INTERACTIONS BETWEEN MARKET REFORM AND A CARBON PRICE IN CHINA'S POWER SECTOR

Fei Teng, Tsinghua University, Phone +86 10 62772759, E-mail: tengfei@tsinghua.edu.cn
Frank Jotzo, Australian National University, Phone +61 02 61254367, E-mail: frank.jotzo@anu.edu.au
Xin Wang, Tsinghua University, Phone +86 10 62772759, E-mail: x-w12@mails.tsinghua.edu.cn

Overview

The electricity sector accounts for a large share of China's carbon dioxide emissions and of the economy-wide abatement potential. China's planned national emissions trading scheme would include electricity generation, as nearly all emissions trading schemes do. The critical difference is that in most existing carbon pricing systems the power sector operates with competitive markets and cost-based pricing, while the Chinese power industry still uses a highly regulated dispatch and pricing system. Together these limitations mean that the effect of a carbon price in China is limited in three ways, namely in terms of the impact on operational decisions for existing power stations, effects on investment decisions, and incentives to reduce electricity use. An emissions trading scheme will need to take limitations in market responses into account, and for a given carbon price will be less effective than if market reform in the electricity system is undertaken, as it is getting underway in China. We explore the channels of interaction between electricity market reform and carbon pricing in China, and provide quantitative estimates of the effects and interactions on electricity sector emissions. A probabilistic discrete choice model is used to simulate the behavior of investors in the power sector. The analysis indicates that market reform can help reduce emissions, but to meet China's 2030 targets a carbon price is also necessary. Without market reform, a high carbon price would be necessary to achieve the 2030 goal. Under our assumptions, the carbon price required for the same share of non-fossil fuel generation would be about twice as high without market reform. Combining market reform and a moderate carbon price is likely to be the most effective and most feasibly policy package to cut emissions from China's power sector.

This paper aims to make a contribution to understanding of the interaction of the two elements of energy and climate policy in China, through qualitative assessment of the interaction and the functioning of China's electricity system, and through a preliminary quantitative assessment of selected aspects of electricity market reform and carbon pricing.

This paper is organized as follows: in section 1, we introduce some background of electricity sector; in section 2, we provide a qualitative analysis of the effects and interactions of electricity sector reform and carbon pricing; in section 3, we review the power pricing and dispatching system in China and also explore the recent overinvestment in China's coal fired power capacity; in section 4, we set out a framework for modelling investment decisions in the power sector and apply this framework to analyze the policy interaction between electricity reform and ETS in China; in section 5, we discuss modelling results; and section 6 concludes.

Methods

Levelized Cost of Electricity (LCOE) and LOGIT Discrete Choice Model

Results

In reference scenario, the share of coal based technology decreases from 66% in year 2010 to less than 50% in year 2030 and about 46% in year 2040. The share of non-fossil fuel increases from 26.8% in year 2010 to 43.7% in year 2030 and 47.4% in year 2040. In terms of generation, the share of non-fossil fuel technology is about 27.5% in year 2020, 31% in year 2030 and 34.6% in year 2040 respectively. Under the REF scenario, the share of non-fossil fuel generation is lower than the requirement in China's national target (NDC) which requires the share of non-fossil fuel generation to reach 30% in year 2020 and 40% in year 2030. Thus in the reference scenario, the non-fossil fuel target will not be achieved.

In the market reform scenario, we assume that the curtailment of renewable generation will be resolved and the LCOE of renewables will be reduced due to the increasing generation hours. As a result, the share of renewable will be improved. Compared with the reference scenario, the share of renewables increases in the short term by avoiding the entailment of wind and solar power. By the year 2020, the share of non-fossil fuel generation increases by 6%, from 27.5% in reference scenario to 33.5% in the market reform scenario. By liberalizing the power market, the 2020 target non fossil fuel share can be achieved. However, the 2030 non fossil fuel target is still not met.

In the carbon price scenario, in the short-term, the share of non-fossil fuel generation is lower than market reform scenario because the low carbon price before 2030 has a lesser effect than the market reform. But

together with the growing carbon price after 2030, the long-run impact of carbon price begins to dominate. In year 2030, the share of non-fossil fuel generation is about 37% for both carbon price scenario and market reform scenario. In the year 2040, the share of non-fossil fuel generation in carbon tax scenario is 46.3%, 5.8% higher than the market reform scenario.

With the combination of a liberalized power market and a growing carbon price through introduction of ETS, the share of non-fossil fuel generation is 43% in year 2030 which is consistent with the target of 20% non fossil fuel share in China's NDC which support the peaking of China's emission around 2030. If the power market cannot be liberalized, then the carbon price needs to be doubled at year 2030 to ensure the achievement of non fossil fuel target. But a higher carbon price may trigger greater concerns about competiveness in other sectors subject to international competition.

Conclusions

China's goal to peak its national carbon dioxide emissions around 2030 needs a substantial decarbonization in power sector. To be consistent with the 2030 peaking target, the share of non-fossil fuel generation need to be more than 40% in year 2030. To achieve this requires a substantial policy intervention in the power generation sector. The current electricity pricing and dispatch system in China is unlikely to be able to deliver this target in part because of distortions between coal price and electricity price - the former is open for competition, the later is heavily regulated by government. The current power sector framework would also reduce the effectiveness of a carbon price, as under China's national ETS planned for introduction in 2017.

We use a probabilistic technology competition model to analyze to what extent China's power sector can decarbonize, under scenarios of electricity market reform, a carbon price, and market reform combined with a carbon price. The results show, market reform can deliver short term impact by reducing curtailment of renewable power. If China can successfully liberalize its power market, then this policy intervention under our assumptions can increase the share of non-fossil fuel generation to 33.6%, fully consistent with the target of 15% non-fossil fuel in primary energy. Without market reform, to achieve the same level of incentive for development of non-fossil fuel technologies, a carbon price of around 25 RMB/tCO2 in year 2020 would be needed.

Although both market reform and carbon tax can individually generate short term impact around 2020, they are not enough to achieve the 2030 target. While the direct impact of market reform to reduce emissions according to our analysis is mostly short-term, market reform can make carbon pricing in China's power sector more effective. We estimate that without market liberalization, in 2030 a carbon price needs to be twice as high than if a carbon price is applied with market reform, in order to achieve the same share of non-fossil fuel generation.

The combination of market reform and a moderate carbon price is likely to be the most effective and arguably most feasibly policy package to cut emissions in China's power sector.

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