

Climate Risk and Renewable Energy Markets: Evidence from Wholesale Electricity Price Volatility

[Junxiang Du](#)

liverpool John Moores University, Liverpool, United Kingdom

Extended Abstract

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Abstract Summary

This study examines how weather driven shocks affect electricity price volatility in renewable dominated electricity markets. As renewable penetration increases, short run weather variability simultaneously influences electricity supply and demand, creating a direct channel through which physical climate risk may translate into market instability.

While existing studies focus primarily on the impact of renewable generation on electricity price levels, they provide limited evidence on how weather driven disturbances propagate through supply and demand and affect volatility. This paper develops a structural framework that links weather conditions to electricity price volatility through jointly identified supply and demand channels.

The empirical analysis adopts a two-stage approach. In the first stage, a Structural Equation Model (SEM) is used to jointly estimate the effects of weather variables on wind generation, solar generation, and electricity demand, allowing the extraction of structural residuals that represent weather driven shocks. In the second stage, these shocks are incorporated into a GARCH-X volatility model to examine how deviations in supply and demand, conditional on weather conditions, influence short run price dynamics.

By linking structurally identified shocks to volatility, the framework provides a direct assessment of the role of weather driven variability in shaping electricity price fluctuations. This identifies variability in both supply and demand as a key mechanism driving electricity price volatility. These insights have important implications for electricity market design, particularly in systems with high renewable penetration that require greater flexibility and more effective balancing.

Presenting Author Biography

Junxiang Du is a PhD researcher at Liverpool John Moores University, supported by the Vice-Chancellor PhD Scholarship. His research focuses on climate risk, renewable energy, and electricity market dynamics. His current work examines how weather driven supply and demand shocks affect electricity price volatility.