Assessment of Energy Price Dynamics: A GAS Model and Quantile Regression Analysis Between Natural Gas, Climate, and Electricity Markets

Orlando Joaqui-Barandica,

Pontificia Universidad Javeriana de Cali, orlando.joaqui@javerianacali.edu.co

Wilber Jr. Hernandez Rosero,

Universidad del Valle,

wilber.hernandez@correounivalle.edu.co

 Gina Paola Ramirez Lozada,

Universidad del Valle, gina.ramirez@correounivalle.edu.co

Cesar Andres Ojeda Echeverry,

Universidad del Valle,

cesar.ojeda@correounivalle.edu.co

# Overview

Energy is a fundamental pillar in a developing world, with a critical distinction between renewable and non-renewable sources. Despite growing environmental concerns and efforts to promote sustainability, non-renewable energy sources, especially natural gas, continue to be pillars in electricity generation globally (Furlan & Mortarino, 2018). This study focuses on the role of natural gas in Europe, particularly in Germany, due to its strategic importance in electricity generation and its direct impact on electricity prices.

The main problem addressed by this research lies in Europe's climate variability and its influence on electricity production. This variability, together with the dependence on non-renewable sources such as natural gas, poses significant challenges for energy security and price stability (Dormido et al., 2022). Furthermore, the geopolitical situation, such as the recent conflict between Russia and Ukraine, has affected the supply and prices of natural gas, exacerbating market volatility and directly affecting electricity production in Germany (Amirov-Belova, 2022). This complex context highlights the need for a deep understanding of the interaction between natural gas prices, climate factors and electricity prices, to inform energy policies and mitigate the risks associated with reliance on non-renewable energy sources.

**Methods**

The methodology of this study is based on a quantitative approach to analyze the relationship between natural gas prices, climatic factors and electricity prices in Germany. Advanced statistical techniques are used to address the dynamics of energy prices and their interaction with exogenous variables such as climatic conditions: temperature, wind speed, precipitation and irradiance (Uribe et al., 2022).

The core of the methodology is the Generalized Autoregressive Scoring (GAS) model, which allows modeling the temporal dynamics of electricity prices based on natural gas prices and climate variables. This model is particularly suitable for capturing the nonlinear nature and heteroskedasticity of time series data. The GAS model is extended to include components such as random walk, order 1 autoregression, and order 5 seasonality, along with the aforementioned exogenous variables (Creal et al., 2013).

To complement the analysis, quantile regression is used, which provides a more complete view of the relationship between the variables by examining different points in the distribution of electricity prices. This technique is particularly useful for identifying how the relationship between natural gas and electricity prices varies at different price levels, thus capturing heterogeneity in price dynamics (Koenker & Bassett, 1978).

The analysis covers the period from 2015 to 2022, a timeframe marked by significant geopolitical events affecting natural gas supply, particularly from Russia.

# Expected Results

The analysis is expected to reveal a substantial correlation between natural gas prices and electricity prices in Germany, highlighting the significant impact of supply disruptions and political restrictions on gas imports on electricity price volatility electricity. Fluctuations in natural gas prices, exacerbated by geopolitical factors such as the conflict between Russia and Ukraine, are anticipated to have a direct influence on electricity generation costs and, therefore, final consumer prices.

Furthermore, the results are expected to show a mitigating effect of renewable energy sources, especially wind, on the increase in electricity prices. The growing incorporation of renewable energy into the German energy matrix could contribute to greater stability in electricity prices, reducing dependence on non-renewable energy sources and their associated price fluctuations.

However, it is anticipated that the predominant influence on electricity price formation will continue to be natural gas prices. This is due to Germany's significant dependence on natural gas for electricity generation and the sensitivity of electricity prices to changes in natural gas prices.

The results of the Generalized Autoregressive Scoring (GAS) model are expected to confirm the relevance of the price of natural gas as a determining factor in modeling electricity prices. Furthermore, quantile regression is expected to provide a deeper understanding of how the relationship between natural gas and electricity prices varies at different price levels, offering a more nuanced view of price dynamics in the German energy market.

**Conclusions**

The research highlights the continued reliance of the German electricity market on natural gas prices, despite efforts to transition to renewable energy sources. The combined use of GAS models and quantile regression provides a robust framework for analyzing the relationship between natural gas prices, climatic factors, and electricity prices. This approach offers valuable insights for policymakers and energy market stakeholders in studying the energy transition and ensuring a stable and sustainable energy supply.

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