China's carbon dioxide emission and driving factors: A spatial analysis

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Abstract

A burgeoning literature is emerging on China’s high levels of carbon dioxide (CO2) emission. Yet policies remain elusive in part because of conflicting empirical findings and insufficient attention to China’s complex spatial terrain. This paper conducts a spatial analysis of China’s CO2 intensity (CEI) based on six major drivers, and shows that region-targeted strategies may be more effective in tackling CEI. Specifically, results from spatial autoregressive models indicate that drivers vary significantly across regions changing the energy production mix through alternative sources of energy is likely to have a stronger effect on the Northwest and Middle Yangtze River but it is less effective for the South and East Coasts. Changes in population, urbanization, industrial structure and technology are more likely to lead to CEI reduction for South and East Coasts. Moreover, at the regional level, spatial effects are more indirect and widespread spilling over to neighboring regions for the Middle Yellow River and Northeast. But they are more direct and contained affecting residents within the region for the Middle Yangtze River, South, North and East Coasts.

Methodology

Model-choosing

(1) OLS Model: the based model

\[ Y_c = \beta X_c + \lambda_c + \mu_c + \varepsilon_c \sim N(0, \delta^2 I_n) \]

(2) SAR Model

\[ Y_c = \rho Wy_c + \beta X_c + \lambda_c + \mu_c + \varepsilon_c \sim N(0, \delta^2 I_n) \]

(3) SEM Model

\[ Y_c = \beta X_c + \lambda_c + \mu_c (W \phi_c + \varepsilon_c) \sim N(0, \delta^2 I_n) \]

Spatial dependence is reflected in the error term

(4) SDM Model

\[ Y_c = \rho Wy_c + \beta X_c + WX_c \alpha + \lambda_c + \mu_c + \varepsilon_c \sim N(0, \delta^2 I_n) \]

when there are both endogenous and exogenous spatial interactions as well as correlated error terms, a spatially lagged exogenous interaction or a spatially autocorrelated error term alone is insufficient. In this case, the spatial Durbin model (SDM) is appropriate.

Results

Table. Spatial dependence tests

We use the spatial econometric model test to select the spatial model for different regions to analyze the influence degree of driving factors. Finally, we find that: CEI declines from coastal regions on the east to the west. The bars for each factor represent the average parametric value over the 1990 to 2014 period. The study covers 1990 to 2014, and data is available at the provincial level from various issues of the China Statistical Yearbook. CO2 emission data are obtained from the Integrated National Energy modeling System (http://www.inems.org/). Aggregating the provinces, eight regions may be identified based on the classification scheme of the Development Research Center of the State Council.

Conclusion

While a substantial scholarship has emerged to tackle the CO2 emission problems of China, what constitutes appropriate strategies may continue to be debated in part because empirical findings of principal drivers have sometimes been conflicting. This paper suggests that such contradictions may be alleviated by examining CEI’s regional variation in CEI and its driving factors using spatial autoregressive models. More specifically, spatial autoregressive models help to alleviate problems of biased estimation from spatial heterogeneity since CO2 emissions tend to concentrate geographically. Results from the spatial autoregressive models indicate both positive and negative spatial dependence effects. The spatial dependence scalar shows that CEI spillovers of North Coast, East Coast and Middle Yellow River tend to be intra-regional. Thus residents living in these regions stand to benefit most from...