

This issue of Research Highlights reviews the following subjects that have been recently analyzed at the Central Bank of Chile (CBC):

- Tail-Risk Indicators with Time-Variant Volatility Models: The Case of the Chilean Peso.
- Heterogeneous UIPDs across Firms: Spillovers from U.S. Monetary Policy Shocks.
- The Effect of Automation on the Labor Market: An Approach Using Firm-Level Microdata.

Tail-Risk Indicators with Time-Variant Volatility Models: The Case of the Chilean Peso

The spot currency market is of great global significance due to its depth and the fundamental economic role, as it enables international trade by converting one currency into another. This market is also the largest in the world, with daily transactions of around US\$7.5 trillion, and it is highly dynamic in financial centers such as New York, London, and Hong Kong. To properly assess its functioning and associated tail risks, it is essential to consider time-varying volatility models, which help capture extreme episodes.

In the working paper [“Tail-Risk Indicators with Time-Variant Volatility Models: The Case of the](#)

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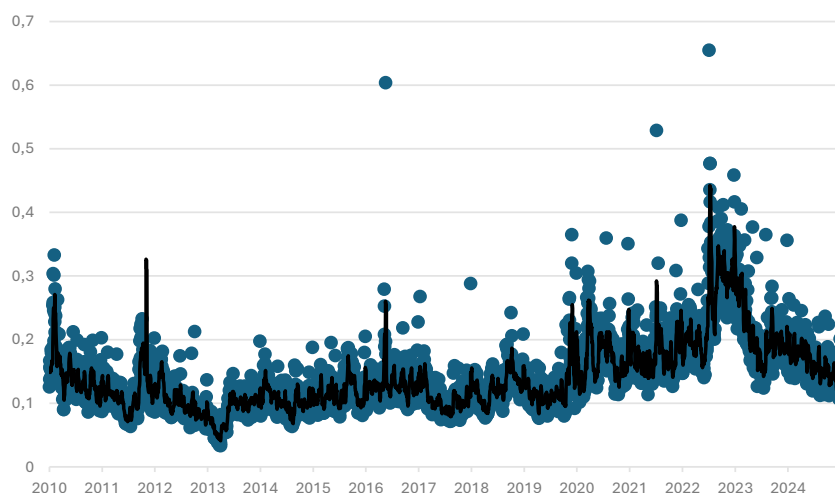
[Chilean Peso.”](#) Central Bank of Chile economist Catalina Estefó and International Monetary Fund economist Rodrigo Alfaro propose a framework for constructing tail risk indicators for the Chilean peso (CLP) based on time-variant volatility models. The study uses three sources of informa-

tion: i) daily returns on the CLP, ii) implied volatility (IV) obtained from option contracts, and iii) realized volatility (RV), calculated using intraday data from transactions on the Datatec platform. The authors' objective is to assess the extent to which the inclusion of these volatility measures improves the estimation and allows for the design of useful indicators for extreme risk scenarios.

The first contribution of this work is that it introduces VR measures to check how well the market is working. This is the standard deviation of intraday returns and shows how much the exchange rate actually changes during the day. Unlike IV, which is inferred from option prices and therefore reflects future expectations, VR is constructed from transactions observed in the foreign exchange market itself. As a result, it provides a direct, real-time indicator of the intensity of CLP movements, that is also analyzed by the authors during the most liquid hours of the day.

Figure 1 shows that the Chilean peso's RV has increased steadily over the last five years, with particularly sharp jumps during the pandemic period (2020–2022). These results underscore the usefulness of RV in charac-

Figure 1: Realized Volatility



Notes: The Figure shows an index of realized volatility (RV) of the CLP for the period 2010-2014. The index considers a moving average for the RV of 5 working days.

terizing episodes of turbulence in the Chilean foreign exchange market and justify its inclusion in conditional volatility models.

The study also estimates the parameters of different time-varying volatility models. Standard GARCH models (GARCH, NGARCH, and TGARCH), EGARCH, and two discrete-time stochastic volatility approaches are considered: the Heston-Nandi (2000) model, proxied by an asymmetric GARCH, and the Taylor (1982) model, which models the logarithm of variance as an autoregressive process. For each case, the

authors compare specifications that incorporate only daily returns with those that also include implied and realized volatility. The results show that both IV and RV contain relevant additional information and that their inclusion significantly improves the in-sample fit of these models. Thereby, the combination of both measures produces the most accurate estimates of CLP volatility.

Finally, following the methodological proposal of Lafarguette and Veyrune (2021), the authors develop a framework to quantify tail risks using Monte Carlo simulations. This methodology is

applied to the estimated models and enables the generation of return distributions under different initial volatility scenarios. The exercises show, for instance, that when volatility is initially high, the range of possible cumulative losses and gains for the CLP widens significantly, reaching variations of between -9% and 11% in one-month horizons.

Heterogeneous UIPDs across Firms: Spillovers from U.S. Monetary Policy Shocks

In the last few decades, capital flows to emerging economies have been heavily influenced by US monetary policy, especially by changes in the federal funds rate (FFR). These changes affect the external and domestic financing conditions of banks and firms. However, the literature has paid little attention to how these shocks are transmitted heterogeneously at the firm level, particularly in terms of financing costs in local and foreign currency, raising questions about pass-through mechanisms and their implications for macroeconomic policy.

The paper [“Heterogeneous UIPDs across Firms: Spillovers from U.S. Monetary Policy Shocks.”](#) co-authored by senior economist [Miguel Acosta](#) and junior economist Montserrat Martí, both from the Central Bank of Chile, together with María Alejandra Amado (Banco de España), and David Pérez (Universidad de Los Andes, Colombia), examines how US monetary policy shocks affect deviations from uncovered interest rate parity (UIPD) at the firm level in Chile (i.e., the cost of borrowing in pesos relative to dollars net of expected exchange rate depreciation). For this purpose, they construct a dataset that links Chilean firms’ bank loans with their banks, including information on amounts, rates, and currencies, along with data on banks’ external financing and characteristics of firms’ performance over time. The analysis focuses on how these shocks affect the cost of borrowing for banks and, through them, the financing costs of firms according to their size and loan currency. They develop a theoretical model of a small open economy with corporate default risk, where firms are heterogeneous in their productivity and finance themselves in both pesos and dollars.

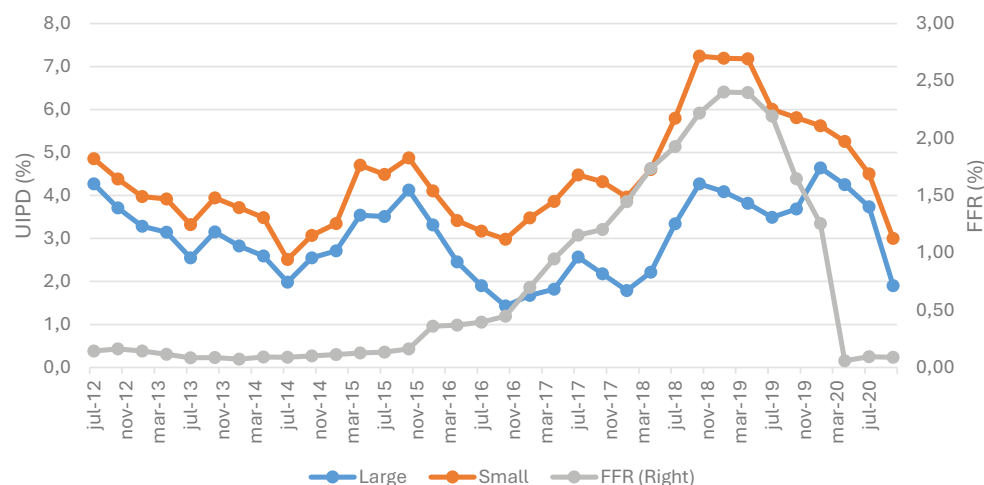
“Our main finding is that monetary tightening in the United States increases the cost of dollar funding for banks in Chile, which disproportionately drives up the cost of local currency funding for small firms relative to large ones. When interest rates on dollar debt increase uniformly across firms, interest rates on loans in pesos increase significantly more for small firms.”

Empirically, the authors find that an increase in the FFR raises banks’ external financing costs, which translates into higher UIPDs for small firms relative to large ones. Underlying this result is an increase in local currency interest rates for small firms compared to large firms (Figure 2). In contrast, dollar rates show no significant differences between firms, and no differentiated effects are observed in credit amounts, suggesting an active response from both the supply and demand side. These results are robust to multiple specifications and are not due to changes in debt composition or firm selection, but rather to a pricing mechanism that reflects the interaction between banking decisions and firms’ optimal choice of debt portfolios.

The theoretical model replicates these patterns: when the FFR rises, banks face higher funding costs, making loans more expensive. Larger firms maintain their risk profiles, leaving their UIPDs unchanged, while smaller, more vulnerable firms face a higher risk of default in pesos, raising their UIPDs. This occurs because the cost of non-payment in dollars is higher, creating asymmetric incentives for less productive firms to default in pesos. At the macroeconomic level,

these mechanisms imply that US monetary policy not only affects aggregate conditions but also distorts the relative cost of capital – impacting smaller and less diversified firms more severely. In addition, the benefits of partial dollarization may be reduced by this increased vulnerability, highlighting a potential stabilizing role for local monetary policy in the face of external shocks.

Figure 2: UIPD at firm level by size and FFR



Notes: The figure depicts the average UIPD across firms per quarter between 2012 and 2020 for small (orange) and large (blue) firms, along with the FFR (gray). The firm-level UIPD is calculated as the firm-level interest rate differential (rate in pesos minus rate in dollars) on its loans, adjusted by expected exchange rate depreciation.

The Effect of Automation on the Labor Market: An Approach Using Firm-Level Microdata

Technological breakthroughs allow certain tasks previously performed by humans to be fully or partially replaced by machines. A natural consequence of this phenomenon is job displacement; although complementary relationships may also exist, since machines capable of automating tasks require highly skilled workers for their design, maintenance, and operation. The literature looking at the automation phenomenon focuses on general equilibrium models (which often make assumptions about the elasticity between machines and employment) or use the risk of automation as a proxy for that elasticity.

The paper [“The Effect of Automation on the Labor Market: An Approach Using Firm-Level Microdata,”](#) authored by economist Camilo Levenier of the Central Bank of Chile, contributes to the literature on automation through an empirical approach. The study examines the relationship between machines and employment across different income quintiles of workers, using firm- and worker-level microdata from 2009 to 2023 for Chile.

“[...]automation has a predominantly negative relationship with employment, especially for workers in the middle-income quintile; however, this relationship is positive in the high-income quintiles, supporting the idea that technological development requires highly skilled workers.”

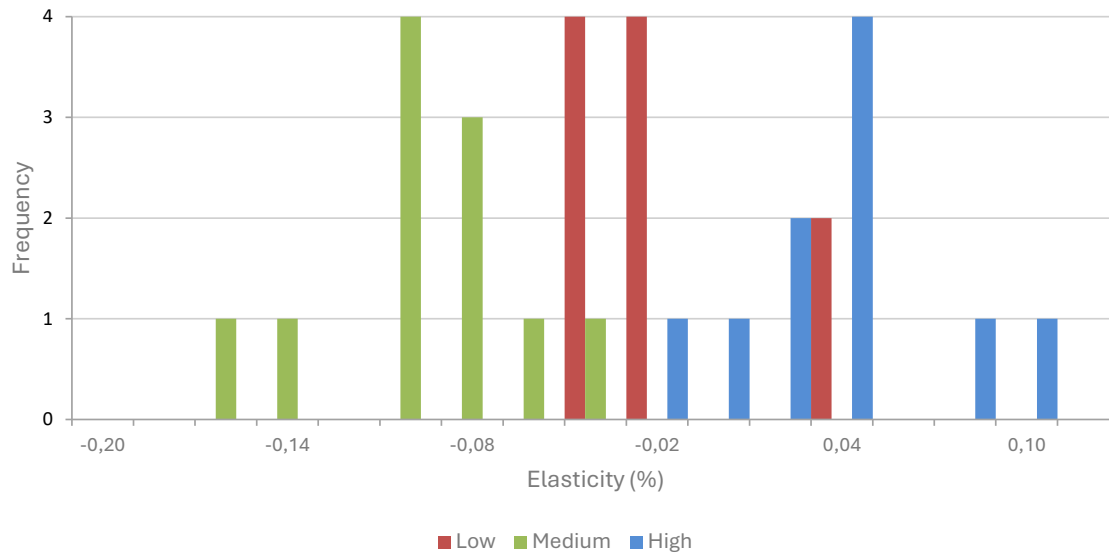
The dataset includes approximately 80,000 firms and 2,900,000 workers. To investigate this phenomenon, the author estimates panel regressions, modeling employment by quintiles as a function of machines and a set of other variables. In addition, he uses a generalized propensity score (GPS) to mitigate the problem of endogeneity.

The findings indicate that the relationship between machines and employment is predominantly negative (Figure 3), especially for workers in the middle-income quintile. The results also suggest that the relationship between machines and employment in the high-income quintiles

is positive, supporting the idea that technological development requires highly skilled workers.

Generally speaking, the results suggest that automation in the Chilean labor market has had mixed effects on employment, and that these effects are more moderate than the literature suggests. However, the rapid advancement of artificial intelligence may amplify the effects of automation on employment in the future.

Figure 3: Machinery employment elasticity by wage quintile (%)



Notes: The figure plots the histogram of the employment elasticity of machinery by wage quintile and sector.

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- Albagli, E., Arias, A. & Kirchner, M. (2024). "Collective Savings Pension Policy in an Economy with Heterogeneity and Informality". *Estudios de Economía*, 51(2): 325-381.
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- García, B., & Skaperdas, A. (Forthcoming). "Central Bank Independence at Low Interest Rates". *Journal of Money, Credit, and Banking*.
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