HEDGING DROUGHT RISK USING A PROPOSED WEATHER DERIVATIVE: THE ROLE OF NATIONAL DROUGHT POLICY

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Overview

Climate change is an external factor of growing importance and consequence in the financial returns of hydroelectric generation in Brazil. Due to the size and diversity in the country's hydrological regimes, there is a high reliance on hydroelectric power in the energy matrix. Thus, reservoirs play an important role in increasing the system's reliability of supply at low economic cost: they store water in the wet years, in which inflow energy is favorable, in order to allow energy production in the dry years (Bezerra et al., 2010). However, there is a great variability in hydroelectric inflow energy from year to year, which impacts the hydropower business model.

In recent years there has been worldwide concern that droughts may be increasing in frequency, severity, and duration due to changing climatic conditions (Peterson et al., 2013). Particularly, since 2014 Brazil has been experiencing one of the most severe droughts in decades. This rainfall deficiency has generated water shortages and a water crisis that has affected hydropower producers and the national economy (Fernandes et al., 2018). A drop in power generation reduces the ability of a hydro business to meet its contractual obligations and may create a state of financial distress. In addition, unexpected measures by the government to control this crisis increased the vulnerability to future hydropower returns. Due to these factors, the adoption of a hedge model that can provide a safety net for the hydropower producers that are most vulnerable while promoting a national drought policy based on the concept of risk reduction is necessary. In this line, weather derivative contracts such as swaps, collars, straddles, put or call options and futures. can be used to mitigate climate risk (Thind, 2014).

The purpose of this paper is to introduce a new swap contract to hedge hydrological risk. More specifically, our aim is: (i) to define a methodology for measuring a customized swap contract of a generation system; (ii) to use this methodology to analyze the current long-term contract model of the Brazilian system; (iii) to analyze the impact of the hedge on the expected revenue of hydro power plants for the next years and (iv) to propose public policies to introduce this new mechanism in the market.

We focus on weather derives for two reasons. First, energy derivatives are emerging as remarkable asset class. The range of products offered to investors range from exchange traded funds to sophisticated products. Second, derivative contracts as risk management tools are necessary and useful for hydropower investors. Today, it becomes an instrument to protect the business activities of the enterprise (Bertrand and Parnaudeau, 2017). To the best of of knowledge, no research has yet discussed this new type of swap contract in Brazil.

Methods

We propose a customized swap model to mitigate the hydrological risk of the Brazilian electricity system. A closed form analytic pricing formula is derived and we determine the fair market price for this energy derivative contract.

The swap is structured in such a way that for each fixed megawatt hour (MWh) delivered to a generator committed to long-term energy contract, the trader receives a quantity of floating energy. The generator receives fixed amounts of energy whenever it deliver a floating quantity indexed to the GSF scaling factor (GSF), which is the relation between the volume of energy effectively generated by the system and the total plant's capacity. The physical guarantee is determined considering that this generation level will be achieved with a 95% confidence interval. The difference between the plant's physical guarantee and the factor of protection FP is the floating amount, i.e, the energy that is available for swapping. The trader receives the factor of floating energy FFE for each MW available to a hydroelectric plant. The uncertainty of the model is in the GSF factor.

Results

Our model conveys important results. In summary, the swap derivative added value to the hydroelectric investment and mitigated the hydrological risk. Also, the swap showed to have the highest impact on revenue compared with the traditional model. Moreover, our model proved to be an efficient instrument to reduce risk while interacting with policies planning process. Therefore, our results suggest that the proposed swap is an efficient hedge mechanism for the hydropower generator, as it increases the expected revenue while still mitigating risk.

Conclusions

This study has important implications for hydropower business research as it brings into focus the importance of considering increasing drought risks as the effects of climate change can generate financial losses and drops in cash inflows and adversely affect hydropower business investments. We customize the swap derivative to protect hydropower generators against the hydrological risk in the Brazilian electricity market and test our model with a representative hydropower generator and run monthly simulations for market price and power generation. The results indicated an appropriate performance of the proposed model to mitigate risk.

References

Bertrand, J.-L. and Parnaudeau, M. (2017), ‘Understanding the economic effects of abnormal weather to mitigate the risk of business failures’, Journal of Business Research .

Bezerra, B., Barroso, L. A., Brito, M., Porrua, F., Flach, B. and Pereira, M. V. (2010), Measuring the hydroelectric regularization capacity of the brazilian hydrothermal system, in ‘Power and Energy Society General Meeting, 2010 IEEE’, IEEE, pp. 1–7.

Fernandes, G., Gomes, L. L. and Brandão, L. E. T. (2018), ‘A risk-hedging tool for hydro power plants’, Renewable and Sustainable Energy Reviews 90, 370–378.

Peterson, T. C., Hoerling, M. P., Stott, P. A. and Herring, S. C. (2013), ‘Explaining extreme events of 2012 from a climate perspective’, Bulletin of the American Meteorological Society 94(9), S1–S74.

Thind, S. (2014), ‘As temperatures tumble in north america, weather derivatives warm up’, Institutional Investor .