Investigate the differential impacts of technology-neutral (RPS) and technology-specific (SRPS) renewable energy policies on different types of renewable energy sources in electricity generation.

Theoretical Framework

- Transitions of electricity generation from fossil fuels to renewable technologies are essential in mitigating greenhouse gas (GHG) emissions.
- Large heterogeneities exist among U.S. states regarding solar and wind energy development and natural endowment.
- Renewable Portfolio Standards (RPS), so far the dominant local instruments in fostering renewable development and reducing GHG emissions from the grid power.
- To promote solar deployment, some states have designed and implemented RPS Solar Curve-Out (SRPS), which is built upon RPS.
- The RPS allows electricity suppliers to select renewable energy from a broad range of technologies and sources, while SRPS directly mandates solar electricity generation.

The Hypotheses:

- **Hypothesis 1:** The adoption of SRPS or a more stringent SRPS target induces a higher share of wind electricity but a non-decreasing share of solar electricity in total electricity generation in that state.
- **Hypothesis 2:** The adoption of RPS or a more stringent RPS target induced more extensive deployment of solar energy in the United States.

Individual supplier’s decision problem:

\[
\min_{\eta_1, \eta_2, \eta_3, \tau_1, \tau_2, \tau_3} \sum_{i} C_i(q_i, \eta_1, \eta_2, \eta_3) + C_{\eta i}(q_i, \eta_1, \eta_2, \eta_3) + C_{\tau i}(q_i, \eta_1, \eta_2, \eta_3) + P_{\tau i} + \theta_{\tau i} y_{\tau i} + \theta_{\eta i} y_{\eta i},
\]

subject to:

- \( q_i + \tau_1 + q_i + \tau_2 + z_i \geq Q_i; \quad q_i + \tau_1 + q_i + \tau_2 \geq \alpha_i Q_i \)
- \( q_i + \tau_1 + q_i + \tau_2 \geq \alpha_i Q_i \)
- \( q_i + \tau_1 + q_i + \tau_2 \geq 0 \)

Empirical Model

Two-way fixed effects model with two treatment variables and staggered timing of treatments:

\[
Y_{it} = \alpha + \delta_i RPS_{it} + \beta_i SRPS_{it} + \gamma_i RPS_{it} \times SRPS_{it} \times \text{target}_i + \epsilon_i \omega_i + \xi_i,
\]

where:

- \( Y_{it} \): the share of solar or wind electricity in total electricity generation;
- \( RPS_{it}, SRPS_{it} \): dummy policy indicators (0/1);
- \( RPS_{it} \times SRPS_{it} \times \text{target}_i \): continuous policy variable in % of electricity required;
- \( \text{target}_i \): other climate change policies, a proxy for preferences for green policies;
- \( \omega_i \): the penetration rate of distributed solar, a proxy for preferences specifically for utility-scale solar;
- \( \xi_i \): a set of control variables;
- \( t, s, m \): indexes of state fixed-effect, year fixed-effect, and region-specific linear time trend;
- \( \epsilon_i, \omega_i \): error term.

Conclusions

- Technology-specific SRPS has been effective in promoting the development of solar energy in the United States.
- Technology-neutral RPS is shown to have imbalanced effects on the development of renewable technologies.
- RPS and SRPS imply significant trade-offs between solar and wind development.

Discussion

- The trade-offs between technology-neutral and technology-specific policies depend on the relative cost competitiveness of the technologies and the relative competitiveness can evolve over time with technology advancement.
- In fact, the cost of solar has fallen dramatically in the last 20 years or so, increasing its competitiveness among renewables. This implies that, even though a solar carve-out has been effective in promoting solar in our study period, a technology-neutral policy may also have the potential to facilitate solar deployment nowadays.
- Policymakers should be attentive to changes in the cost structure of renewable technologies when making renewable energy policies.