Working Papers Economics - Dynamic Balance Sheet Simulation and Credit Default Prediction: A Stress Test Model for Colombian Firms

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The proposed model is structured into three interrelated blocks that enable dynamic simulation of non-financial firms' balance sheets and the forward-looking assessment of credit risk under an adverse macroeconomic scenario.

Publication Date: Friday, 29 of August 2025 **Approach**
This document presents a stress testing model designed to assess, from a forward-looking perspective, the financial vulnerability of non-financial corporations in Colombia. This tool is used by the Financial Stability Department of Banco de la República (the Central Bank of Colombia) as part of its monitoring and surveillance functions regarding the risks faced by the corporate sector—one of the main borrowers in the Colombian financial system.

Contribution
Following the 2008 global financial crisis, regulatory and supervisory authorities widely adopted stress testing models as key tools to quantify the resilience of the financial system under extreme scenarios, based on restrictive behavioral assumptions. Later, the COVID-19 crisis—characterized by simultaneous supply and demand shocks and high levels of uncertainty—highlighted the need to complement these exercises with tools that allow for early assessment of the corporate sector's financial health. This need arises from two main reasons: (i) the sector's relevance to financial stability, both through its role in the credit market (direct channel) and in the broader economy (indirect channel), and (ii) the limited availability of high-frequency financial information on firms.

In this context, the document presents an innovative methodological framework that extends the scope of traditional stress testing to the non-financial corporate sector. The proposed tool combines dynamic balance sheet simulations with credit default probability estimates using machine learning models, under an adverse macroeconomic scenario. This tool enhances Banco de la República's capacity to monitor and assess corporate sector risks from a forward-looking perspective, supports the preparation of the semiannual Financial Stability Report, and contributes to policy design by enabling the early identification of vulnerable firms.

Results
The proposed model consists of three interrelated blocks that allow for the simulation and assessment of credit risk for non-financial firms under an adverse macroeconomic scenario. The first block, based on accounting

rules and econometric relationships, performs a dynamic simulation of firms' balance sheets and projects, for the 2024–2025 horizon, a contraction in sales, a decline in return on assets (ROA) and the interest coverage ratio (ICR), and an increase in financial leverage, in line with the adverse scenario outlined in the second-half 2024 Financial Stability Report of Banco de la República.

Out-of-sample validation suggests that the model adequately reproduces the observed distribution of operating profits and ROA, although it tends to overestimate leverage ratios and the share of firms with ICR below one—consistent with a conservative approach recommended for stress testing exercises.

The second block uses machine learning techniques to estimate the probability of credit default. Among the models analyzed—including logistic regression and tree-based models—XGBoost stood out for its superior out-of-sample performance.

Finally, the third block integrates the results from the previous two to identify firms with the highest probability of default. These firms generally exhibit higher leverage and lower profitability, ICR, and operational revenue growth in the preceding period compared to firms not classified as in default.