FROM CLEAN ENERGY TO FERTILIZERS

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Overview

The fertiliser market has faced significant challenges recently, with supply chain disruptions during the COVID-19 pandemic and geopolitical conflicts contributing to price volatility. Brazil's heavy reliance on imported fertilisers, primarily from Russia and neighbouring countries, highlights its vulnerability to external factors, as approximately 86% of fertiliser volume was imported in 2022. Despite efforts outlined in the National Fertiliser Plan (PNF) to enhance domestic production, the country remains dependent on foreign sources in the short term. Additionally, the high cost of natural gas hampers domestic nitrogen fertiliser production, prompting initiatives to leverage green hydrogen and the Haber-Bosch ammonia process to mitigate this reliance.

This scenario extends to the renewable energy sector, where wind energy projects, particularly prevalent in Brazil's Northeast region, face similar challenges of price instability. Surplus wind energy presents an opportunity to produce ammonia and urea, thus offsetting renewable energy surpluses while bolstering domestic fertiliser production. This integrated approach demonstrates the optimisation of industrial processes to align with energy transition goals and agricultural stability.

Methods

Employing Real Options Analysis (ROA), the study evaluates the returns associated with the option to switch between energy and fertiliser production. A comparative analysis is conducted to assess the performance of this flexible approach against conventional energy production methods. Moreover, the study determines the appropriate stochastic process to simulate returns based on historical data analysis. By integrating ROA with Monte Carlo Simulation (MCS), the study aims to estimate the value added by the flexibility inherent in exchanging output streams. This comprehensive approach enables a thorough examination of the financial implications of incorporating flexibility into the operational framework of wind farms, thereby informing strategic decision-making processes within the renewable energy sector. To value production flexibility, we model the prices of urea futures contracts with stochastic models, which is adjusted for the most liquid maturities.

Results

The initial findings suggest that switching between energy and fertiliser production holds significant value compared to conventional energy production methods. Moreover, it surpasses the value of fertiliser production from natural gas due to the additional benefits of carbon credits generated when utilising green hydrogen as a feedstock for green ammonia.

Conclusions

Real options valuation offers a robust framework for evaluating the flexibility inherent in investment opportunities, particularly those characterised by significant uncertainty and the potential to adapt strategies in response to market developments. This analysis underscores the importance of having the flexibility to switch between electricity sales and nitrogenous fertiliser production. The benefits of this flexibility are particularly pronounced when the prices of these outputs are not strongly correlated. Consequently, advanced pricing models play a critical role in assessing the economic viability of investments with diverse outputs.

The research findings hold practical implications for regions with port infrastructure in the Northeast, facilitating the commercialisation of nitrogenous fertilisers. Ports such as Pecém and Aratú exemplify suitable locations for applying the research, given their logistical capabilities and existing infrastructure for electrolysis equipment necessary for ammonia and urea production. By addressing both the energy transition and fertiliser production, this research intersects two crucial themes in the Brazilian economic agenda, aiming to optimise surplus energy for meeting domestic demand for essential agricultural inputs.

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