Research Proposal for the NBER Energy Markets and the Macroeconomy Conference

Do Renewables Boost the Economy? Evidence from Firm-to-Firm Tax Records in Chile

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1. Summary

Effective and economical expansion of renewable energy is one of the most urgent and important challenges in addressing climate change. In our previous project, "The Investment Effects of Market Integration: Evidence from Renewable Energy Expansion in Chile" (*Econometrica,* 91(5): 1659–1693, 2023), we showed that market integration in wholesale electricity markets significantly boosted investments in renewable energy in Chile.

In this new research proposal, we will, for the first time, integrate Chile's central bank firm-to-firm tax transaction records with electricity market data to answer our core research question: "Do renewables boost the economy?"

Because renewable energy has near-zero marginal cost, its expansion reduces local electricity prices, particularly in regions close to renewable generation or transmission lines connected to these regions. We ask whether this expansion incentivized manufacturing plants to (1) relocate their production facilities to areas that benefited from renewable growth and (2) shift production quantities toward these regions and away from areas that did not experience such benefits.

Answering this question has historically been difficult because linking firm-level inputs, outputs, and productivity data with electricity market data has been highly challenging. We have just received an approval from the Central Bank of Chile to conduct this integration for the first time in the country's history. The Central Bank maintains firm-to-firm tax records that cover nearly all business transactions in Chile, and we leverage this dataset to investigate our research questions.

Our project is highly policy-relevant. The transition to renewable energy is often portrayed as economically costly. Our study offers a contrasting perspective: we will show that renewable energy expansion can lower energy costs for energy-intensive industries and, in turn, potentially stimulate economic activity.

2. Datasets

We will use the following datasets from Chile:

- **Firm-to-firm tax transaction records:** Comprehensive transaction-level data covering all inter-firm transactions in Chile over the past 15 years (access approved by the Central Bank of Chile in April 2024).

- **Wholesale electricity market data:** Detailed market-level records that we previously constructed for our *Econometrica* (2023) paper.

- **Retail electricity price data:** Publicly available price information that will require research assistant support for compilation and cleaning.

- **Long-run electricity contract data:** Contract-level records obtained from the electricity system operator, which will also require research assistant support for compilation and cleaning.

3. Empirical strategy

A common challenge in the electricity literature is that long-run changes in electricity prices are often endogenous to industrial activity. We address this issue by exploiting two sources of exogenous variation: (1) natural variation in the abundance of renewable resources (e.g., sunlight and wind patterns) and (2) pre-existing congestion in electricity grids prior to market integration. In our empirical strategy, we use these sources of variation as instruments for changes in long-run electricity prices to estimate the causal impact of electricity prices on (1) firms' choices of industrial location and (2) shifts in production intensity across a company's manufacturing sites.

An example regression specification is:

$$y_{it} = \alpha + \beta p_{it} + \gamma X_{it} + u_{it,}$$

where y_{it} is the outcome for firm i and time t (the firm's output, productivity, or relocation to renewable-intensive region), p_{it} is the electricity price, and X_{it} is a set of covariates. As stated above, we use natural variation in the abundance of renewable resources (e.g., sunlight and wind patterns) and pre-existing congestion in electricity grids (before market integration) as instruments to overcome the potential endogeneity of the price variable.

The figure below illustrates the price variation generated by market integration and renewable expansion in Chile. We exploit the fact that market integration caused different regions to experience substantially different long-run price changes. This regional heterogeneity allows us to estimate how the industrial sector responds to these changes.

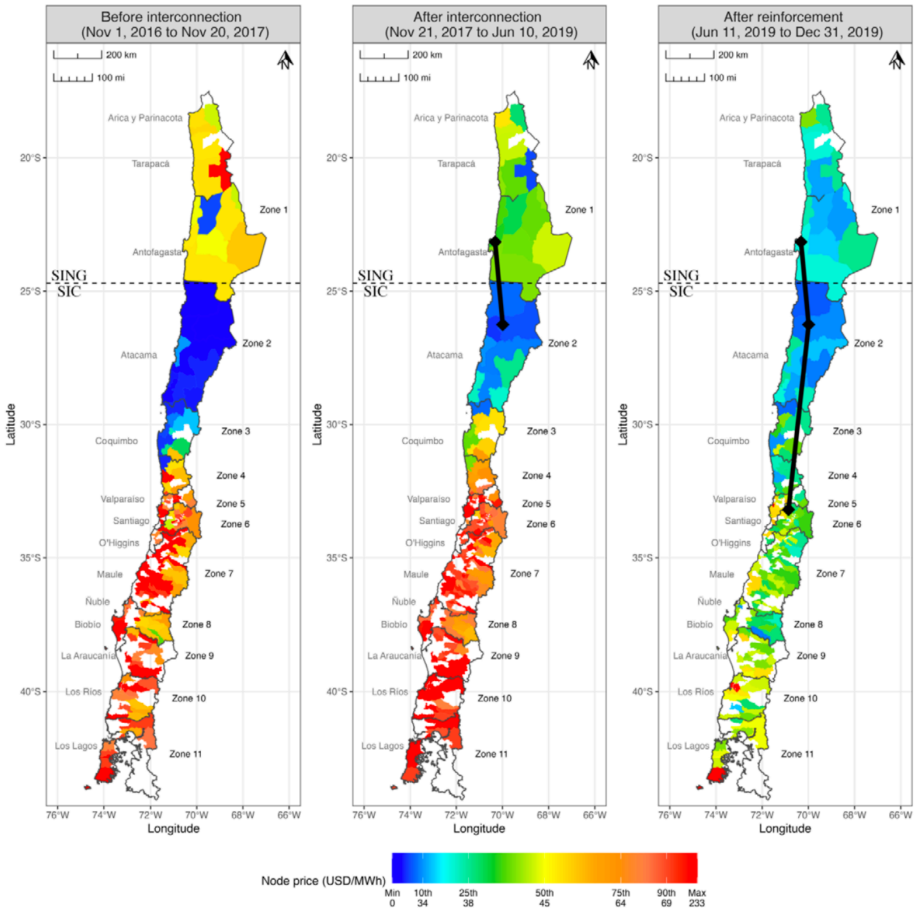


FIGURE 2.—Market integration and spatial variation in electricity prices. *Note*: These heat maps examine spatial heterogeneity in wholesale electricity prices. We calculate the commune-level average node prices, weighted by the hourly generation at the node level, and make heat maps for three time periods: (1) before the interconnection, (2) after the interconnection but before the reinforcement, and (3) after the reinforcement. We use the percentiles of the node price distribution to define color categories as shown in the legend. We also show the boundaries of zones defined in Section 5. Zones 1–11 include the following regions (a more detailed mapping is provided in Figure A.2). Zone 1: Arica y Parinacota, Tarapacá, Antofagasta; Zone 2: Atacama, and one commune in Antofagasta; Zone 3: parts of Coquimbo; Zone 4: parts of Coquimbo, parts of Valparaíso; Zone 5: parts of Valparaíso; Zone 6: Santiago, parts of O'Higgins; Zone 7: parts of O'Higgins, Maule, Ñuble; Zone 8: Biobío; Zone 9: La Araucanía; Zone 10: Los Ríos, parts of Los Lagos; Zone 11: parts of Los Lagos.

Source: “The Investment Effects of Market Integration: Evidence from Renewable Energy Expansion in Chile, ***Econometrica***, 91 (5): 1659-1693, 2023”

4. The importance of the topic for addressing the climate and energy challenge

Effective and economical expansion of renewable energy is one of the most urgent and important challenges in addressing climate change. The electricity sector accounts for one of the largest shares of global greenhouse gas emissions, alongside the transportation sector. Moreover, a substantial portion of transportation is expected to be electrified in the near future. Decarbonizing electricity generation is therefore essential for mitigating climate change.

Despite its importance, no previous studies have examined how renewable energy expansion affects economic activity. The transition to renewables is commonly viewed as economically costly. Our study offers a contrasting perspective: we will show that renewable energy expansion can reduce energy costs for energy-intensive industries and, in turn, potentially boost economic activity.

5. Novelty of the proposed research or project design

Our study makes two key contributions to the literature. First, to our knowledge, no previous research has been able to integrate renewable energy data with firm-to-firm tax records to investigate the question posed in this project. As described above, in April 2024 we received approval from the Central Bank of Chile to conduct this integration for the first time in the country’s history. The dataset includes essentially all inter-firm transactions, capturing energy purchases and sales, other input purchases such as capital and labor, and the sale of final goods and services.

Second, a central empirical challenge in this literature is that declines in energy prices are typically endogenous. Our research design exploits variation arising from transmission expansion and pre-existing congestion in the Chilean electricity market, which enables us to address this difficult endogeneity problem in a way that has not been possible in previous work.

6. The goals and impact of the research on the field of study

This project could offer important insights for ongoing policy discussions. For example, the Biden administration has identified investment in transmission lines and renewable energy as a central component of the Inflation Reduction Act of 2022 (IRA). To our knowledge, no existing studies quantify the potentially substantial benefits of renewable expansion that may arise from shifts in energy-intensive industrial production from high-carbon to low-carbon electricity. Such

shifts would represent previously unrecognized private and social benefits of renewable energy expansion.

7. Policy relevance

As we mentioned above, this project could provide important implications to ongoing policy discussions. For example, the Biden administration in the United States explicitly included investment in transmission lines and renewable energy as a key part of the Infrastructure Investment and Jobs Act. To my knowledge, no studies yet quantify the possibly substantial benefit of renewable expansion that could arise from the shifts in energy-intensive industrial production from high-carbon electricity to low-carbon electricity, which would be an unrecognized private and social benefit of renewable expansion.

8. Research team

- Koichiro Ito, Professor, Harris School of Public Policy, University of Chicago and NBER
- Luis Gonzales, Senior Economist at Economic Analysis Department at the Central Bank of Chile
- Mar Reguant, Professor, Northwestern University, BSE, CEPR, and NBER

9. Estimated project timeline

By 1st month: Recruit a research assistant dedicated to this project
By 6th month: Collect all necessary data and compete data clearing
By 10th month: Complete the primary data analysis
By 12th month: Primary findings will be available, and we complete a working paper.

10. Projected research outcomes

We plan to publish research outcomes in leading economics and/or science academic journals. In addition, we plan to present our findings in a variety of conferences. Finally, we plan to work with PR staff members at the University of Chicago to do outreaches such as publishing a research brief to the general public.