Equity Considerations in China's Carbon Emissions Trading

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Abstract

Overview

China faces much pressure from addressing climate change and energy supply security associated with the rapid economic growth. The pressure has also intensified the government's efforts to shift to a lower-carbon, more resource-efficient development pathway. Especially, carbon trading system is considered as a key instrument of China's climate policy.

As CO_2 allowance, a man-made new commodity, whether bought at auction or received for free, has value because of its scarcity. A cap and trade system with gratis distribution gives ownership to the recipients of the allowances. Different allocation rules have different wealth effects. The temporal and spatial distribution of GHG emission allowance therefore concerns much on regional equity. Furthermore, there are wide differences in economic structure, growth rates, energy efficiency, resource endowment and carbon intensities across Chinese provinces and both costs and benefits of GHG mitigation are widely dispersed.

This study has proposed a scheme for allocating regional initial CO_2 allowances. Similar to most countries' allocation plans, this scheme is also based on historic emissions. And by developing an identical forecast model and with a built-in idea of convergence on per capita CO_2 emissions for each region, this study demonstrates that the regional equity related to carbon-trading can be pursued by the choice of a suitable initial distribution of emission allowance.

Methods

The simulation platform developed consists of three modules. One key module is the identical econometric model; another module transfers the intensity-based target into absolute reduction cap with some assumption on GDP growth scenarios. The third module is the adjustment module, with which decision-makers' expertise can be conveyed. As for the identical econometric model, we consider the following reduced-form econometric model:

$$y_{i,t} = \delta y_{i,t-1} + Z_{i,t}\beta + \eta_i + \varepsilon_{i,t} \qquad (1)$$

where the subscript i province index, t year index, $y_{i,t}$ is per capita CO2 emissions of province in year t, $y_{i,t-1}$ and its first order lag item; δ scalar coefficient while β a vector of parameters; η_i represents the individual effect, capturing the idiosyncratic characters of each

province; $\varepsilon_{i,t}$ the error term; $Z_{i,t}$ a vector of exogenous variables, including per capita GDP, industry composition, urbanization level, energy consumption structure, technology progress, and trade openness, etc. All variables take logarithmic forms.

The independent variables are constructed as follows:

Per capita GDP (denoted as per_GDP). We include per capita GDP and its quadratic term in our regression models. The data of GDP and population are derived from provincial statistic yearbooks over the years, with GDP deflated to 1995 price.

Energy consumption structure (denoted as ratio_coal). In order to control for possible provincial variations in fuel mix, we use the share of coal consumption in total energy demand to proxy the energy consumption structure.

Industry structure (denoted as ratio_heavy). We measure industry structure by the share of heavy industry. The data of gross output value of heavy and light industries are derived from provincial statistic yearbooks over the years.

Urbanization level (denoted as ratio_urban). We use the percentage of non-agriculture population to proxy urbanization level with all the data derived from China Population Statistics Yearbook and China Population and Employment Statistics Yearbook over the years.

Technology progress (denoted as energy_inten and time). We use both energy intensity and time trend to proxy technology progress in this study. Energy intensity is used to capture the heterogeneity and variation in technology progress across provinces, while time trend is employed to control for exogenous technology shocks common to all of the provinces.

Trade openness (denoted as tradeopenness). We use the standard trade intensity measure, i.e. the sum of export and import as a share of nominal GDP, as the proxy for trade openness. The data of export and import are derived from China Statistical Yearbook.

Based on the above econometric models and provincial panel data on energy environmental economy, this study investigates the driving forces, emission trends and reduction potential of each region carbon dioxide emissions. A provincial panel data of CO_2 emissions, covering the years 1995-2010 is used. A series of static and dynamic panel data models are estimated, and then an optimal forecasting model selected by out-of-sample criteria is used to forecast the emission trend and reduction potential up to 2020, as the following identical econometric model (Du et al. (2012).).

$$\begin{aligned} &\ln(per\_CO_2)_{i,t} = \alpha + \beta_1 \ln(per\_GDP)^2_{i.t} \\ &+\beta_2 \ln(per\_GDP)_{i.t} + \beta_3 \ln(ratio\_heavy)_{i.t} \\ &+\beta_4 \ln(time)_{i.t} + \beta_5 \ln(energy\_inten)_{i.t} + \eta_i \end{aligned} \tag{2}$$

As for the key assumptions, the average annual GDP growth rates is 7.5% for period 2011–2015 and 6% for period 2016–2020 (EIA, 2009). Province-level population forecast is referred to Liu (2009). Suppose carbon intensity 40% down and national 15% non-fossil energy ratio in 2020 can be achieved.

Results

The simulation results show that, under current assumptions, there is no doubt that China's absolute emissions will grow over this next decade as China is still a developing country, where there are unmet infrastructure and energy needs. And even with active abatement policy interventions, the absolute increments are considerable as large as 4.1 Billion ton, from 5.6 Bton (2005) to 9.7 Bton (2020). Absolute emissions will grow more if the economic growth rate is greater.

The results also show that equity objectives can be pursued by the choice of a suitable initial distribution of emission allowance and the per capita CO_2 emission of China is about 6.79 Mton/person in year 2020, in contrast to 4.38 Mton/person in year 2005. Because of the lag time of regional industrial structure adjustment and the knocked-in effect of technology, the differences of carbon intensity among regions keep, that is, it takes much time for per capita CO_2 emissions' convergence.

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ACKNOWLEDGEMENT

Supports from the National Natural Science Foundation of China under Grant No. 71173205 and No. 71133005, Ministry of Education Foundation (No. 10JZD0018), and from the Project of China's National Technology Support Program No. 2012BAC20B07 are greatly acknowledged.