Working papers economics - From Climate Shocks to Financial Risk: A Framework Applied to the Colombian Hydropower Sector

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How do climate risks affect hydropower generation and the financial sector in Colombia? This paper develops an integrated, forward-looking framework to analyze how precipitation shocks associated with the El Niño phenomenon are transmitted to hydropower generation and the financial performance of hydropower-generating firms, in order to identify their financial vulnerability and, ultimately, assess the credit risk of financial institutions in Colombia.

Publication Date: Friday, 20 of November 2026 **Approach**
Drawing on estimates fromplant-level hydropower production models, firm-level financial statements, credit registry supervisory data, and climate scenarios projections, this paper develops an integrated, forward-looking climate stress-testing framework. The framework analyze the transmission of precipitation shocks associated with the El Niño episodes to hydroelectric power generation, the financial performance of hydropower-generating firms, and ultimately, the credit risk of financial institutions in Colombia.

Contribution
This paper makes three main contributions to the literature. First, it develops a forward-looking framework to analyze the transmission of precipitation shocks to credit risk of financial institutions in Colombia. Second, to the best of our knowledge, this is one of the first applications to combine climate scenarios with econometric hydropower production models to quantify how physical risk affects the financial resilience of electricity-generating firms under different emissions pathways. Third, the proposed framework provides a practical methodology that enables central banks and financial supervisors to identify vulnerable sectors, firms, and credit exposures, thereby facilitating the incorporation of sector-specific physical climate risks into climate stress-testing exercises.

Results
The results show that while abundant rainfall only modestly increases electricity generation, drought conditions associated with the El Niño phenomenon result in substantially larger reductions. This asymmetry reflects the characteristics of the Colombian electricity system, in which hydropower accounts for the largest share of total electricity generation under normal hydrological conditions. Consequently, additional rainfall offers limited scope for increasing production, whereas water scarcity directly constrains water inflows into reservoirs and

hydropower generation capacity.

Furthermore, projections under climate scenarios associated with higher greenhouse gas emissions results in larger contractions in hydroelectric generation. These reductions constitute the main physical shock considered in the proposed framework and provide the basis for simulating its effects on the financial performance of electricity-generating firms.

Lower hydroelectric generation reduces firms' revenues in proportion to their dependence on this energy source. Although the magnitude of the shock varies across firms, those with greater reliance on hydroelectric generation experience the largest deterioration in operating profitability. In addition, the need to purchase electricity in the wholesale market to cover generation shortfalls increases their operating costs. The combined effect of lower revenues and higher costs results in a decline in earnings before interest and taxes (EBIT) and, consequently, weakens firms' ability to meet their financial obligations, generating spillover effects onthe financial sector.Moreover, although banks' aggregate exposure to financially vulnerable firms is relatively limited, the impact varies across institutions depending on the concentration of their credit exposures to vulnerable firms within the electricity generation sector.

These results highlight the importance of incorporating physical risks into financial stability analysis, particularly in sectors whose activities depend directly on environmental conditions. Specifically, they underscore the need for financial institutions and supervisory authorities to assess their portfolios' exposure to firms vulnerable to climate stress scenarios, in order to identify potential deterioration in credit quality at an early stage and strengthen the management of financial risks associated with physical risks.

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