driving factors explicitly based on the advantage of weighted average in dealing with cross terms.

$$\Delta CO_2 = \sum_{ijsktd} f(|d|) \prod_{\substack{h=1 \\ h\neq g}}^{d} x_{ijt}^{rks}{}_h \left(\Delta x_{ij}^{rks}{}_g\right) \quad f(|d|) = \frac{|d|!\,(n-|d|-1)!}{n!}$$

Driving factors (x)

Carbon intensity: $\boldsymbol{E} = diag(\frac{CO_2}{X})$ Consumption structue: $T_j^s = \sum_k \boldsymbol{F}_j^{sk} \Big/ \sum_k \sum_j \boldsymbol{F}_j^{sk}$

Production efficiency: $\boldsymbol{B} = (I - A)^{-1}$

Consumption preference: $\boldsymbol{S}_j^{sk} = \frac{\boldsymbol{F}_j^{sk}}{\sum_k \boldsymbol{F}_j^{sk}}$ Per capita consumption: $G^s = \sum_k \sum_j \boldsymbol{F}_j^{sk} / P^s$

Population: P

Results and Discussion

Figure 2 shows China's CO_2 Emission trend. China's coal consumption has fueled the economic development and brought out a large amount of CO2 emissions in 2000-2013. Owing to cutting overcapacity, the emissions have undergone a slight decline in 2013-2016. However, the rebounding emissions since 2017 imply that it is crucial to take into account the contribution of driving factors under the new normal.

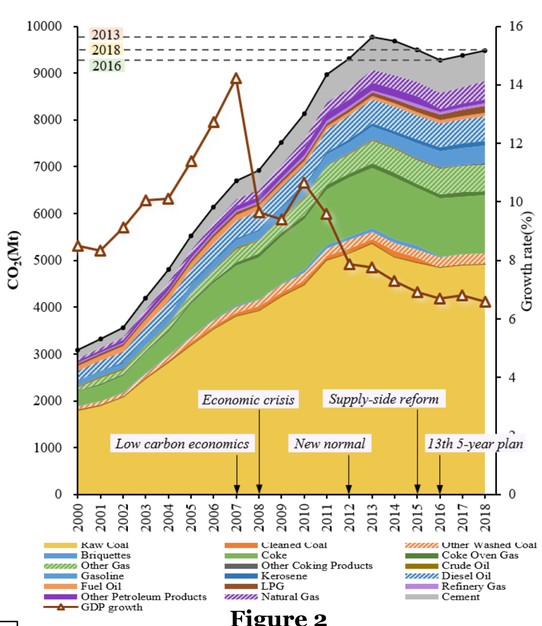

Figure 2

In **Figure 3,** the emission mitigation effect of low carbon consumption has currently dropped from 8.0% to 0.5%, while the economic restructure contributed to 0.8% of emission mitigation. The per capita consumption still dominates the increment of emission, accounting for around 46% of the change of emissions.

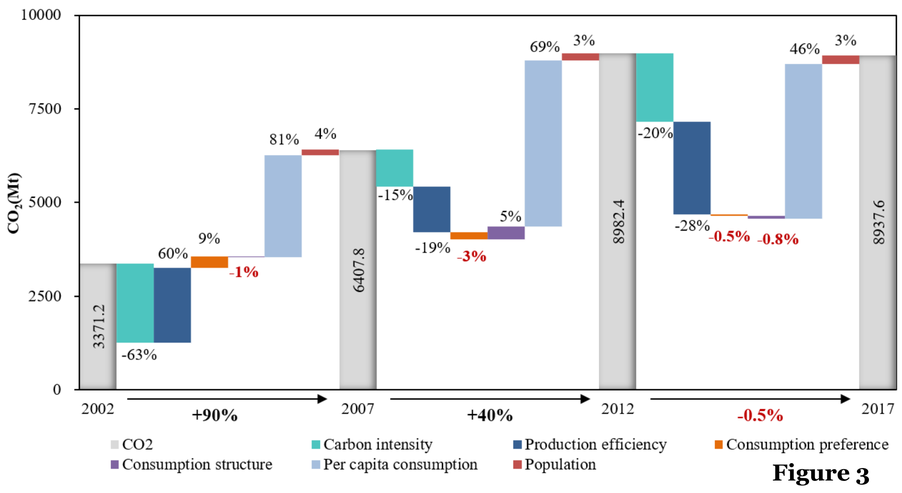

Figure 3

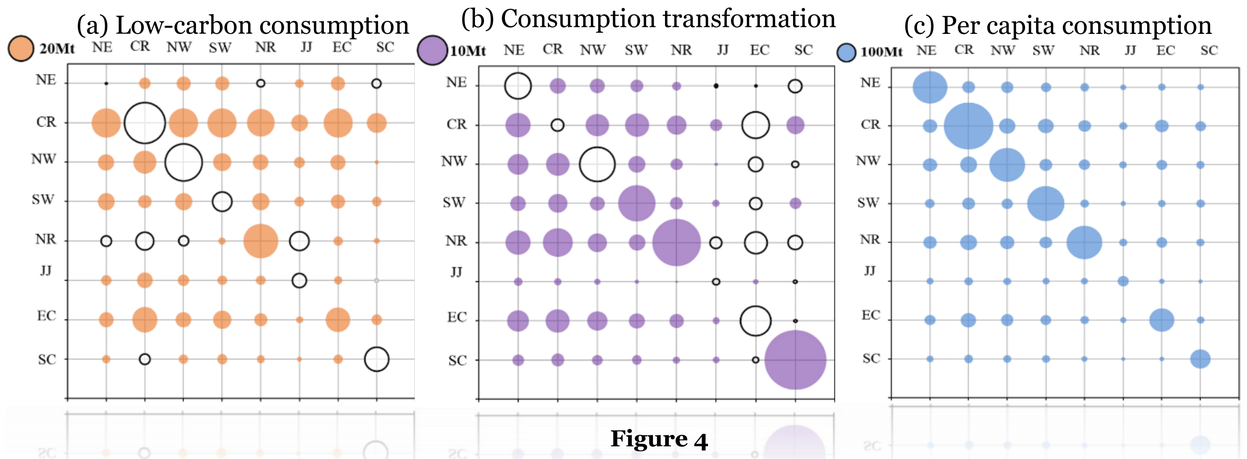

Figure 4

Figure 4 shows the spillover effect of factors. As the current low carbon consumption yielded the intra-regional mitigation effect through emission transfers, its **"apparent"** mitigation effect shrank under the new normal due to less decarbonization space in the stable trade flows. In contrast, **the consumption transformation will enhance the mitigation effort through the spillover effect**. Furthermore, the infrastructure demand dominates per capita consumption and induces increasing emission outflow from developing regions.

Policy implication

Therefore, it is supposed to take both of those factors into account as emission reduction suggestions provided for consumption pattern. On the one hand, more guidance about green consumption should be provided with the active finical support, while promoting the transformation from investment to consumption. Another significant aspect is to reduce the emission increment led by emission transfer and increasing demand for infrastructure through the emission reduction spillover effect of economic transformation.