[*THE UNINTENDED CONSEQUENCES OF CHINA'S CARBON TRADING ON RENEWABLE ELECTRICITY TRANSITION*]

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Overview

Different from a cap-and-trade system, China's ETS pilot policy allocates quotas for free primarily based on historical CO2 intensity. From 2000 to 2023, China achieved a compound annual growth rate (CAGR) of 14.4% in renewable electricity capacity (REC), accounting for nearly 40% of the global total. However, much of the REC growth appears to occur in regions without a carbon emission trading scheme (ETS), which motivates this study to explore whether China's ETS has a negative causal impact on REC.

By analysing the REC data of 29 Chinese provinces from 2006 to 2020 with a difference-in-difference (DID) model, this study finds that China's ETS suppressed an increase of 8.31 GW in REC and resulted in a 9% decrease in the share of REC out of total electricity generation capacity. The results show that China's ETS pilot policy has a significant negative impact on the transition towards a renewable electricity supply system.

Methods

This study adopts a DID model for estimation. In 2011, China announced 6 ETS pilot provinces[1]. The ETS design and the target participants were then confirmed in 2013, slightly before their formal implementation. this study designates 2013 as the year of policy implementation. Since the participants in China's national ETS were announced at the end of 2020, observations after 2020 are excluded to avoid potential confounding effects from the national ETS.

To validate the parallel trend assumption, this study first conducts an event study using Model (1). Then, this study uses Model (2) to estimate the overall causal effect of ETS implementation.

$$Y_{i,t} = \alpha + \beta_1 \times ETS_{it}^{-7} + \beta_2 \times ETS_{it}^{-6} + \cdots + \beta_{15} \times ETS_{it}^{7} + Control_{it} + \mu_i + \theta_t + \varepsilon_{i,t} \quad (1)$$

$$Y_{i,t} = \alpha + \beta ETS_{it} + +Control_{it} + \mu_i + \theta_t + \varepsilon_{i,t} \quad (2)$$

where $Y_{i,t}$ indicates REC and REC share by province i in year t. $ETS_{i,t}$ is an indicator which equals to 1 for year 2013 and its following years, otherwise equals to 0. $Control_{it}$ is a set of control variables. μ_i and θ_t represents province-level individual fixed effects and year-level time fixed effects, respectively.

The data of the outcome variable used in this study is collected from the China Electricity Council (CEC), which is the national association for the electricity industry founded with the approval of the State Council.

Results

Table 1 provides the summary statistics. The average province-level thermal and renewable electricity generation capacity is 28.85 GW and 13.08 GW, respectively. The average share of REC out of total capacity reaches 31.6%.

Table 1. Summary Statistics

Variables	Observations	Mean	STD	Min	Max
Thermal	435	28.85	2385.60	0.01	111.35
Renewable	435	13.08	1413.44	0.00	87.49
Renewable_share	435	31.6%	0.23	0.0%	97.6%

Figure 1. REC trend by group

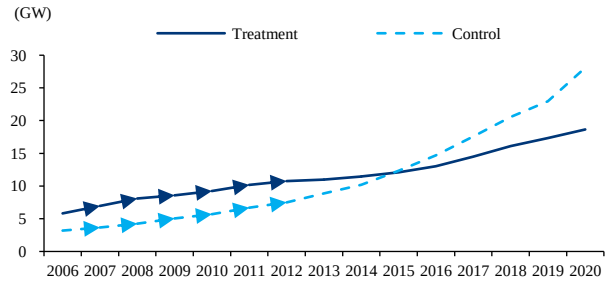
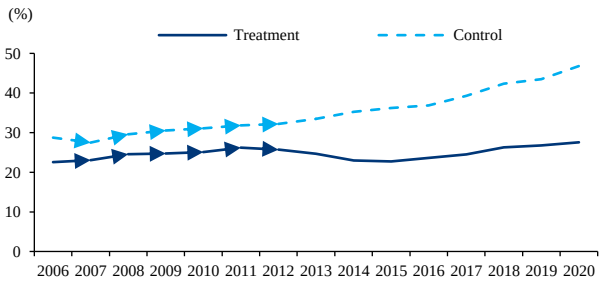


Figure 2. REC share trend by group



[1] The 6 ETS pilot provinces are Beijing, Shanghai, Tianjin, Chongqing, Hubei and Guangdong.

Figure 1 and Figure 2 show that **parallel trends are observed in both outcome variables before 2013, when the ETS pilot policy was implemented.**

Figure 3 and Figure 4 present the results of Model (1) **The results show that the gap in REC and REC share between the treatment group and the control group do not precede ETS pilot adoption, and the impact materializes quickly afterwards. Additionally, the operation of pilot ETS demonstrates a continuous impact.**

Figure 3. Parallel trend test of REC

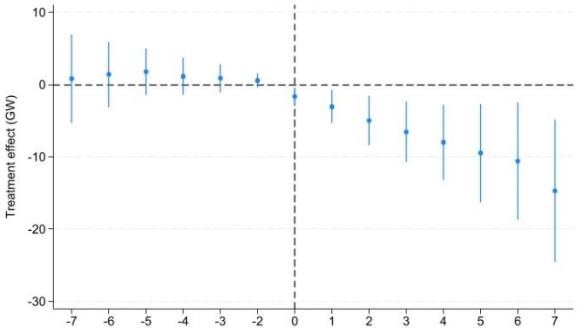
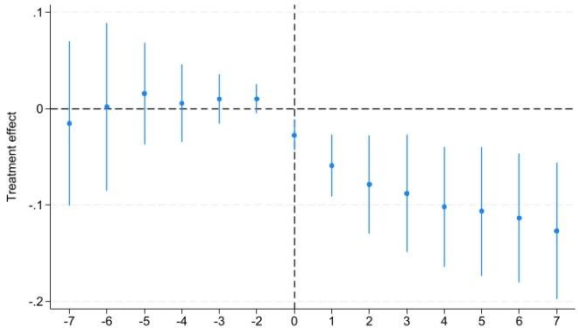


Figure 4. Parallel trend test of REC share



After validating the parallel trend assumption, this study estimates Model (2) for the overall impact of ETS pilot policy. **Table 2 presents the results, indicating that ETS pilots fall behind non-pilots in REC by 8.31 GW during 2013-2020, with their REC share declining by about 9%.**

Table 2. Effects of the ETS pilots on REC and REC share.

	(1) REC	(2) REC share
ETS	-8.31** (3.38)	-9.01%*** (0.026)
Control	Yes	Yes
Province fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
Observations	435	435

*Note: () Standard errors are clustered at the province level. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.*

This study also addresses potential identification problems like the Stable Unit Treatment Value Assumption and confounding policies. Further robustness check results and further information are available upon request.

Conclusions

The results show that China's ETS pilot policy has a significant negative impact on the transition towards a renewable electricity supply system. The possible reason is that, according to China's ETS pilot policy, quotas are allocated for free based on historical CO_2 intensity, which is different with a cap-and-trade system, so that electricity generators only need to slightly improve their CO_2 efficiency to achieve a quota surplus, avoid carbon pricing cost or even profit from ETS. This research will further investigate whether the ETS pilot policy pushes power plants to switch from coal to gas in electricity generation.

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