

Interest rate differential and depreciation shocks on credit dollarization of firms in Peru: Does firm size matter?

The views expressed in this working paper correspond to those of the authors and do not necessarily reflect the position of the Central Reserve Bank of Peru.

1. Introduction: motivation

- Credit dollarization in emerging markets reflects complex macro-financial dynamics, notably exchange rate fluctuations and interest rate differentials.
- Heterogeneous responses across firm sizes remain relatively underexplored (Beck et al., 2008; Di Giovanni et al., 2024), despite evidence of differential pass-through (Amado, 2022; Gutierrez et al., 2023).
- Peru offers a unique case:
 - High historical dollarization, declining with policy interventions (e.g., de-dollarization program, 2013–2014).
 - Diverse firm landscape, from corporates to microenterprises.
- Key question: How do depreciation and interest rate shocks affect credit dollarization across firm sizes in Peru?

1. Introduction: main ideas (1)

- Larger firms exhibit resilience to depreciation and interest rate differential shocks:
 - Access to hedging and alternative financing reduces sensitivity (Brown et al., 2011b; Hardy, 2023).
- Smaller firms are more vulnerable:
 - Stronger responses to depreciation (reduced dollarization) and interest rate differentials (increased dollarization).
- Policy impacts:
 - De-dollarization program (2015–2016) reduced dollarization in larger firms.
 - Pandemic credit support amplified spillovers, affecting mainly medium/large firms.

1. Introduction: main ideas (2)

- Spillover analysis reveals dynamic transmission:
 - Higher spillovers during Covid-19; lower for microenterprises overall.
 - Large/medium firms: Net transmitters; small/micro: Net receivers.
- Policy implications:
 - Tailored interventions needed—systemic measures alone insufficient.
 - De-dollarization and liquidity policies effectively target larger firms.

3. Methodology

- We analyze the responses of credit dollarization by firm-size segment to macro-financial shocks using a Bayesian Panel Vector Autoregression (PVAR) model.
 - Firm-size dynamics: Estimates heterogeneity across firm groups (corporates, large, mid-sized, small, and micro firms).
 - Common structure: Shared dynamics across all firm groups.
 - Macro-financial shocks: Impact of exogenous variables on credit dollarization.
- The model follows the frameworks of Jarociński (2010) and Canova & Ciccarelli (2013).

3.1 Methodology: Bayesian Panel VAR Model

- The model is specified as:

$$Y_{it} = Y_{i,t-1}B_{1i} + Y_{i,t-2}B_{2i} + \cdots + Y_{i,t-p}B_{pi} + C_{it}x_t + \epsilon_{it},$$

where:

- $i = 1, \dots, N$ refers to firm size groups.
- $t = 1, \dots, T$ to periods.
- $Y = (\text{Capital flows, Dollar deposit, Credit growth, Depreciation, Interest differential, Dollarization})$.
- We consider $N = 5$ firm size groups: corporates, large firms, mid-sized, small and micro firms.

3.1 Methodology: Exogenous variables

The exogenous variables included are:

- Terms of Trade: External sector impact.
- Federal Funds Rate: Global interest rates.
- EMBIG Peru Index: Sovereign risk indicator.
- GDP Growth: Real economic shocks (e.g., pandemic effects).
- Central Bank Liquidity: Policies.

3.1 Methodology: Recursive identification strategy

Structural Shock Decomposition:

- Recursive ordering based on exogeneity:
- Capital flows → Dollar deposit growth → Credit growth → Exchange rate depreciation → Interest rate differential → Credit dollarization.

Rationale:

- External shocks first (capital flows, dollar deposit growth).
- Real sector dynamics (credit growth, exchange rate depreciation).
- Financial variables last (interest rate differentials, credit dollarization).

This ordering reflects the anticipated transmission mechanisms across variables.

3.2 Methodology: Spillover index approach D&Y(2012)

The spillover index is constructed using the Cholesky matrix P with the vector moving average representation:

$$Y_t = c + \sum_{h=0}^{\infty} A_h \epsilon_{t-h}$$

Where:

- A_h obeys a recursion: $A_h = B_1 A_{h-1} + B_2 A_{h-2} + \dots + B_p A_{h-p}$,
- A_0 is the identity matrix.

The forecast error and its covariance are computed as:

$$\xi_t(H) = \sum_{h=0}^{H-1} A_h \epsilon_{t+H-h}, \quad \text{cov}(\xi_t(H)) = \sum_{h=0}^{H-1} A_h \Sigma_{\epsilon} A_h'$$

3.2 Methodology: Connectedness measures

Contribution of variable j to Forecast Error Variance of i :

$$\theta_{ij}^c(H) = \frac{\sum_{h=0}^{H-1} (e_i' A_h P e_j)^2}{\sum_{h=0}^{H-1} (e_i' A_h \Sigma A_h' e_i)}$$

$$\tilde{\theta}_{ij}^c(H) = \frac{\theta_{ij}^c(H)}{\sum_{j=1}^N \theta_{ij}^c(H)}$$

Total Connectedness Index (TCI):

$$TCI = \frac{\sum_{i,j=1, i \neq j}^N \tilde{\theta}_{ij}^c(H)}{\sum_{i,j=1}^N \tilde{\theta}_{ij}^c(H)} = \frac{\sum_{i,j=1, i \neq j}^N \tilde{\theta}_{ij}^c(H)}{N}$$

This measures the overall spillover effects across all variables in the system.

3.2 Methodology: Directional spillovers

Directional Spillovers (D.S.):

$$TO_{\bullet \leftarrow i} = \frac{\sum_{j=1, j \neq i}^N \tilde{\theta}_{ji}^c(H)}{\sum_{i,j=1}^N \tilde{\theta}_{ji}^c(H)} \times 100$$

Measures the spillovers transmitted by variable i to all other variables.

$$FROM_{i \leftarrow \bullet} = \frac{\sum_{j=1, j \neq i}^N \tilde{\theta}_{ij}^c(H)}{\sum_{i,j=1}^N \tilde{\theta}_{ij}^c(H)} \times 100$$

Measures the spillovers received by variable i from all other variables.

Net Directional Spillover:

$$NET_i = TO_{\bullet \leftarrow i} - FROM_{i \leftarrow \bullet}$$

This captures the net spillover of shocks within the system.

4. Data

Covers 2010-2024 with 153 monthly observations.

Key variables by firm size:

- Credit dollarization ratio
- Interest rate differential
- Credit growth

Key variables:

- Capital (in)flows
- Dollar deposits
- Depreciation

Exogenous variables:

- GDP growth
- Terms of trade
- EMBIG
- Federal funds rate
- Liquidity

4. Data

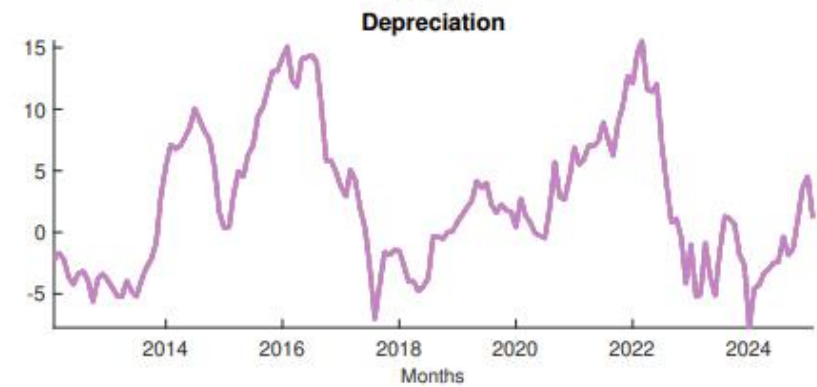
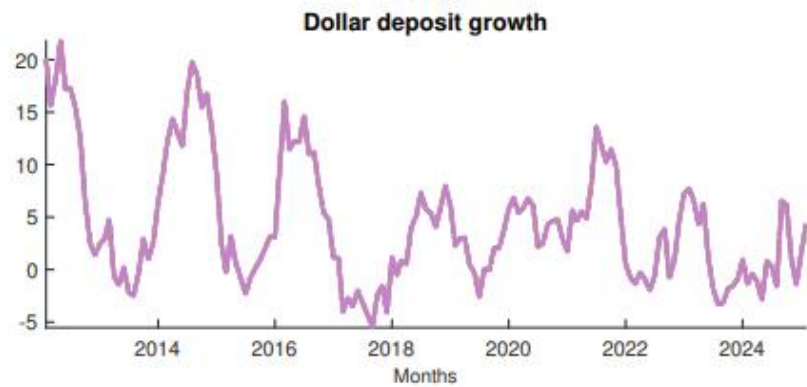
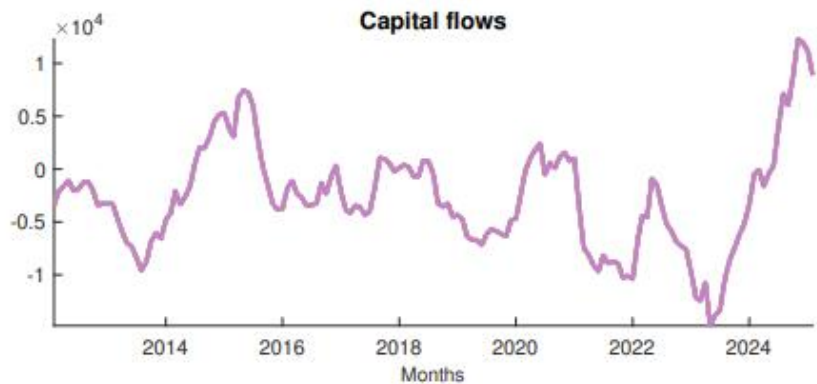
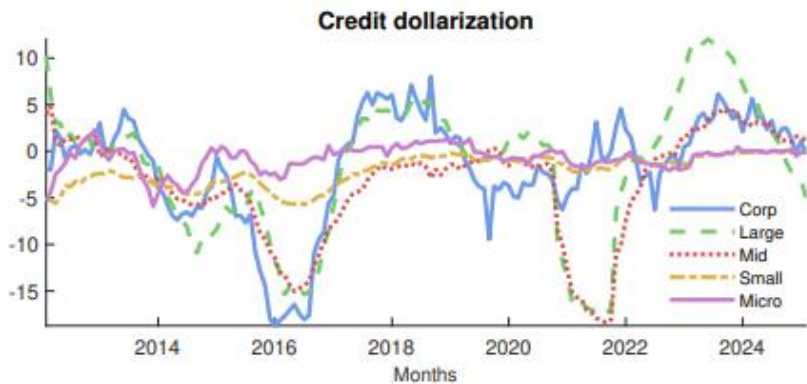
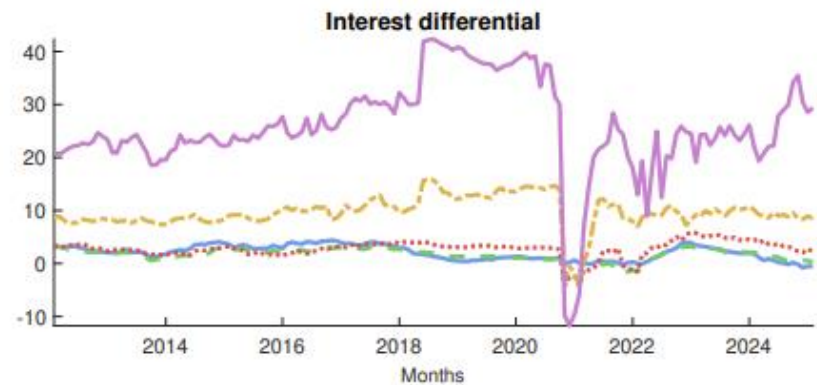
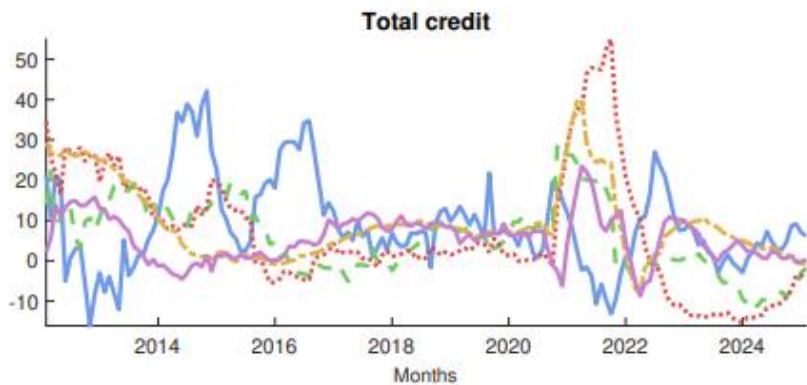
Table: Statistic description of variables

Variable	Mean	Median	Max.	Min.	Std. D.	Skewness	Kurtosis	Jarque-Bera	ADF	Obs.
Dollarization										
Corporate	-1.660	-0.470	8.010	-18.720	5.808	-1.146	4.247	44.528*	-2.025(0)	157
Large	-1.571	0.020	12.030	-17.320	7.357	-0.490	2.634	7.159**	-2.927(3)**	157
Mid-size	-3.418	-1.710	4.800	-18.430	5.599	-1.028	3.376	28.595*	-2.785(3)***	157
Small	-2.062	-1.550	-0.020	-5.700	1.633	-0.635	2.278	13.954*	-2.054(1)	157
Micro	-0.742	-0.420	2.300	-5.930	1.402	-1.113	4.614	49.480*	-3.908(0)*	157
Interest Differential										
Corporate	2.040	2.130	4.390	-0.800	1.379	-0.104	1.765	10.264*	-1.779(3)	157
Large	1.639	1.960	3.220	-3.300	1.225	-1.401	5.417	89.571*	-2.644(0)***	157
Mid-size	2.737	2.970	5.870	-4.200	1.631	-1.672	7.597	211.404*	-3.808(3)*	157
Small	9.680	9.350	15.780	-4.090	3.053	-1.380	8.320	234.937*	-3.631(0)*	157
Micro	25.875	24.400	42.330	-11.760	9.009	-1.144	7.343	157.632*	-3.143(0)**	157
Credit Growth										
Corporate	9.038	6.910	42.120	-16.120	11.326	0.736	3.477	15.665*	-3.167(0)**	157
Large	5.813	6.411	28.982	-11.413	9.024	0.293	2.449	4.231	-2.243(0)	157
Mid-size	6.785	2.189	54.994	-15.334	15.312	0.933	3.651	25.559*	-2.100(13)	157
Small	9.349	7.216	40.124	-7.807	9.364	1.142	3.703	37.352*	-2.744(1)***	157
Micro	5.518	5.600	23.439	-8.676	5.654	0.266	3.142	1.978	-2.957(4)**	157
Capital Flows	-2670	-3259	12292	-14807	5024	0.408	3.536	6.232**	-2.335(1)	157
Dollar Deposit	4.407	3.044	21.776	-5.525	6.000	0.856	3.032	19.166*	-5.619(5)*	157
Depreciation	2.468	1.450	15.530	-7.740	5.739	0.502	2.308	9.720*	-2.110(0)	157
GDP Growth	3.270	3.350	60.070	-39.240	8.573	1.473	24.329	3032.648*	-4.436(3)*	157
Terms of Trade	0.734	-0.318	21.744	-16.122	8.689	0.333	2.444	4.916***	-2.454(0)	157
EMBIG Peru	170	166	282	108	35	0.696	3.377	13.595*	-3.485(0)*	157
Federal Funds Rate	1.269	0.340	5.330	0.050	1.708	1.441	3.753	58.043*	-1.147(3)	157
Liquidity Policy	1661	0	48177	-20598	14942	1.379	4.883	72.943*	-2.616(2)	157

Notes: *** denotes significance at 1%, ** at 5%, * at 10%. ADF denotes the ADF unit root test, and the optimal lag order based on the Schwarz Information Criterion is shown in parentheses.

1/ As of October 2024, the Peruvian bank system classified 912 firms as corporate, 4,189 as large, 46,384 as medium-sized, 345,889 as small, and 580,964 as microenterprises.

4. Data: Key variables

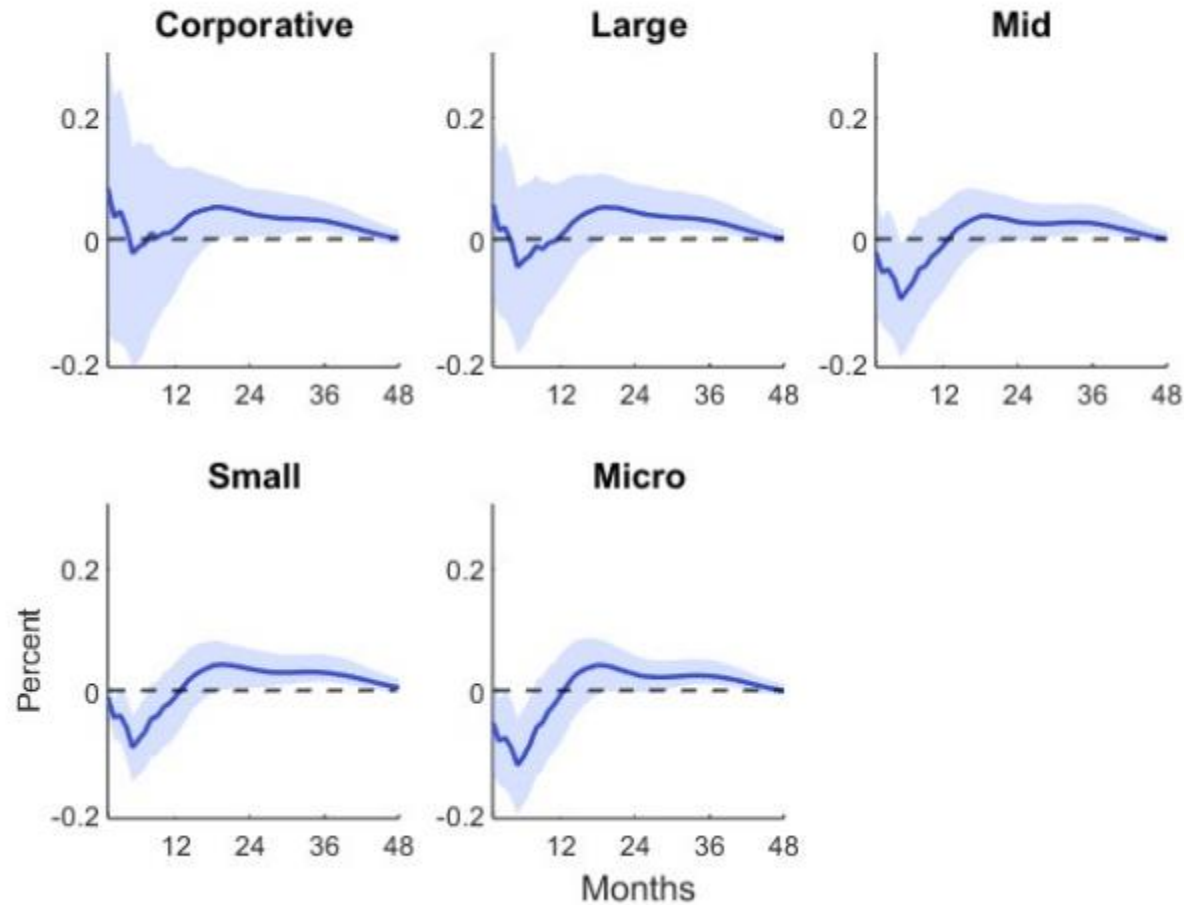


5. Results

- Panel VAR decomposes shocks affecting credit dollarization by firm size.
- Exchange rate depreciation shocks have a negative impact on credit dollarization across all firm types.
- Corporate firms appear to have no significant response to either depreciation or interest rate differential shocks.
- Smaller firms, particularly small and micro firms, exhibit more pronounced responses to both depreciation and interest rate differential shocks.
- Appendix illustrates the responses of dollarization to shocks in exogenous variables.

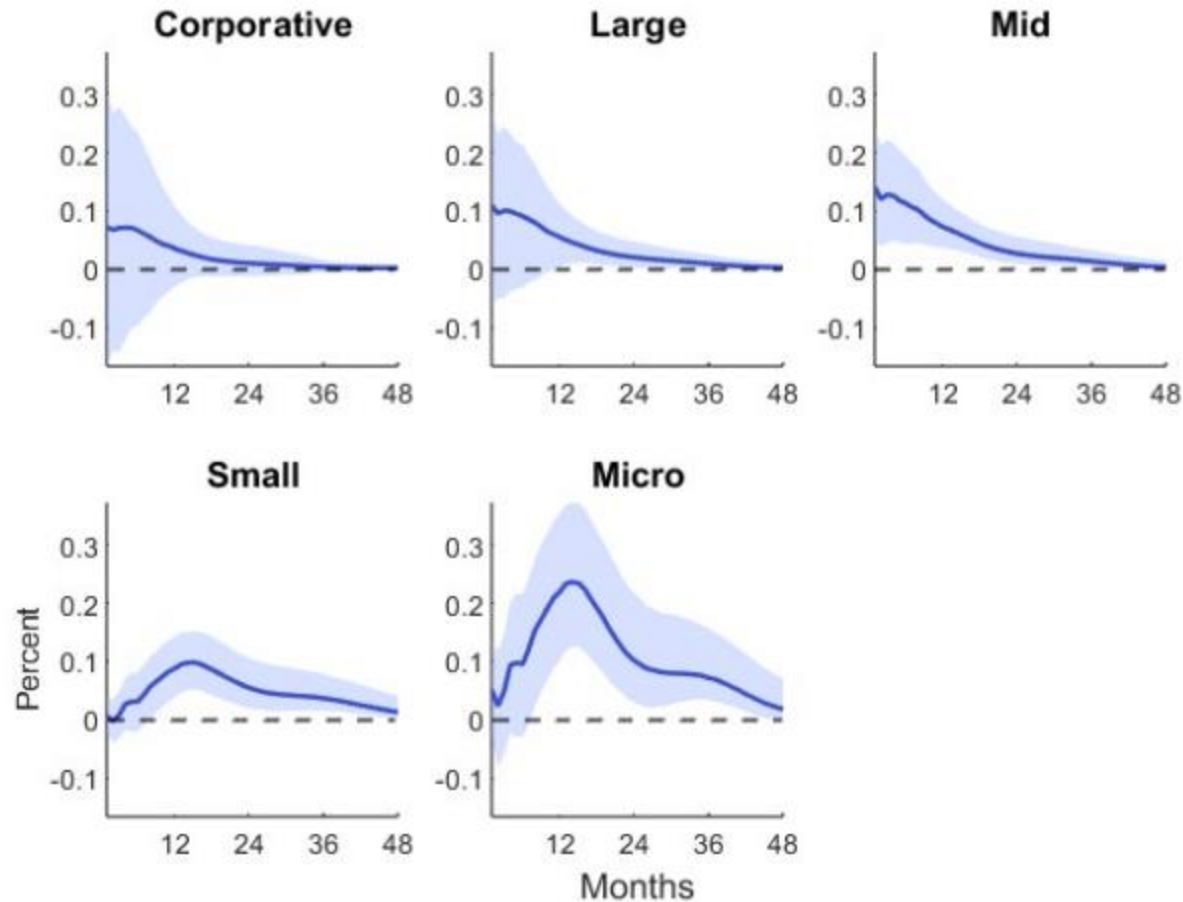
5.1 Results: Response to shocks

Response of credit dollarization to depreciation shock



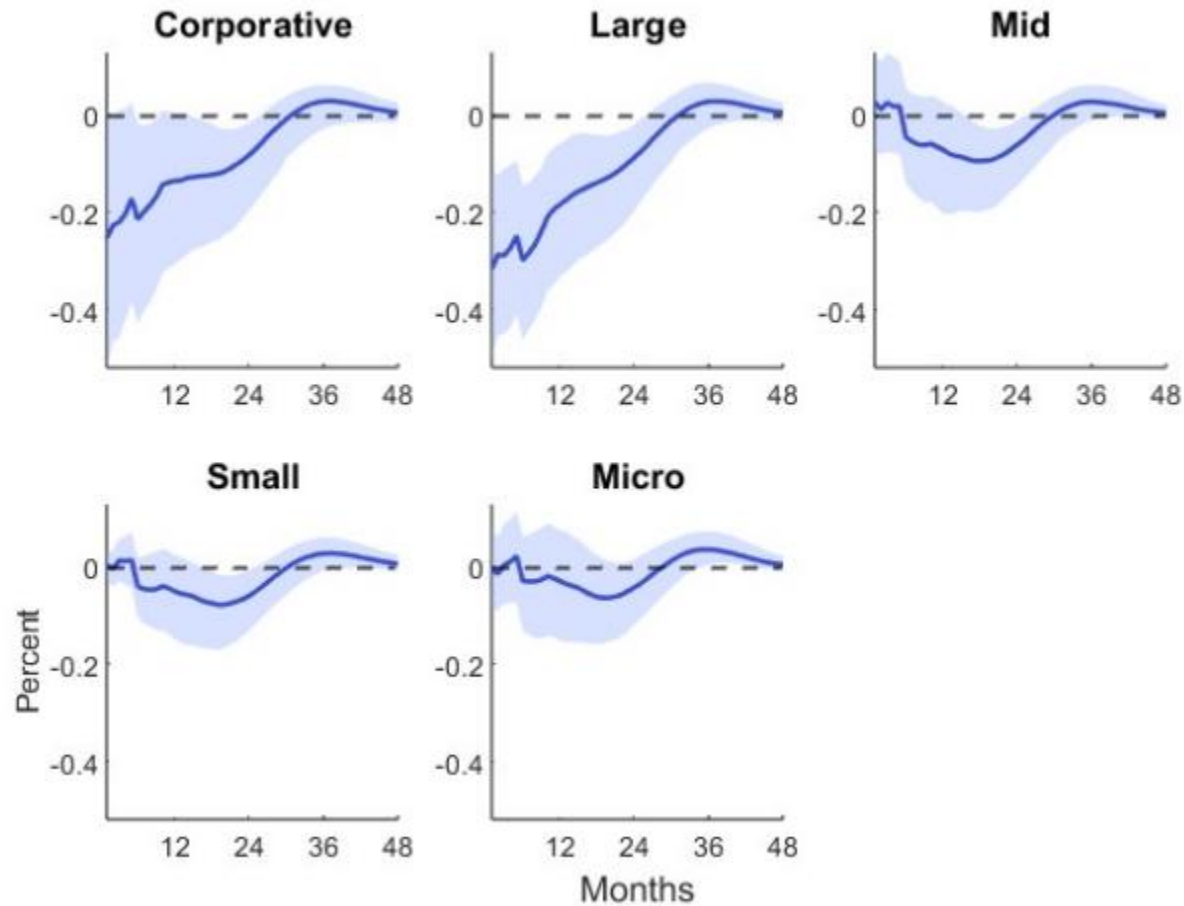
5.1 Results: Response to shocks

Response of credit dollarization to interest rate differential shock



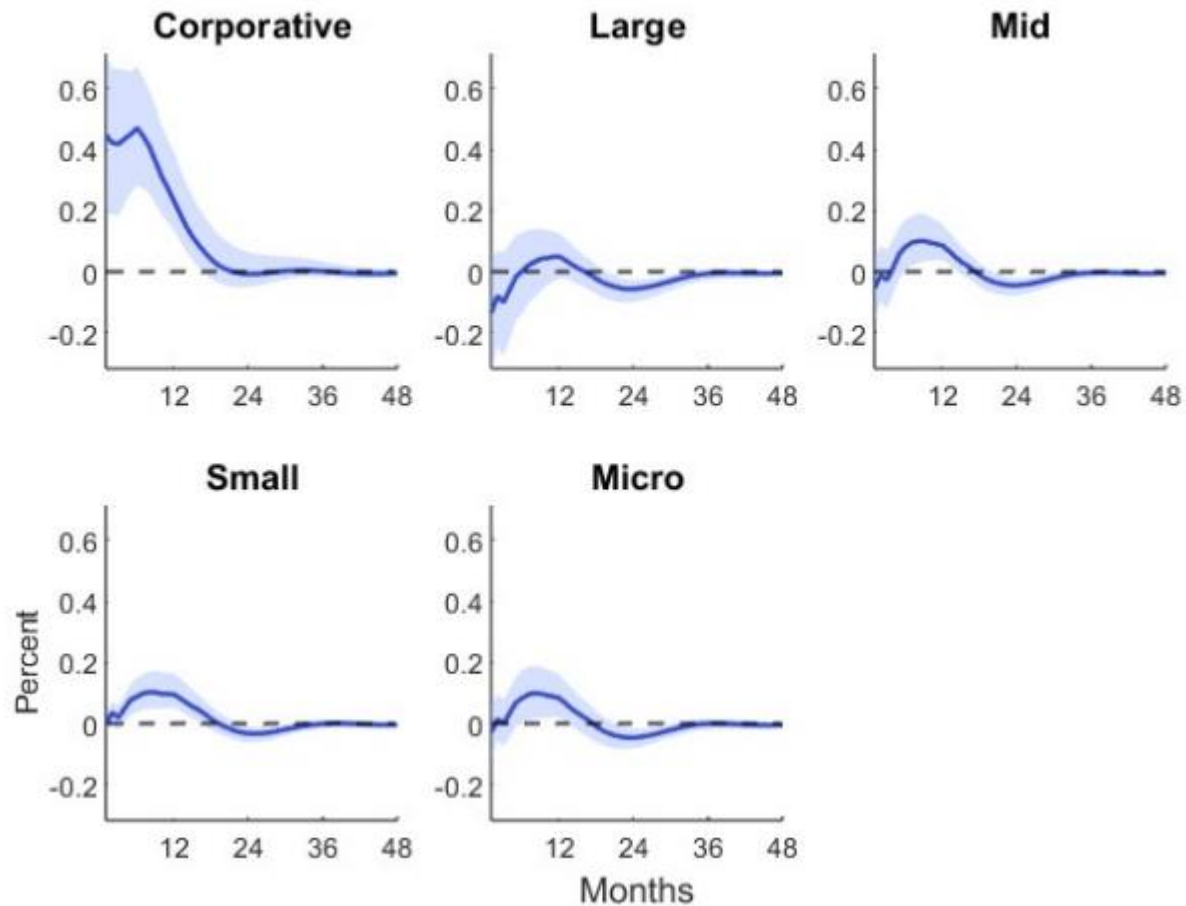
5.1 Results: Response to shocks

Response of credit dollarization to capital flows shock



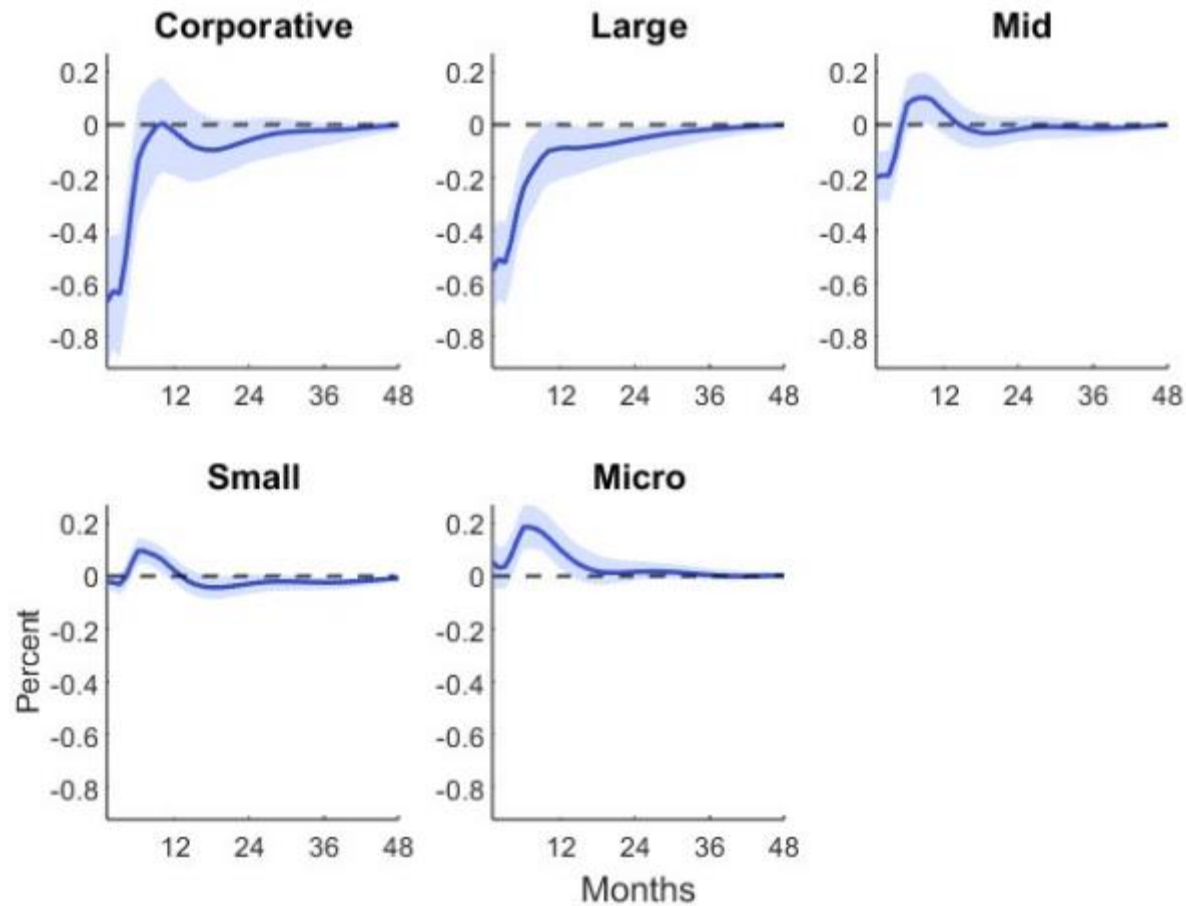
5.1 Results: Response to shocks

Response of credit dollarization to dollar deposits shock



5.1 Results: Response to shocks

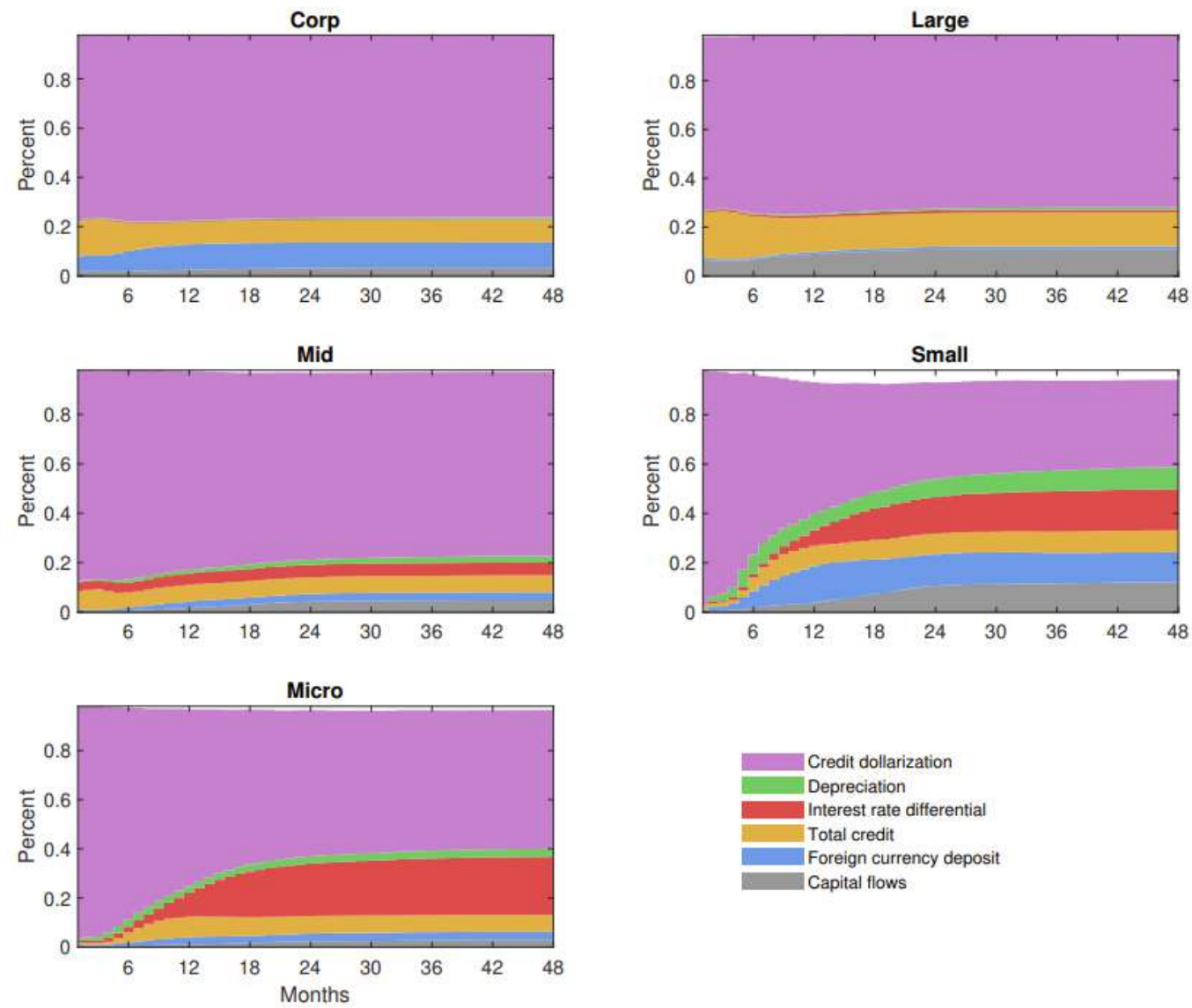
Response of credit dollarization to total credit shock



5.1 Results: Key findings

1. Interest rate differential:
 - Increases dollarization, stronger in micro/small firms.
2. Depreciation:
 - Reduces dollarization, minimal effect on corporate firms, insulated via hedging (Brown et al., 2011). Small firms: Strong negative response due to exchange rate risk vulnerability.
3. Capital inflow shocks:
 - Reduce dollarization, mainly in large firms (up to 2 years). Aligns with alternative financing (Beck et al., 2008).
4. Dollar deposit shocks:
 - Increase dollarization in corporate firms (lower credit risk). Driven by banking regulations (Amado, 2022).
5. Total credit growth:
 - Lowers dollarization in large/corporate firms; raises it in micro/small firms due to credit constraints.

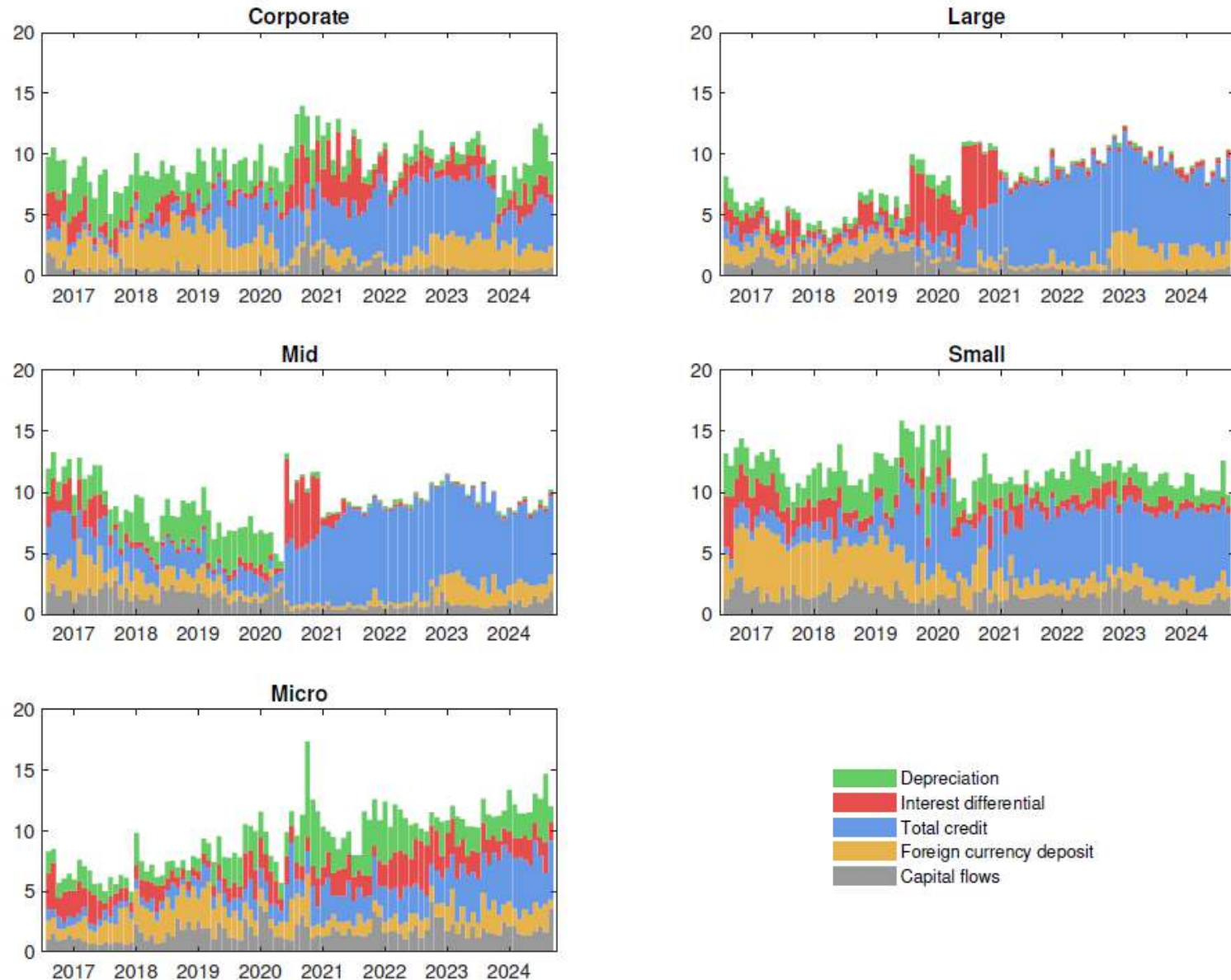
5.2 Results: Forecast error variance decomposition



5.2 Results: Key findings

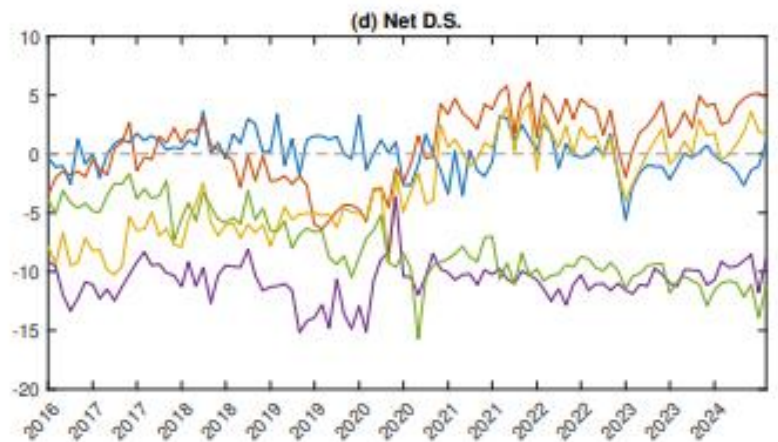
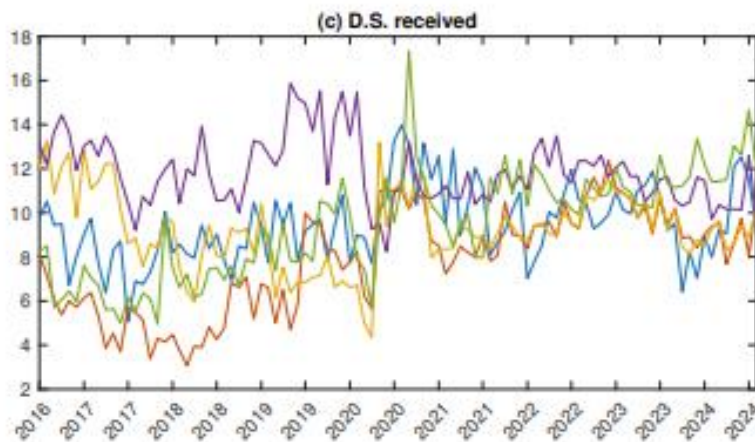
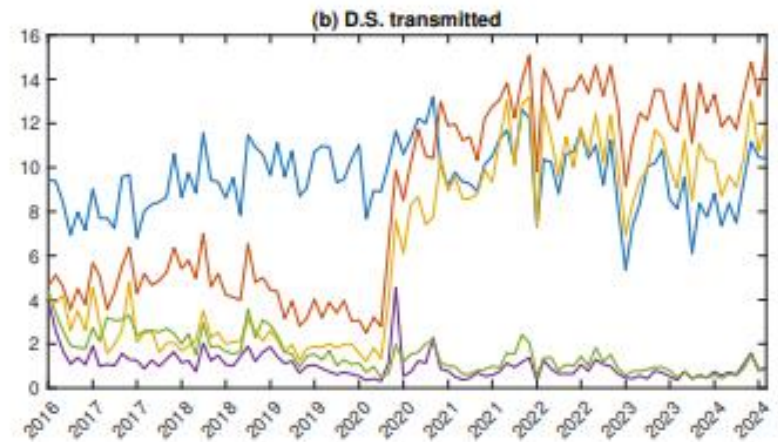
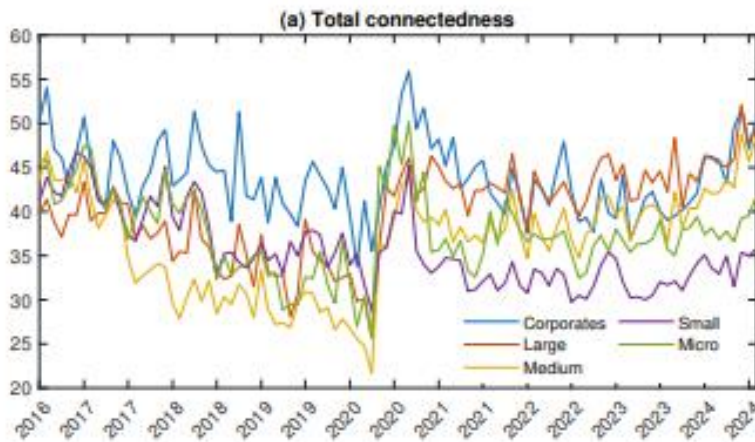
- Analyzes contribution of shocks to credit dollarization variance.
- Key results:
 - Important differences by firm size. Credit supply shocks: Modest, growing effect in large firms.
 - Depreciation shocks: Larger impact on micro/small firms.
 - Interest rate differential: Minimal for corporate/large firms and larger impact on micro/small firms.
 - Persistence of factors related to dollarization remains key in determining firm's decisions on the currency composition of credit.
 - Credit dollarization of larger firms segments are mainly explained by its own shocks.

5.3 Results: Spillover decomposition



*Dynamic spillovers to credit dollarization by firm size (10-month horizon).

5.3 Results: Connectedness metrics by firm size



*Dynamic connectedness and spillovers by firm size (60-month window, 10-month horizon).

5.3 Results: Key findings

- Time-varying analysis (Diebold & Yilmaz, 2012) with 60-month rolling window.
- Findings:
 - Pandemic increased connectedness across all firm sizes.
 - Post-pandemic: returns to pre-crisis levels.
- Spillover decomposition:
 - Large/medium firms: Main spillover transmitters.
 - Small/micro firms: Net receivers, amplified during the pandemic.
 - Deposit dollarization, credit demand: Strongest spillovers.
 - Interest rate differentials: More impact on small/micro firms.
 - Pandemic: Reduced depreciation effects in large/medium firms.

6. Conclusions

- Our analysis shows that the dollarization behavior of firms is shaped by shocks related to exchange rates and borrowing costs.
- Divergence by firm size highlights the distinct risk profiles and decision-making processes across firm sizes, emphasizing the need for tailored financial policies and strategies.
- High degree of interconnectedness, intensified during systemic risk episodes.
- Particularly for corporate firms and microenterprises, as indicated by the connectivity index proposed by Diebold and Yilmaz (2012).
- Future research: Estimate loan demand elasticities using granular data (Altavilla et al., 2023).

**Interest rate differential and depreciation shocks
on credit dollarization of firms in Peru:
Does firm size matter?**

Thank you!

APPENDICES

1. Introduction: contribution

- Analyzes credit dollarization heterogeneity by firm size, a relatively underexplored dimension (Beck et al., 2008; Di Giovanni et al., 2024).
- Employs a Bayesian Panel VAR to quantify differential responses to macro-financial shocks.
- Uses Diebold and Yilmaz (2012) connectedness framework to examine dynamic spillovers, especially during crises (e.g., Covid-19, de-dollarization).
- Provides policy insights for tailoring financial stability measures in dollarized emerging markets.

2. Literature review

- Literature groups dollarization determinants into supply factors (deposits and bank's optimal portfolio) and demand factors (interest rate differentials and exchange rate changes).
- Other factors: inflation, economic growth, regulation.
- Interest rate differentials and exchange rate depreciation drive foreign currency borrowing (Cowan, 2006; Rosenberg & Tirpák, 2008; Catao & Terrones 2016).
- Interest rate differentials influence both loan and deposit dollarization (Gutierrez et al., 2023).
- Firms borrow in foreign currency when domestic rates are higher (Keloharju & Niskanen, 2001).
- Greater access to foreign funds increases credit dollarization (Basso et al., 2007).

2. Literature review

- Firm size also plays a role.
- Small firms face higher loan spreads, pay more than large firms (Chodorow-Reich et al., 2022).
- Corporate firms manage exchange rate risk better than smaller firms (Martínez & Werner, 2002).
- Large firms use the dollar for revenue and expenses, limiting currency mismatches (Fernández et al., 2020).
- Corporate firms have better tools to manage exchange rate risk, using hedging instruments (Abbassi & Bräuning, 2023).
- Small firms' borrowing tied to foreign revenues, not carry-trade (i.e., borrowing in the low-interest rate currency) (Brown et al., 2011).
- We integrate firm size responses to macro-financial shocks using a Panel VAR approach and a connectedness framework.

3.1 Methodology: Prior settings

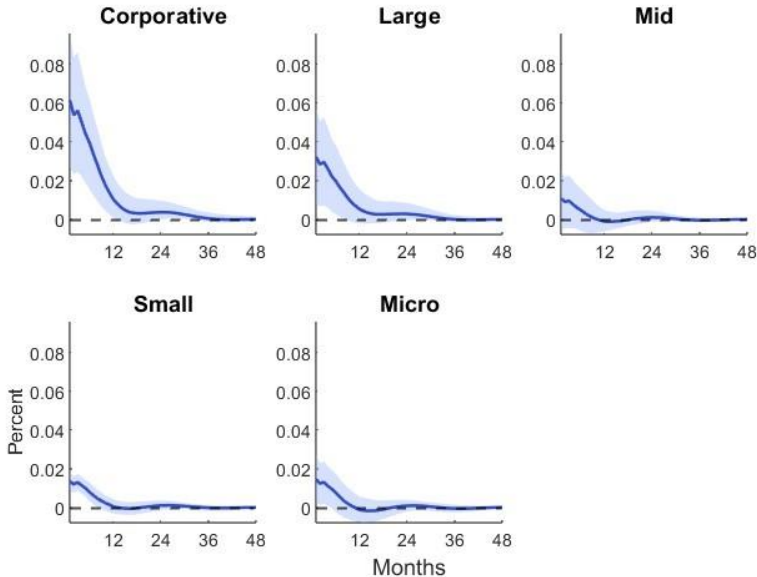
- Estimation approach: hierarchical prior of Gelman (2006).
- The hyperparameters include overall tightness (λ_1), cross-variable weighting (λ_2), lag decay (λ_3), and variance parameter (λ_4). We use $\lambda_2 = 0.5$, indicating that own lags carry more weight, $\lambda_3 = 1$ for linear decay, and $\lambda_4 = 100$ to allow for heteroscedasticity. The prior for λ_1 follows an Inverse Gamma distribution, $\lambda_1 \sim IG\left(\frac{s_0}{2}, \frac{v_0}{2}\right)$.
- The coefficients β_i are distributed as $\beta_i \sim N(b, \Sigma_b)$, where b is a diffuse prior ($\pi(b) \propto 1$), and Σ_b replicates the Minnesota prior covariance matrix Ω_b :

$$\Sigma_b = (\lambda_1 \otimes I_q) \Omega_b, \Omega_b = \begin{pmatrix} 1 \\ l^{\lambda_3} \end{pmatrix}^2 \quad \text{if } i = j, \Omega_b = \frac{\sigma_i^2}{\sigma_j^2} \left(\frac{\lambda_2}{l^{\lambda_3}} \right)^2 \quad \text{if } i \neq j.$$

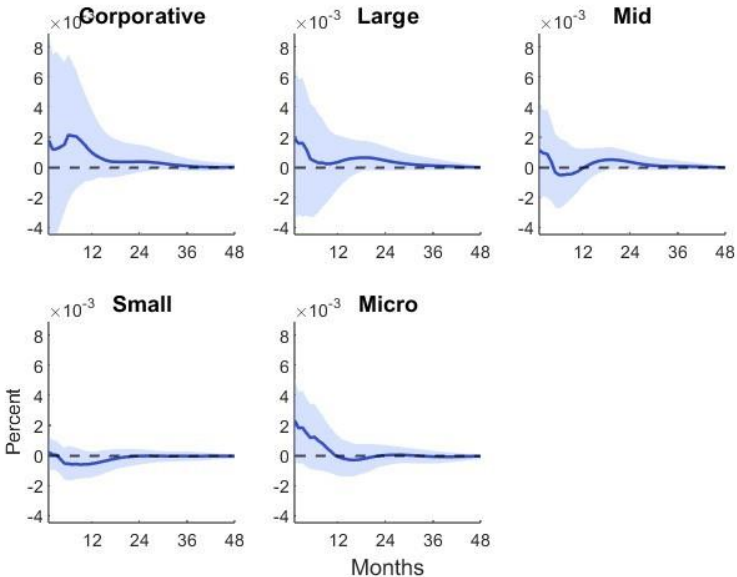
- Finally, the prior distribution for the covariance matrix for the residuals Σ_i is simply the classical diffuse prior given by $\pi(\Sigma_i) \propto |\Sigma_i|^{-(n+1)/2}$.

5.1 Results: Response to shocks

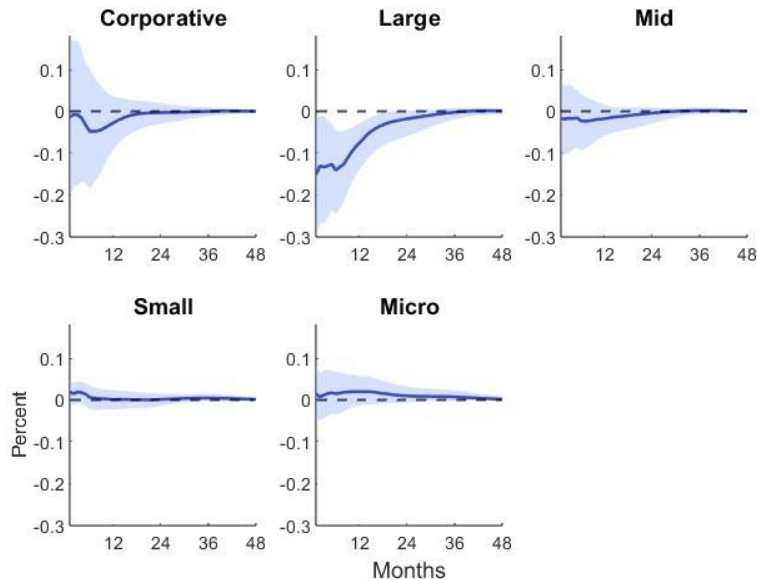
Response of credit dollarization to terms of trade shock



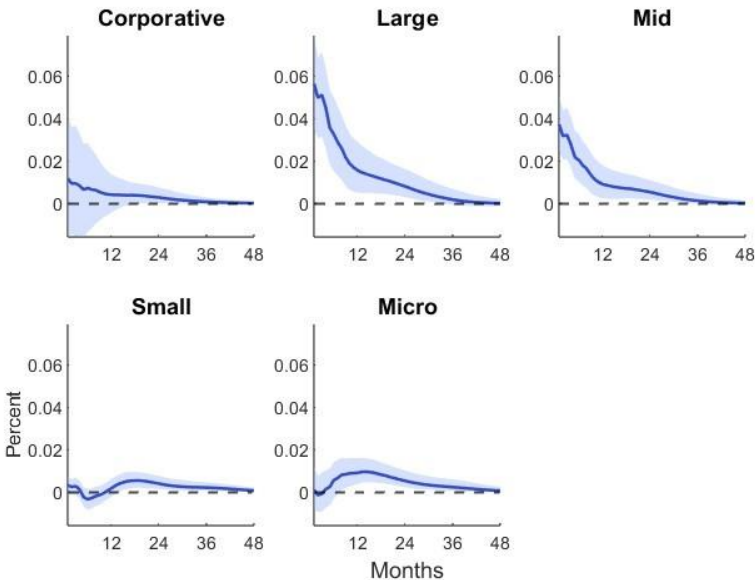
Response of credit dollarization to EMBIG Peru shock



Response of credit dollarization to Fed funds rate shock

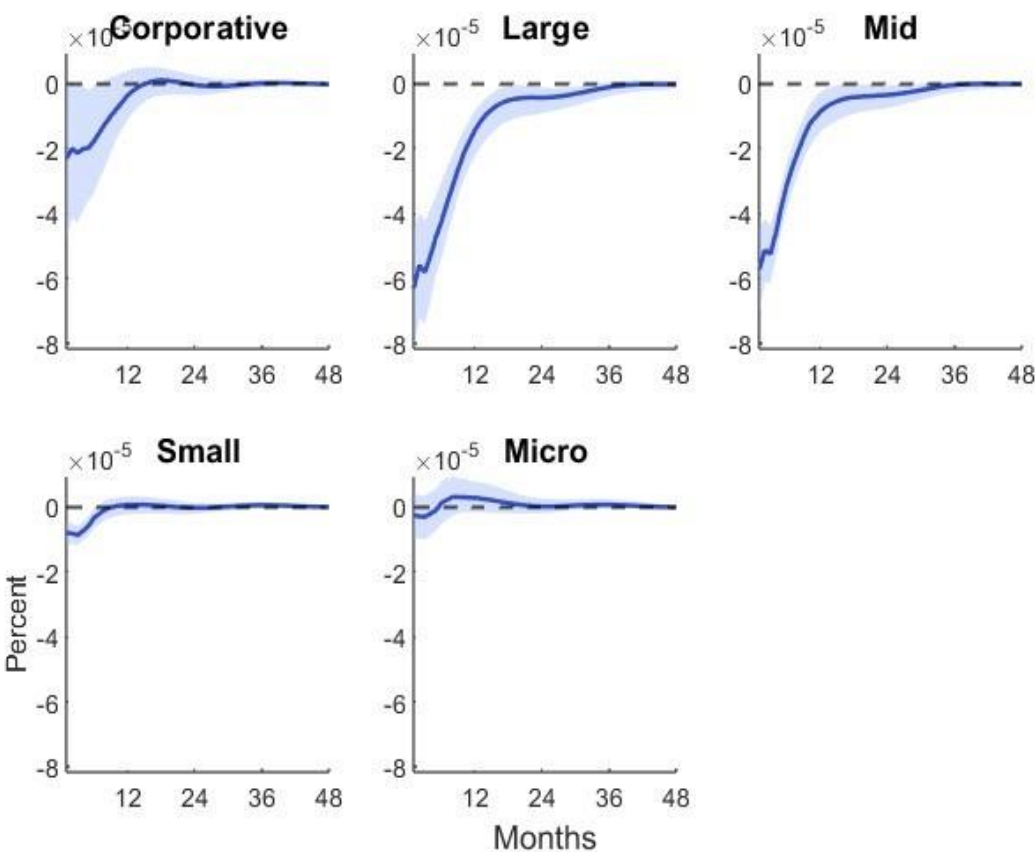


Response of credit dollarization to GDP growth shock

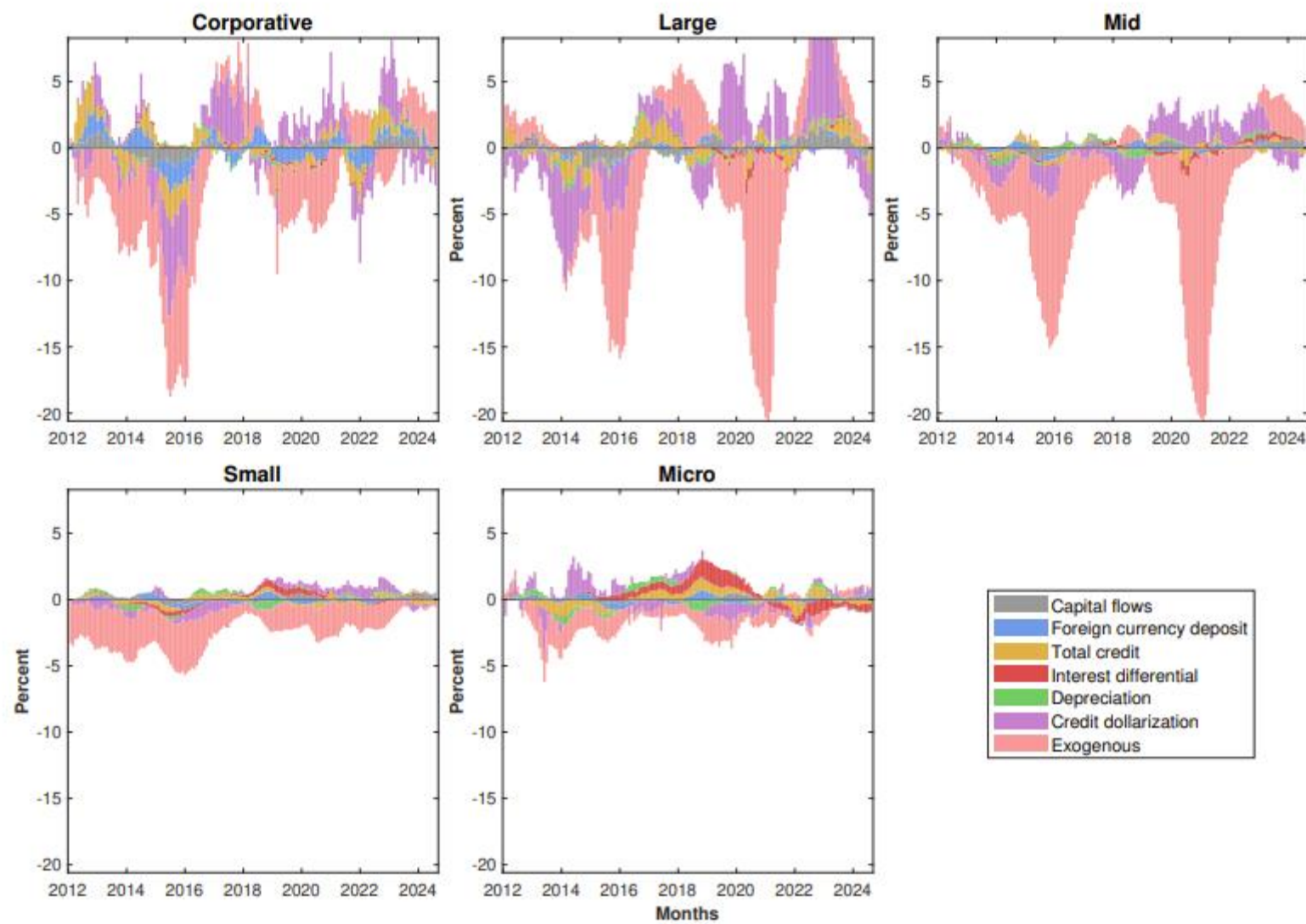


5.1 Results: Response to shocks

Response of credit dollarization to liquidity policy shock



5.2 Results: Historical decomposition



5.2 Results: Key findings

- Two significant episodes of dollarization decline: dedollarization program and pandemic.
- Exogenous shocks dominate in credit dollarization dynamics for corporate and large firms.
- Dollarization shocks dominate early periods, decline over time.
- Confirms that large firms less sensitive to depreciation and interest differential shocks.
- 2015–16: Dedollarization program reduced dollarization (corporate/large firms).
- Pandemic: Substitution effect increased dollarization in corporate firms.