

# *Provincial and Sectoral Impacts of Meeting China's NDC through a National ETS*

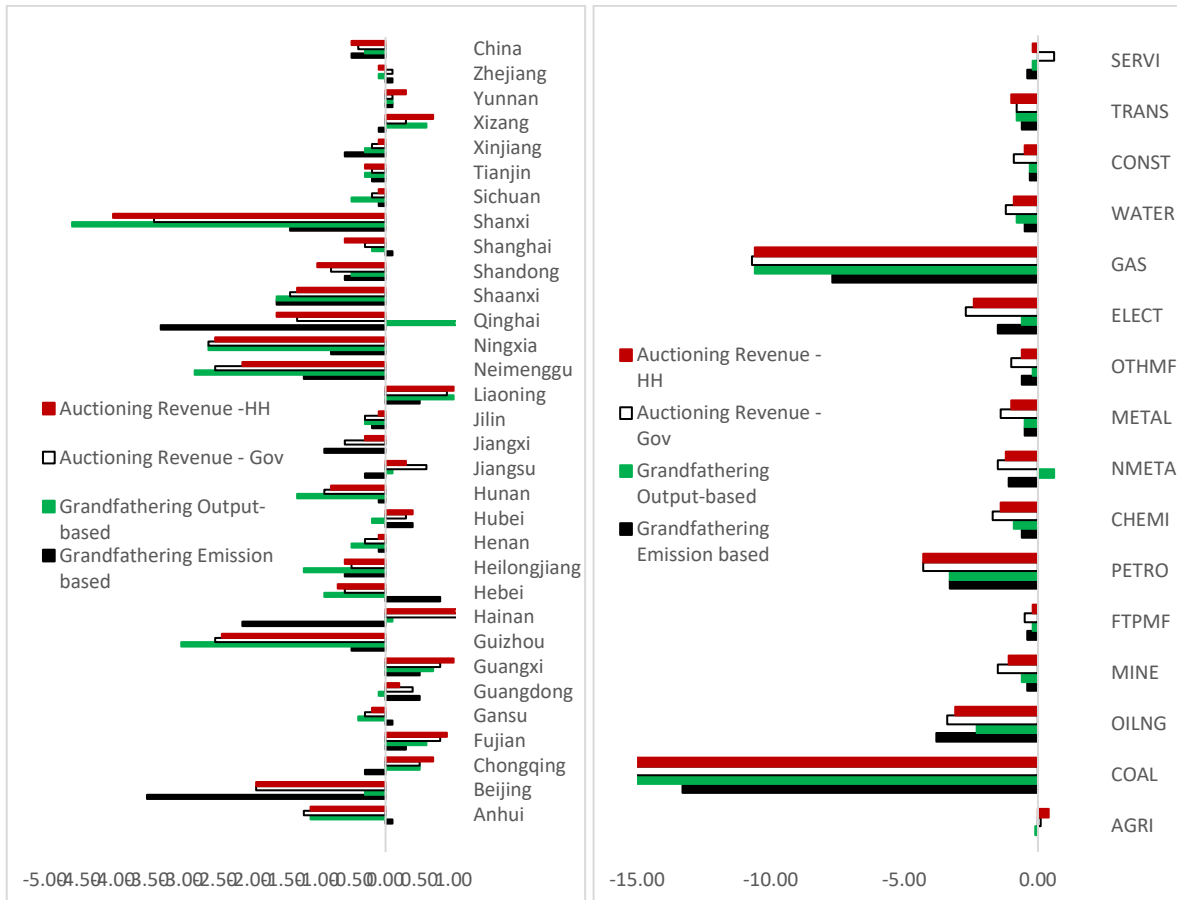
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**Overview:** China is implementing both market (carbon pricing) and non-market (i.e., regulatory or administrative) policy instruments to achieve its Nationally Determined Contributions (NDCs) under the Paris Climate Agreement. For the market instruments, China introduced a national emission trading scheme (NETS) in 2017. Before launching the NETS, China experimented with domestic emission trading through seven pilot projects in Beijing, Shanghai, Tianjin, Chongqing, Guangdong, Hubei and Shenzhen (Zhang, 2015). Under the NETS, some provinces would be the buyer of the emission allowances and some would be the seller, thereby causing some redistribution of wealth. Also, for some sectors, specifically the emission-intensive ones, the relative competitiveness in various provinces would change, which may lead to the relocation of capital and investment among different regions (Zhu et al. 2017). The study estimates how much GHG emissions each of the 31 provinces and 16 sectors in each province will reduce by 2030 to meet the NDC; and how the provinces and sectors would trade their emission allowances under alternative schemes of emission allowances. It assesses the economic costs (impacts on GDP), household consumption, investment, commodity prices and interprovincial and international trade of goods and services.

**Methodology:** We developed a multi-regional multi-sector dynamic computable general equilibrium (CGE) model for the analysis. It explicitly represents the behavior of four economic agents: households, governments (provincial and national), enterprises and the rest of the world (ROW) in all 31 provinces in China. Production sectors in each region are classified into 16 sectors, of which five are energy supply sectors (coal mining, oil and gas extraction, petroleum refinery, gas processing, and electric power generation). We considered two approaches for the allocation of allowances: free allocation (or grandfathering) and auction. Under the free allocation, we considered two criteria (i) baseline emissions of the emitters (sectors), (ii) baseline sectoral outputs. Under auctioning, we considered two schemes to recycle auction revenues to the economy: (i) provincial government consumption and investment, and (ii) recycling to households as a lump-sum rebate. One of the key strengths of the model is that it captures inter-provincial trade of goods and services among the 31 provinces. The study contributes to the literature on three fronts. First, to our knowledge, this is the first study to analyze the provincial level economic impacts of meeting China's NDC in 2030 through an emission trading scheme. Second, it uses a dynamic regional CGE calibrated with latest available data (2012 provincial SAM). Third, we utilize estimated values for an important model parameter known as automatic energy efficiency index (AEEI), whereas existing studies use arbitrary values for this parameter.

**Results:** In order to meet the NDCs that corresponds national CO<sub>2</sub> intensity 65% below 2005 level, China emit 8,502 million tons of CO<sub>2</sub> in 2030, which is 13.3% below the baseline emissions in that year. There is a huge difference in the volume of emission traded and prices of emission permits between the allowance allocation rules. The size of the emission market is much larger under the output-based grandfathering rule as compared to the emission-based allocation rule. The market-clearing permit price under the former case would be ¥164/tCO<sub>2</sub> as compared to ¥263/tCO<sub>2</sub> under the latter case. Allowance prices would be smallest, ¥149/tCO<sub>2</sub>, under the auctioning indicating its efficiency over the free allocation through grandfathering. At the national level, the total value of emission trade in 2030 ranges from 51 billion yuan under the emission-based allowance allocation case to 3,155 billion yuan under the output-based allowance allocation. The NETS would cause 0.3% to 0.5% reduction of GDP in 2030 depending on allowances allocation rules. Provincial GDP impacts widely vary (Figure 1a). While the ETS provides opportunities to some provinces to increase their economic outputs, it causes economic losses in the remaining provinces. Neimenggu, Ningxia, Shanxi and Shaanxi that highly rely on the coal mining sector and coal-intensive manufacturing sectors (electricity, non-metallic minerals, metals) would face relatively higher economic loss under all schemes of allowances allocation considered. Detailed results show that fossil fuel sectors of some provinces would face a deep decline in their outputs (Figure 1b). Coal sector outputs, for example, drop more than 20% in several provinces under all allowances distribution rules. The ETS also significantly affects the interprovincial and international trade of goods and services in China. In our study we also corrected the baseline through the adjustment of AEEI parameters based on information from Timilsina et al. (2019), which used a bottom-up energy sector optimization model, TIMES, to estimate the impacts of existing policies and measures, such as energy efficiency improvements in energy supply and utilization systems; fuel switching in the energy supply system, in the baseline. If we assume that these policies and measures are not implemented, China would require to reduce 30% of its 2030 emissions to meet its NDC target, which is 16.7 percentage point higher than what we have in this analysis (13.3%). Although it would increase market-size of the ETS, the permit prices and

economic impacts would increase substantially. The permit prices would be 2.7, 2.5 and 2.4 times higher than what we got under, respectively, the emission-based grandfathering, output-based grandfathering and auctioning rules for allocating allowances. Similarly, GDP loss would be about three times higher than that we got.



(a) Percentage change of GDP by province (b) Percentage change of sectoral outputs  
**Figure 1. Economic impacts in 2030 (% change from the baseline)**

**Conclusions:** We investigate the distribution of economic impacts across 31 provinces and 496 economic sectors in China of a national carbon dioxide emission trading scheme that aims to accomplish China’s emission reduction pledges under the Paris Climate Agreement. We find that meeting China’s pledges through the emission trading scheme would reduce 13% of national CO<sub>2</sub> emissions from the baseline scenario in 2030. It would cause up to 0.5% reduction of the country’s GDP in 2030. While a few provinces would realize economic gain others would experience economic loss. The impacts on provincial economies and CO<sub>2</sub> emissions are sensitive to initial emission allocation rules. The provincial economies that rely on coal mining and coal-intensive manufacturing industries are the hardest hit by the emission trading scheme irrespective of the allowance allocation rules.

**References**

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