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Designing an emissions trading scheme for China—An up-to-date climate policy assessment

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HIGHLIGHTS

- 45% Chinese carbon intensity target for 2020 implemented via emissions trading.
- 1% GDP/welfare loss in 2020 and 2% in 2030 for a fixed emissions target after 2020.
- 0.5 percentage points higher (lower) growth, increases (decreases) climate policy-induced welfare loss in 2030 by about 0.5 percentage points.
- Similar macroeconomic effects for free allocation and full auctioning, but higher reductions in output under full auctioning in ETS sectors.
- Restricted linking to EU emissions trading creates at best a small benefit for China.

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ABSTRACT

We assess recent Chinese climate policy proposals in a multi-region, multi-sector computable general equilibrium model with a Chinese carbon emissions trading scheme (ETS). When the emissions intensity per GDP in 2020 is required to be 45% lower than in 2005, the model simulations indicate that the climate policy induced welfare loss in 2020, measured as the level of GDP and welfare in 2020 under climate policy relative to their level under business-as-usual (BAU) in the same year, is about 1%. The Chinese welfare loss in 2020 slightly increases in the Chinese rate of economic growth in 2020. When keeping the emissions target fixed at the 2020 level after 2020 in absolute terms, the welfare loss will reach about 2% in 2030. If China's annual economic growth rate is 0.5 percentage points higher (lower), the climate policy-induced welfare loss in 2030 will rise (decline) by about 0.5 percentage points. Full auctioning of carbon allowances results in very similar macroeconomic effects as free allocation, but full auctioning leads to higher reductions in output than free allocation for ETS sectors. Linking the Chinese to the European ETS and restricting the transfer volume to one third of the EU's reduction effort creates at best a small benefit for China, yet with smaller sectoral output reductions than auctioning. These results highlight the importance of designing the Chinese ETS wisely.

1. Introduction

The European Union's (EU) emissions trading scheme (ETS) has been extensively researched, in particular with the help of Computable General Equilibrium (CGE) models (e.g. Klepper and Peterson (2006), Böhringer and Löschel (2005), Böhringer et al. (2009a, 2009b), Hübler and Löschel (2013)). This literature highlights that deliberate climate policy design can drastically attenuate climate mitigation costs. It highlights furthermore that different policy designs create various sectoral effects. Such sectoral effects are eminently crucial with respect to national and international competitiveness. Deliberate design encompasses the inclusion of relevant sectors, the way of distributing carbon emissions allowances and the international scope or linking of climate policies.

To date, the spotlight is shifting from Europe to China. The People's Republic of China has initiated ETS pilot projects in Beijing, Shanghai, Guangdong, Hubei, Tianjin, Chongqing and Shenzhen. These pilots envisage CO_2 emissions reductions per unit of output between 17% and 21% by 2015 vis-à-vis the respective 2010 level. The emissions reductions are in accordance with China's pledges in the Copenhagen Accord. These pledges presume an intensity target

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for Chinese carbon emissions (carbon emission measured in physical units per value unit of gross domestic product) between 40% and 45% for 2020 vis-à-vis 2005. The European Commission supports Chinese policy makers in designing and implementing an emissions trading scheme considering the experience of the EU ETS. To date, policy assessments of how to implement the Chinese emissions targets efficiently are, however, largely missing. In particular, a quantitative model-based assessment of policy design options would help policy makers implement the prevailing emissions targets at low macroeconomic costs and to avoid excessive sectoral losses as well. The China-related climate policy literature has not yet studied the implementation of a national ETS in detail (see Section 2).

A particular challenge in this respect is the uncertainty about the future growth path of the Chinese economy (cf. Hübler, 2011). If China sustains its high economic growth and relies on coal as an energy source, carbon emissions will substantially grow. Consequently, the costs of reaching a given emissions target will rise. If, on the contrary, Chinese growth rates decline and converge to a moderate growth steady state, carbon emissions will only moderately grow. Hence, mitigation costs of a given emissions target will be lower. The impact of economic growth is more complex with respect to intensity targets: on the one hand, higher economic growth augments business-as-usual (BAU) emissions; on the other hand, higher economic growth allows China to emit more under climate policy. Higher economic growth driven by higher technical progress may also result in a lower BAU carbon intensity. The resulting carbon intensity under climate policy is given by the intensity target and independent of economic growth. Nonetheless, higher growth expands emissions in absolute terms so that emissions reductions starting at this higher level (on the marginal abatement curve) might be more costly. As a consequence, it is ambiguous whether and how economic growth affects the carbon price and total carbon mitigation costs under an intensity target.

Moreover, European experience shows that some sectors are under higher competitive pressure than others. This may apply in particular to energy-intensive and trade-exposed industries as they are potentially prone to carbon leakage, i.e. their relocation to countries without climate policies. Therefore, it is of high importance to analyze specific sectoral impacts and to detect what sectors suffer most from the introduction of an ETS.

Another significant issue to be considered is the involvement of a Chinese ETS in the international climate policy context. In more detail, linking the Chinese ETS to the EU ETS is supposed to imply positive welfare effects for both regions. The EU may benefit from the presumably lower marginal abatement costs in China, whereas China could profit from the revenues generated by exporting of offset credits.

Our paper tackles these issues. It evaluates policy design options for China and takes up the three points mentioned above: the uncertainty about future growth, competitiveness at the sectoral level, and the linkage of the Chinese to the EU ETS. Besides these three main points, it evaluates the costs of different Chinese intensity targets and auctioning versus free allocation of emissions allowances.

Our analysis devises the following macroeconomic results in terms of China's climate policy-induced GDP and welfare losses: assuming a carbon intensity target of 45% for 2020 vis-à-vis 2005 and medium economic growth, the Chinese GDP and welfare losses compared to BAU amount to about 1% in 2020. They rise to about 2% in 2030 provided that the emissions target for 2020 is kept constant in absolute terms thereafter. Under the intensity target in 2020, higher Chinese economic growth slightly enhances mitigation costs. Under the fixed emissions cap in 2030, the results are relatively sensitive to the assumptions on Chinese economic growth: augmenting (attenuating) the medium annual growth rate by 0.5 percentage points increases (decreases) the GDP loss in 2030 by 0.4 and the welfare loss by 0.5 percentage points. If the intensity target for 2020 is set to 50%, i.e. more stringent than the Copenhagen pledge, and is kept constant thereafter, the welfare loss will ascend to 2.9% in 2030, yet the GDP loss will only reach 2.2%. Linking the Chinese ETS to the EU ETS limited to a transfer volume of 300 Mt of CO_2 per year would at best slightly reduce these macroeconomic costs. Furthermore, the difference between full auctioning and free allocation of allowances is minor and ambiguous at the macro level.

At the level of energy-intensive Chinese sectors that participate in emissions trading, the results are quantitatively much more diverse than at the macro level. Climate policy-induced sectoral output changes under medium growth and a 45% intensity target vary roughly between +1.5% and −3% in 2020 and +0.5% and −7% in 2030. This result applies to free allocation of allowances. Full auctioning of allowances strongly augments (e.g. doubles) the sectoral output reductions. Therein, the sectoral output reductions are compensated by revenues from auctioning at the macro level. Linking the Chinese to the EU ETS (restricted to 300 Mt of CO_2 annually) also diminishes sectoral output, but clearly to a smaller extent than full auctioning. In this case, the sectoral output reductions are compensated by revenues from exporting allowances to Europe at the macro level. The macroeconomic effects of different economic growth assumptions explained above translate to the sector level in terms of output reductions. Augmenting (attenuating) the medium annual growth rate by 0.5 percentage points increases (decreases) the sectoral output losses in 2030 by around 15%, although also higher and lower losses occur in specific sectors. For example, the chemical sector can benefit from higher growth under climate policy in 2030.

Our paper is structured as follows: Section 2 reviews related literature strands. Section 3 provides a brief narrative model overview. Section 4 describes the policy scenarios under scrutiny. Section 5 presents and interprets the policy simulation results. Section 6 concludes.

2. Literature

The literature has so far examined the stringency and achievability of China's Copenhagen intensity targets. The literature has also evaluated China's importance for mitigating climate change and China's economic incentives to join a global emissions trading scheme (ETS). A few scholars have theoretically scrutinized the economic effects of linking a Chinese system of carbon pricing to the European ETS, and they have estimated the volume of carbon allowance transfers between China and Europe within an efficiently connected system. The lessons we learn from these literature streams are the basis for our research as presented in this paper.

Like our study, one recent literature stream evaluates the stringency and achievability of China's Copenhagen pledge, defined as an emissions intensity target. According to its Copenhagen pledge, China announced to reduce its carbon emissions intensity between 40% and 45% until 2020 vis-à-vis 2005.[1] Steckel et al. (2011) show that the Chinese 45% intensity target, as given by the Copenhagen pledge, is capable of meeting a 450 ppm concentration target, resulting in a two degree temperature increase above the pre-industrial level. Saveyn et al. (2012) aver, based on their CGE model, that China's emissions intensities in a reference scenario are comparable to or even lower than required by the Copenhagen pledges. Hence, the Chinese intensity targets would not be binding. Different to Saveyn et al. (2012), Dai et al. (2011) estimate with their CGE model that

[1] Qualitatively, we use carbon and CO_2 as synonyms throughout the paper. Quantitatively, we report emissions as tons of CO_2.