# Mutual Fund Runs and the Transmission of Liquidity Risk to Banks*

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— Preliminary and incomplete draft, February 2026 —

**Abstract**

We study how stress originating in mutual funds transmits to banks' funding and lending behavior. In a setting where redemptions unrelated to bank fundamentals force funds to liquidate bank-issued certificates of deposit (CDs), we link redemptions to the stability of banks' wholesale funding and lending — a rarely observable transmission. In Colombia, where funds hold a sizable share of banks' CDs, large redemptions generate sharp declines and heightened volatility in CD demand. Banks more exposed to this funding stress originate smaller and shorter-maturity loans, while loan rates decline due to a shift toward safer borrowers. Temporary disruptions in market-based funding thus meaningfully shape banks' maturity choices and the composition of new credit.

**Keywords**: uninsured deposits, wholesale funding, liquidity risk, credit supply, non-bank financial intermediaries

**JEL Codes**: G01, G21, G23, E44, E58

*The authors thank Viral V. Acharya. Allen N. Berger, Ricardo Correa, John Duca, José Fillat, Jon Frost, Victoria Ivashina, Elena Loutskina, Ilhyock Shim, Christian Upper, Wolf Wagner and participants at the 2023 IBRN Winter Workshop (Basel), the BIS Research Seminar (Mexico City) and the 2024 IBEFA-WEAI Conference (Seattle, US) for valuable comments and suggestions. We thank Hernando Vargas, Andrés Murcia, Carlos Quicazán, Juan Sebastían Mariño, Camilo Gómez, Camilo Sanchez, Daniela Rodríguez, and participants at the IBRN meetings, Banco de la República Research Seminar, and Financial Regulation Unit of the Ministry of Finance meetings for useful discussions and suggestions. All errors are our own. The views expressed here are those of the authors and do not necessarily reflect those of Banco de España, the Eurosystem, BIS or Banco de la Republica.

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# 1 Introduction

Wholesale funding markets have become a central channel through which liquidity shocks originating in nonbank financial intermediaries (NBFIs) propagate to the banking sector (see, e.g., Chernenko and Sunderam, 2014; Acharya et al., 2023). In normal times, money market and investment funds roll over short-term bank liabilities, providing an important source of near-cash funding that supports banks' liquidity management and maturity transformation. Yet episodes of market stress have shown that these investors are themselves exposed to run risk, which can trigger sudden redemptions and force large-scale liquidation of bank liabilities (IMF, 2023; FSB, 2023). Because wholesale deposits lack a formal liquidity backstop (Covitz et al., 2015), such withdrawals can generate abrupt funding pressure for banks and disrupt credit supply, with coordination failures and market externalities amplifying these dynamics (Drechsler et al., 2023).

Wholesale funding disruptions constrain banks primarily by tightening balance-sheet conditions, but they may also alter banks' exposure to liquidity risk. When funding becomes scarce or more expensive, banks contract and reprice lending in line with standard balance-sheet constraints (e.g., Ivashina and Scharfstein, 2010; Cornett et al., 2011). Beyond these effects on funding levels, stress in wholesale funding can also increase the rollover risk of short-term liabilities — a key input into banks' maturity transformation. Because banks fund longer-term assets with short-term liabilities, greater exposure to rollover risk can raise liquidity risk even when aggregate financing remains available (e.g., Drechsler et al., 2023). When this funding becomes less stable, banks may therefore adjust not only the scale but also the structure of lending, shifting away from longer-maturity credit to align asset horizons with a less stable funding base.

In this paper we examine how redemption-driven disruptions in investment fund financing transmit to banks' wholesale funding and how banks adjust new lending in response. Our central question is whether, beyond standard balance-sheet constraints, stress in wholesale

funding increases banks' exposure to rollover risk and thereby reshapes the structure and horizon of credit. A distinctive feature of our setting is that we directly observe the key elements of this transmission mechanism: investor-driven redemptions at the fund level, the security-level portfolios of funds across banks' certificates of deposit, and contract-level lending terms for newly originated corporate loans. These data allow us to trace, in a testable way, the full sequence from investor withdrawals to the liquidation of bank-issued liabilities and the resulting funding pressures faced by banks.

Distinguishing how wholesale funding stress reshapes bank lending is empirically challenging. To examine the role of rollover risk associated with maturity transformation, one would ideally observe investor-driven funding withdrawals that are unrelated to bank fundamentals while aggregate funding markets continue to function. This separation is difficult in practice because wholesale funding conditions, bank risk, and lending decisions are jointly determined (Kashyap et al., 2002). Banks that rely more heavily on short-term NBFI funding may differ systematically in risk or business models, and funds may selectively liquidate claims on weaker banks, confounding liquidity-driven withdrawals with information-based rebalancing (see, e.g., Ivashina et al., 2014; Pérignon et al., 2018). Moreover, most data do not allow tracing the full transmission from investor withdrawals to bank funding conditions and loan contract terms. As a result, existing evidence provides limited insight into how redemption-driven funding disruptions affect rollover risk and the structure of credit.

Our setting closely approximates this ideal experiment. The mechanism we study is most visible in financial systems where investment funds hold a large share of banks' short-term wholesale liabilities and can rapidly reduce these positions in response to investor withdrawals. The environment we examine provides precisely such conditions. Local investment funds allocate a large fraction of their portfolios to negotiable certificates of deposit issued by banks — about 22% of assets under management — creating tight fund–bank funding linkages, while certificates of deposit account for roughly 28% of bank liabilities. These

features characterize Colombia, a mid-sized emerging economy with extensive reliance on wholesale funding, redeemable investment funds, and a bank-dependent corporate sector. This institutional configuration allows us to observe investor-driven funding withdrawals that vary across banks depending on their pre-existing exposure to funds, while broader funding markets remain active. As a result, the setting provides a natural laboratory to examine how redemption-driven funding disruptions transmit to banks' funding conditions and, in turn, to the structure and horizon of new lending.

We assemble regulatory data from Banco de la Republica, the Colombian central bank, that allow us to trace how investor redemptions at investment funds transmit to banks' wholesale funding and ultimately to loan-level lending. The first component is weekly balance-sheet information for the universe of investment funds, which records assets under management and enables measurement of redemption flows. The second is daily security-level data on all certificates of deposit issued by banks and held by each fund, allowing us to observe pre-shock fund–bank exposures and track how funds adjust these positions during the redemption wave. The third is the credit registry, which reports the universe of corporate loans at the bank–firm level, including volumes, maturities, and rates. Linking these sources produces a panel that tracks the transmission from investor withdrawals to bank funding conditions and lending responses.

The empirical setting is characterized by a large and sudden redemption shock triggered by the outbreak of COVID-19 in early March 2020. Within three weeks, mutual funds experienced withdrawals of roughly one-third of their assets under management -— a magnitude comparable to a run episode. Because these redemptions were driven by global uncertainty rather than bank-specific information, they provide plausibly exogenous variation in funds' liquidity needs. Consistent with this interpretation, redemption intensity is largely unrelated to ex-ante characteristics of the banks whose CDs the funds held. Given that open-ended funds invest a substantial share of their portfolios in bank-issued CDs, the shock translated

into a sharp contraction in CD holdings. The redemption wave unfolded over a short window, generating heterogeneous funding withdrawals across banks depending on their pre-existing exposure to funds.

We first quantify how investor withdrawals translate into liquidation of banks' certificates of deposit. Because funds hold sizable CD positions across multiple banks, redemption pressure varies across funds while each bank simultaneously faces multiple fund counterparties. We estimate weekly fund–bank regressions around the COVID outbreak that relate changes in a fund's CD holdings at a given bank to its investor redemptions. The specification includes bank–week fixed effects, absorbing time-varying funding conditions and information at each bank. Identification therefore comes from comparing, within the same bank and week, funds facing different redemption pressure. This design links changes in CD positions to investor-driven liquidation rather than bank-specific funding demand, providing granular evidence on how redemption shocks translate into wholesale funding withdrawals.

We next examine how exposure to redemption-driven funding withdrawals affects bank lending. Our main exposure measure captures the realized change in each bank's outstanding CDs over the shock window, providing a bank-level measure of funding loss attributable to fund liquidations. As a complementary check, we also use an ex-ante exposure measure based on pre-shock fund holdings of bank CDs relative to total liabilities. We merge these measures with credit-registry data and estimate loan-level effects using firm–time fixed effects in the spirit of Khwaja and Mian (2008), holding constant borrower-specific conditions common to all lending relationships at a given point in time. This framework allows us to examine how funding withdrawals associated with increased rollover risk are reflected in loan size, maturity, and pricing.

Our estimates show that funds experiencing larger redemptions substantially reduce their CD holdings, indicating that investor withdrawals are associated with lower demand for banks' wholesale liabilities. The response is concentrated in the months when redemptions

peak, consistent with rapid liquidation following funding pressures rather than gradual portfolio rebalancing. We also find that the pass-through is stronger for open-ended funds and those with lower liquidity buffers, suggesting that more fragile investors adjust their positions more aggressively. Transaction-level evidence further shows active sales and reduced purchases of CDs during the stress period. Together, these patterns point to a rapid and economically meaningful withdrawal of wholesale funding from banks more exposed to investment funds, consistent with increased rollover risk in these funding relationships.[1]

Turning to loan outcomes, banks more exposed to redemption-driven funding withdrawals adjust credit primarily along the quantity and maturity margins, consistent with efforts to limit exposure to funding instability. Exposed banks originate smaller loans and significantly shorter-maturity contracts relative to less-exposed peers. These adjustments are economically meaningful: a one–standard-deviation increase in exposure reduces loan volumes by about 5–10 percent and shortens maturities by roughly 15 percent, equivalent to a decline of around five months relative to the mean loan term. The contraction is concentrated in longer-term lending, indicating a retrenchment in credit that requires more stable funding. At the same time, lending shifts systematically toward firms that are ex ante safer, consistent with a reallocation toward lower-risk borrowers. Reflecting these compositional adjustments, estimated effects on loan rates are small and not statistically distinguishable from zero once borrower-time conditions and contract characteristics — including loan size and maturity — are held constant. Overall, the evidence indicates that funding withdrawals are reflected primarily in the scale, composition, and horizon of new lending rather than in broad repricing.

[1]Specifically, affected funds prioritize selling CDs that constitute a large share of their portfolios but a small share of the issuing bank's outstanding CDs, and they predominantly liquidate CDs issued by banks outside their own financial conglomerate. In preliminary tests, we verify that changes in CD holdings are largely unrelated to standard bank risk indicators, suggesting that liquidations are not driven by systematic reallocation away from weaker banks. In addition, investor redemptions in this market typically incur fees, implying that CD withdrawals reflect substantial liquidity pressure rather than routine portfolio adjustment. We also show that a central bank's intervention program, initiated roughly two weeks after the outbreak, attenuates but does not eliminate the pass-through from redemptions to CD liquidations.

Taken together, this evidence indicates that wholesale funding stress can reshape lending not only through balance-sheet tightening but also through changes in banks' exposure to liquidity risk. Although aggregate bank liabilities remained broadly stable, the composition of funding shifts as withdrawals by investment funds reduce a source of short-term financing critical to supporting banks' maturity transformation (Brunnermeier and Oehmke, 2013; Krishnamurthy et al., 2014). The redemption episode makes the fragility of this funding source salient, effectively revealing the extent of rollover risk embedded in banks' liability structure. When funding becomes subject to rollover risk, banks adjust the scale and horizon of new lending to align asset maturities with a less stable funding base. In this sense, redemption-driven funding withdrawals affect not only the quantity of available financing but also the effective stability of banks' funding structure. More broadly, our findings are aligned with and provide empirical support for theoretical accounts in which liquidity risk constrains maturity transformation and thereby shapes the allocation and duration of credit (Drechsler et al., 2023).[2]

**Related literature.** We contribute to a strand in the literature that examines the financial-stability implications of non-bank financial intermediaries through the lens of their interaction with the banking sector. Most research documents fragilities and run-like episodes in secured and unsecured wholesale markets caused by NBFIs withdrawing funding (e.g., see Krishnamurthy et al., 2014; Copeland et al., 2014; Li et al. (2021); Pinter (2023); Sarmiento, 2024). Other studies explore whether runs in wholesale funding reflect banks' fundamentals (Chernenko and Sunderam, 2014; Pérignon et al., 2018; Magnani and Wang, 2023). Previous studies on bank-fund connections have highlighted a positive side of some interconnections:

[2]A complementary interpretation of the joint adjustment in loan size, maturity, and pricing we document is that banks reallocate credit toward lower-risk borrowers following the shock. Consistent with this view, exposed banks concentrate lending on firms that were priced as safer prior to COVID. Because safer borrowers command lower contractual rates, and shorter maturities mechanically carry lower spreads, this compositional shift can dampen observed changes in average loan pricing even as banks retrench on scale and duration. Such patterns are consistent with models linking liquidity risk to maturity shortening, tighter screening, and reallocation toward lower-risk borrowers (e.g., Stein, 1998; He and Krishnamurthy, 2013; Drechsler et al., 2023).

funds that are affiliated through institutional or ownership ties to a bank support the bank with liquidity in times of stress (Gil-Bazo et al., 2020) and prop up its share prices (Golez and Marin, 2015). We complement these findings by analysing characteristics of bank-fund links that amplify the transmission of liquidity risks from NBFIs to banks in an emerging economy.[3] Moreover, we use the information on fund redemptions to identify an entity-specific effect on demand for bank funding instruments. We further add to this literature by documenting a causal link between fund redemptions and lending conditions in the real sector.[4]

The focus on loan-level effects connects our work with an extensive literature analyzing the impact of funding shocks to the real economy in different settings (e.g., see Ivashina and Scharfstein, 2010; Cornett et al., 2011; Kapan and Minoiu, 2014; Ippolito et al., 2016).[5] To the best of our knowledge, this literature has not looked at funds' redemptions as a source of changes in loan terms through their impact on bank funding. Closer to our findings is a subset of this literature that has empirically assessed the impact of wholesale funding shocks on bank credit. Ivashina et al. (2014) and Correa et al. (2021) study how global banks' exposure to wholesale dollar funding affects credit supply in times of financial distress. Aldasoro et al. (2022) explores how a regulation-driven squeeze in U.S. Money Market Funds triggered a spillover that reduced liquidity in other wholesale funding markets, negatively affecting credit. Differences in the empirical setting aside, our approach complements these findings in two ways. First, we shift the focus to the implications for retail loan terms, illustrating a link between loans' maturity and price and the liquidity risk faced by investment funds. Second, we show that the transmission of liquidity risks from NBFI investors to wholesale funding markets can cause such a reaction in bank loan portfolios.

[3]Bank–nonbank linkages may also reflect complementarities in joint credit provision, as in syndicated loans where nonbanks step in when banks retrench (see Elliott, Meisenzahl and Peydró, 2024 or Aldasoro, Doerr and Zhou, 2025).

[4]A growing related literature examines the role of bank–fund affiliations and information sharing within financial conglomerates. See Li (2021), Golez et al. (2024) or Pratobevera (2024). Related work also shows that regulatory innovations themselves can be a key driver of the expansion of bank–nonbank linkages and the reallocation of intermediation toward shadow banking (Irani et al., 2021; Gebauer and Mazelis, 2023).

[5]For complementary evidence from retail deposit runs, see Acharya et al. (2022).

Our findings link individual wholesale investor decisions to wholesale funding risk, allowing us to trace the causal connection between the CDs' funding shock and loan terms through shifts in investor-level market dynamics. Therefore, our results are useful to inform policy debates about vulnerabilities in the banking sector stemming from NBFIs.[6] While NBFIs can boost financial system efficiency, shifts in investor sentiment leading to fund redemptions can indirectly threaten the stability of bank funding. Therefore, strengthening policies that address the ripple effects of investor-level dynamics on bank funding risks could improve the resilience of financial markets and allow countries grasping the benefits of NBFIs while mitigating their downside risks.

# 2 Institutional background

## 2.1 Bank–fund wholesale funding linkages

The market for certificates of deposit (CDs) is a central unsecured wholesale funding channel through which banks intermediate liquidity from non-bank financial institutions. CDs are short- to medium-term negotiable liabilities issued by banks and traded bilaterally in an over-the-counter market dominated by investment funds, broker-dealers, and bank treasuries. In many respects, this market resembles the unsecured analogue of repo markets studied by Gorton and Metrick (2012) and Krishnamurthy et al. (2014): it provides scalable term funding to banks while remaining sensitive to rollover risk. Because CDs mature at relatively short horizons and are frequently rolled over, funding continuity depends on investors' willingness to renew positions or purchase CDs sold in secondary markets.

Mutual funds hold CDs as near-cash assets used for liquidity management and short-term portfolio allocation. Banks, in turn, rely on CDs as flexible wholesale deposits that

[6] Our findings on the role of central bank outright liquidity provision in stabilizing the Colombian wholesale deposit market further relate our work to studies on the effectiveness of central bank interventions (see, e.g, Garcia-de Andoain et al., 2016; Falato et al., 2021; Breckenfelder and Hoerova, 2023).

complement retail funding and support maturity transformation. When funds face investor withdrawals, they can unwind CD positions either by not rolling over maturing instruments or by selling them in secondary markets, directly transmitting liquidity shocks to issuing banks (Pérignon et al., 2018). These features resemble a classic maturity-transformation friction: banks finance illiquid assets with liabilities whose rollover depends on intermediaries exposed to redemption risk and mark-to-market pressures (Acharya and Mora, 2015). This structure links the balance-sheet fragility of NBFIs with banks' short-term funding conditions, creating a channel through which investor liquidity demand affects the stability of bank funding.

Funding arrangements of this kind are common in financial systems where mutual funds play a major role in wholesale bank funding, with Colombia providing a particularly transparent setting in which these linkages are quantitatively important. Mutual funds in the country represent a major investor base in the CD market and allocate a substantial share of their portfolios to bank-issued instruments, accounting for roughly 22% of assets under management. In turn, CDs account for about 28% of bank liabilities, making funds key providers of wholesale funding to the banking system. The fund sector itself is sizable and has expanded rapidly in recent years, increasing both the scale of fund assets and their role in bank funding. These funds are managed by non-bank financial intermediaries and pool resources from households and firms into diversified portfolios, reinforcing their position as an important source of market-based liquidity for banks.[7]

Most of the mutual funds active in this market are open-ended vehicles whose liabilities are redeemable on short notice. Investors can withdraw capital with limited delay, requiring funds to manage liquidity and adjust portfolio positions in response to changing redemption demand. Because bank-issued CDs represent a substantial share of fund portfolios, redemption pressures can translate into reduced rollover or outright liquidation of these instruments, affecting banks' access to short-term wholesale funding. Because early liquidation of CDs

[7]Mutual investment funds in Colombia operate under the regulatory framework established by Decree 2555 of 2010, which governs fund structure, disclosure, and liquidity requirements.

can involve fees or penalties, large-scale sales typically reflect substantial liquidity pressure rather than routine portfolio adjustment. Regulatory liquidity requirements require funds to hold liquid assets against potential withdrawals, but these safeguards are designed to manage liquidity risk rather than eliminate redemption-driven portfolio adjustment.[8] This institutional structure makes banks' wholesale funding directly sensitive to sudden redemption shocks.

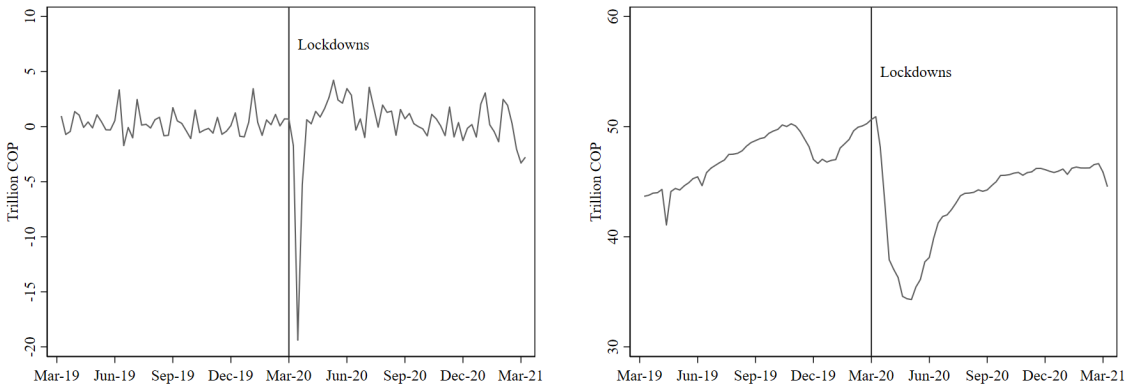
## 2.2 The March 2020 redemption shock and funding adjustment

In March 2020, Colombian open-ended mutual funds experienced a sudden and severe wave of investor withdrawals. Between March 6 and March 31, assets under management declined by 31.3 percent, corresponding to redemptions of COP 24.6 trillion (USD 7.1 billion), or roughly 2.7 percent of GDP. Because these funds held a large share of their portfolios in bank-issued certificates of deposit, the redemption shock translated rapidly into withdrawals from banks' wholesale funding. Over the same period, funds' CD holdings declined by 27 percent, a reduction of COP 13.8 trillion (USD 3.9 billion). The speed and magnitude of these changes indicate that redemption pressures were transmitted directly into the CD market over a short and concentrated window.

The redemption wave generated substantial selling pressure in the secondary market for certificates of deposit. As funds liquidated positions to meet investor withdrawals, CD prices declined, yields increased, and return volatility rose sharply. These movements were particularly pronounced for instruments more actively traded by mutual funds, consistent with concentrated selling pressure in segments of the market most exposed to redemption-driven liquidation. Figure 1 illustrates this transmission from investor withdrawals to CD liquidation. Panel (a) shows the abrupt spike in fund outflows in March 2020, while Panel (b) documents

[8] Investment funds in Colombia operate under a regulatory framework that imposes liquidity requirements and limits on asset composition. These provisions are intended to ensure that funds can meet expected withdrawals under normal conditions but do not prevent portfolio rebalancing in response to large or sudden redemption shocks.

Figure 1: Redemptions and outstanding certificates of deposit.




(a) Funds' net contributions.

(b) Banks' outstanding CDs held by funds.

Notes: Panel (a) shows the time series of the funds' net contributions (contributions minus redemptions). The graph plots weekly data between March 2019 and March 2021. Panel (b) displays the weekly time series of the banks' outstanding CDs held by funds for the same period. Panel (c) exhibits the daily total CDs purchased by the Central Bank. Values in the figures are expressed in trillion COP.

the parallel contraction in banks' outstanding CDs held by funds, indicating that redemptions were met through the unwinding of CD positions.[9]

As redemptions surged, funds' liquidity buffers deteriorated and some temporarily breached regulatory thresholds. In response, the Banco de la República introduced a sequence of emergency liquidity facilities aimed at stabilizing mutual funds and the CD market. Beginning on March 12, 2020, the central bank expanded repo operations to accept private debt securities, extended eligibility to public debt on March 18, and, on March 23, began outright purchases of bank-issued CDs and other highly rated private instruments with short remaining maturities (Vargas et al., 2022). Figure A1 in the Appendix documents the scale and timing of these interventions. These measures provided funds with alternative sources of liquidity and helped absorb part of the selling pressure in CD markets. However, they followed the initial wave of redemptions and did not fully offset the contraction in funds' CD

[9]While less fund-traded CDs returned relatively quickly to pre-shock conditions, yields and volatility for more heavily fund-traded instruments remained elevated for an extended period. These dynamics indicate that the shock translated not only into reduced holdings of bank liabilities but also into sustained stress in the market through which these liabilities are traded. Figure A1 in the Appendix provides descriptive evidence of this market dynamic.

holdings. Banks therefore experienced a sharp and uneven withdrawal of wholesale funding during the early phase of the shock, before broader funding conditions stabilized.[10]

Although banks experienced substantial withdrawals from investment funds, aggregate funding in the banking system remained broadly stable, as inflows into other funding sources — particularly sight deposits — largely offset the decline in wholesale CD financing. This apparent stability, however, masked an important shift in the composition and maturity structure of bank liabilities. Deposit inflows were concentrated in highly liquid accounts with no minimum holding period, and newly issued CDs carried shorter maturities than before the shock. As a result, banks' funding profiles became more short-term and potentially more sensitive to liquidity fluctuations, even in the absence of an aggregate funding shortfall.[11] This distinction between funding quantity and funding stability is central to our empirical analysis. The redemption episode generated heterogeneous withdrawals from a funding source that normally supports maturity transformation while leaving overall balance-sheet capacity broadly intact, allowing us to examine how differences in funding stability — rather than aggregate funding availability — shape bank lending responses.

# 3 Empirical strategy

## 3.1 Redemptions and funds' demand for bank CDs

We begin by examining whether fund redemptions are associated with adjustments in funds' positions in bank-issued CDs following the March 2020 liquidity shock. We perform this analysis on a weekly panel at the fund–bank level, where observed CD holdings reflect the

[10] These interventions resemble liquidity backstops deployed in other jurisdictions during the COVID-19 crisis, including the Federal Reserve's SMCCF and the ECB's PEPP; see Falato et al. (2021) and Breckenfelder and Hoerova (2023). By reducing the need for asset sales under stress, these facilities helped stabilize fund outflows. Consistent with this, redemption volumes stopped increasing by May 2020 and returned to pre-COVID monthly levels by August, indicating that the episode was temporary rather than a persistent funding disruption.

[11] Evidence on the evolution of aggregate funding shares and volumes is reported in Figure A1 in the Appendix.

joint outcome of both demand and supply forces: funds may reduce exposures because redemptions constrain their liquidity, while banks may change issuance or rollover policies in response to market conditions. Our empirical objective is to estimate the demand-side component – i.e., how funds adjust their CD portfolios when facing redemptions. To this end, all specifications include bank–time fixed effects, which absorb bank-specific variation in issuance, pricing, or liquidity conditions and allow us to compare funds facing different redemption intensities but exposed to the same bank–week supply environment.

To characterize how funds rebalanced their portfolios, we examine several complementary outcomes at the fund–bank–time level: the logarithm of CD holdings ($\log CD$), log changes in holdings ($\Delta \log CD$), net secondary-market sales and purchases ($\Delta CD, Sales$, $\Delta CD, Purchases$), and the within-fund volatility of CD holdings ($SD(\Delta \log CD)$). These variables capture both the level and the intensity of portfolio adjustment. We leverage on these metrics to provide an empirical description of how fund-level redemption shocks map into changes in their exposures to individual banks' wholesale funding instruments.

Our baseline specification estimates the association between fund-level redemptions and adjustments in CD positions in a weekly fund–bank panel:

$$\textit{CD-Outcome}_{k,b,t} = \beta RED_{k,t} + \omega X_{k,t-1} + \gamma_{b,t} + \delta_k + \epsilon_{k,b,t} \tag{1}$$

where $\textit{CD-Outcome}_{k,b,t}$ denotes one of the CD holding measures described above for fund $k$ with respect to bank $b$ in week $t$. The variable $RED_{k,t}$ captures log redemptions at the fund level, and $X_{k,t-1}$ includes predetermined characteristics of fund $k$. The bank–week fixed effects $\gamma_{b,t}$ absorb contemporaneous bank-specific issuance, pricing, and liquidity conditions, while fund fixed effects $\delta_k$ account for time-invariant heterogeneity across funds. The coefficient of interest, $\beta$, summarizes how funds facing different redemption pressures adjust their CD exposures when holding constant the supply conditions of each bank in each week.

We estimate this relationship separately for "normal" periods (2019Q1–2020Q1) and "stressed" periods (2020Q2–2021Q1), and examine windows of 3, 6, and 12 months after the onset of the COVID-19 shock. This separation allows us to benchmark fund behavior in tranquil times and to capture how the intensity and persistence of portfolio adjustments evolved during the liquidity shock.

To distinguish the effect of redemptions on adjustments in funds' CD positions from changes on the issuing side, we include bank–week fixed effects $\gamma_{b,t}$. As emphasized above, this absorbs bank-specific issuance, pricing, and liquidity conditions in each week, so identification comes from comparing how different funds adjust their CD exposures to the *same* bank under varying redemption pressure. We further include fund fixed effects $\delta_k$ to capture time-invariant differences in investment strategies or portfolio mandates across funds. Together, these fixed effects restrict the variation used for identification to within–fund–bank comparisons.

In addition, we include a set of lagged fund-level controls $X_{k,t-1}$ to account for time-varying differences across funds. These controls capture size (*log total assets*, *log number of investors*), liquidity available to meet redemptions (cash-to-assets ratio), and investment strategy (*share of fixed-rate holdings*). We also incorporate measures of funds' exposure to CDs, including the ratio of CDs to total assets, the share of a bank's outstanding CDs held by a fund (*market share*), and the share of CDs from a given bank in the fund's overall CD portfolio (*portfolio share*). To account for alternative liquid buffers, we include past volatility in treasury and bond holdings. Finally, we control for regulatory and policy conditions, including the fund-level liquidity coverage ratio (*LCR 30-day*) and the intensity of central bank CD purchases, measured as the share of a fund's secondary-market trades conducted with the Banco de la República in a given week. Standard errors are clustered at the fund level.

A central concern is that funds may have selectively unwound positions in CDs issued by

weaker banks during the onset of the pandemic.[12] If redemption pressure were systematically higher for funds more exposed to banks with weak balance sheets, our fund-level redemption measure would correlate with bank fundamentals, confounding the interpretation of the within–bank–week variation used in our baseline specification. To assess this possibility, we conduct a placebo test that relates fund-level redemptions during the March–June 2020 episode to the weighted average of banks pre-COVID characteristics in each fund's CD portfolio, using December 2019 fundamentals and weighting each bank by its share in the fund's CD holdings. The bank traits include the NPL ratio, capital ratio, deposit ratio, log assets, leverage ratio, and RoA. The regressions include week or month fixed effects and are estimated both on the full 2019–2021 sample and on the shock period alone.[13]

Across specifications, we find no robust association between fund redemptions and bank fundamentals (see Figure 2 and Table A3): coefficients on NPL ratios, capital ratios, deposit ratios, leverage ratios, and profitability are small and largely statistically insignificant. The only detectable pattern is a marginally significant positive loading on banks capital ratio, suggesting that funds exposed to more capitalized banks experienced slightly larger redemptions.[14] Overall, these results indicate that funds' redemption shocks were not

[12] Relatedly, Bechtel et al. (2023) document that bank-specific liquidity risk is priced in short-term funding markets. Our focus, instead, is on forced deleveraging by wholesale investors during a run.

[13] We assess whether funds experiencing larger redemptions were disproportionately exposed to weaker banks before the COVID shock. For each fund $k$, we construct an exposure measure to bank fundamentals defined as

$$BankExp_k = \sum_b w_{k,b} \cdot Z_b,$$

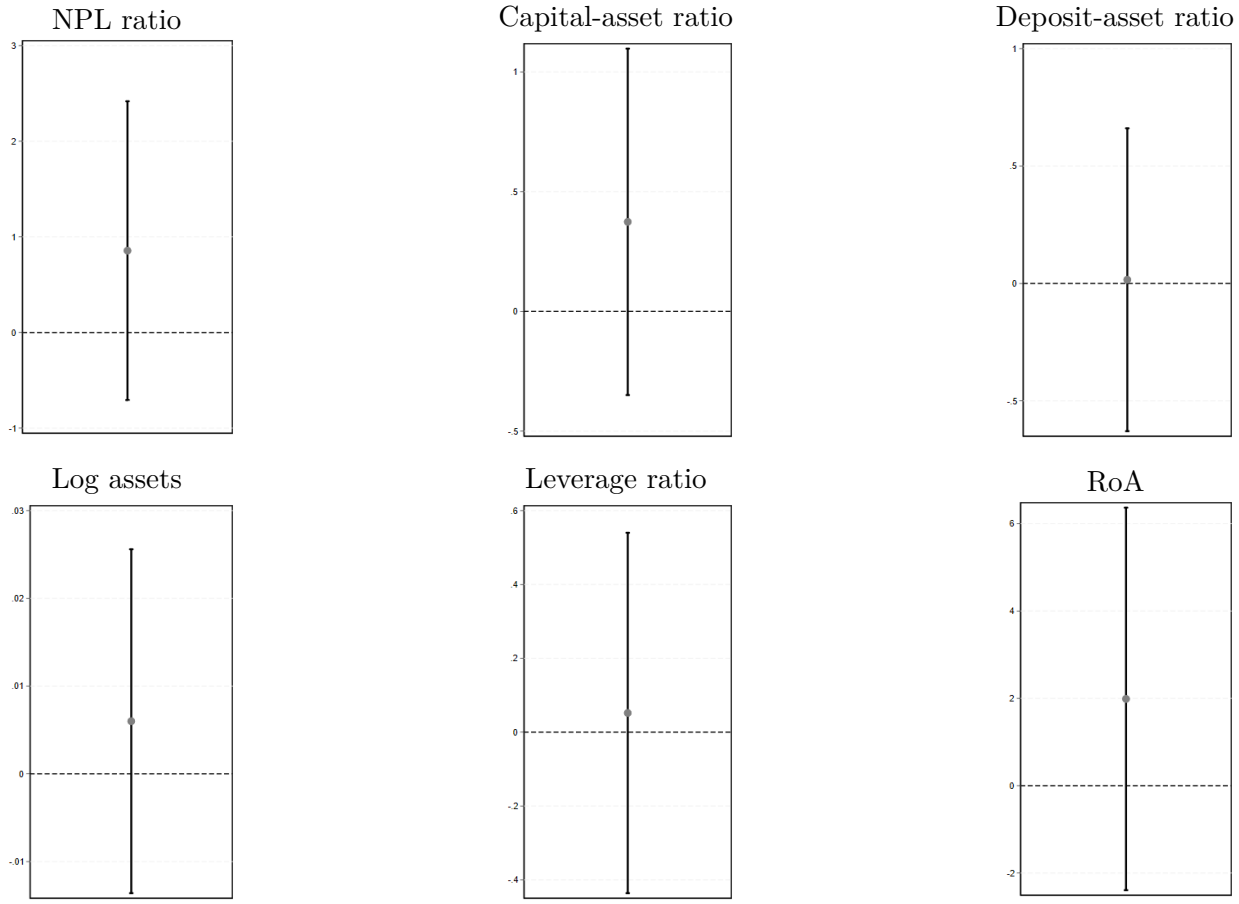
where $Z_b$ denotes a pre-COVID (December 2019) characteristic of bank $b$ (NPL ratio, capital ratio, leverage ratio, deposit ratio, log assets, or ROA), and $w_{k,b}$ is the share of bank $b$'s CDs in fund $k$'s total CD portfolio. We then estimate

$$RED_{k,t} = \theta\, BankExp_{k,t-1} + \phi_t + \eta_{k,t},$$

where $RED_{k,t}$ is the log of net investment outflows for fund $k$ in week $t$, and $\phi_t$ and $\mu_m$ are week and month fixed effects, respectively. A series of specifications using the full panel (2019–2021) and the COVID period (March–May and March–August 2020) show no robust relationship between redemptions and any bank characteristic, indicating that funds facing larger outflows were not disproportionately exposed to weaker banks. Standard errors are clustered at the fund level.

[14] In unreported regressions, we replicate the exercise in Table A3 using one-week-lagged weights capturing funds' exposures to banks. The results, available upon request, are quantitatively similar and reinforce the reported findings.

Figure 2: Fund redemptions and bank characteristics




Notes: This figure plots coefficient estimates and 95% confidence intervals from regressions of fund-level redemptions on weighted averages of banks' pre-COVID balance-sheet characteristics, estimated at a weekly frequency over the pre-shock period (December 2019–February 2020). For each fund, bank characteristics are aggregated using the fund's December 2019 CD holdings as weights, where the weight for each bank equals its share in the fund's total CD portfolio. Bank characteristics include the NPL ratio, capital ratio, leverage ratio, deposit ratio, log assets, and return on assets (ROA). All explanatory variables are lagged by one period and include week fixed effects. The dependent variable is weekly redemptions, defined as the log change in assets under management (AUM) from week $t-1$ to week $t$. Standard errors are clustered at the fund level. Estimated coefficients and complementary tests are reported in Table A3 in the Appendix.

systematically concentrated in portfolios with weaker banks, reducing concerns that portfolio reallocations across banks drive our main results. While we remain cautious in interpreting any observational setting as fully exogenous, the evidence suggests that redemption pressure was largely driven by fund-level investor behavior rather than by bank-specific information, supporting the use of fund redemptions as a plausibly independent source of variation in CD adjustments.

## 3.2 Redemptions and bank lending conditions

In a second step, we examine whether the funding disruptions transmitted from investment funds to banks translated into changes in loan terms. This link is central to understanding the real implications of stress in market-based bank funding: if banks adjust their lending behavior when their access to wholesale liabilities is impaired, redemption shocks in the non-bank sector can have consequences for the allocation of credit in the broader economy. To study this channel, we relate banks' exposure to fund redemptions to subsequent loan conditions around the COVID-19 shock. Specifically, we estimate:

$$Y_{b,f,t} = \beta \left( Exposure_b \times Post_t \right) + \omega X_{b,t} + \gamma_{f,t} + \delta_b + \varepsilon_{b,f,t}, \tag{2}$$

where $Y_{b,f,t}$ denotes different dimensions of loan pricing and quantities between bank $b$ and firm $f$ at time $t$. The variable $Exposure_b$ is a bank-specific metric of liquidity dry-ups in the CDs market: for each bank $b$, we compute the cumulative change in outstanding CDs held by investment funds over the initial shock window, capturing the realized loss of this funding source starting with the March 2020 dislocation. Formally, we define $Exposure_b$ as the change in the stock of bank $b$'s CDs held by funds between the pre-COVID reference period (2019) and the end of the shock window (December 2020), scaled by the pre-COVID level of CD funding. This measure therefore summarizes the intensity of the funding shock each bank experienced through the CD channel. To facilitate interpretation, we define $Exposure_b$ as a loss-based measure: we take the change in CDs held by funds, multiply it by -1, and scale it by the pre-COVID level, so that larger values correspond to larger funding losses through the CD channel.

To address identification concerns on the credit side, we saturate the specification with firm–quarter fixed effects ($\gamma_{f,t}$), which absorb time-varying shifts at the firm-level that can be associated to unobserved demand shocks. Following standards in the use of credit-registry data in similar specifications (Khwaja and Mian, 2008; Williams, 2018), we estimate Eq.

2 on the sample of new loans – that is, loans recorded once at origination – so that the outcome reflects banks' pricing and quantity decisions at the point of granting credit. Using firm–quarter fixed effects avoids an excessive loss of observations, since a firm must borrow from at least two banks within a fixed-effects period for the observation to remain in the sample (Amiti and Weinstein, 2018). We further include bank fixed effects ($\delta_b$) and a set of lagged bank-level controls to account for changes in balance-sheet conditions.[15]

Because banks typically set multiple loan terms jointly, we also control for other contractual features – loan size, loan rate, or loan maturity, depending on which variable is not the dependent variable – as well as indicators for loan risk, including a dummy for A-rated borrowers and a dummy for guaranteed loans. Together, these controls help ensure that the estimated relationship reflects variation in banks' funding stress rather than shifts in firm demand, bank fundamentals, or contemporaneous loan-pricing choices.

Beyond our baseline specification, we explore a number of complementary approaches to assess the robustness of the credit effects. First, we re-estimate Eq. 2 using pre-determined exposure measures – most notably the share of CDs in each bank's liabilities as of December 2019 – to verify that our findings are not driven by unobserved bank-level shocks correlated with our realized exposure measure. Ex-ante ratios have the advantage of mitigating endogeneity concerns, but they may to overstate the potential impact of funding disruptions, since exposures may not fully materialize in equilibrium, especially in the presence of central bank interventions. In contrast, our ex-post measure, based on realized CD losses, captures the effective funding losses experienced by banks during the shock.

Second, we examine the timing of the effects by estimating a time-varying version of Eq. 2, which allows the coefficient on exposure to evolve over the quarters surrounding the COVID-19 shock. This exercise not only sheds light on the term structure of the adjustment

[15]These include bank size (log total assets) and standard CAMEL indicators such as the tier-1 equity ratio, the non-performing loan ratio, the cost–income ratio, return on equity, and the liquid-asset ratio.

in lending conditions, but also enables us to detect any systematic pre-trends between more and less exposed banks that could affect the validity of our findings. We explicitly assess the robustness of our results to these alternative specifications in the following sections.

# 4 Data and sample

## 4.1 Data

We combine four sources of regulatory data provided by Banco de la República (BdR) and the Colombian Financial Supervisory Authority (Superintendencia Financiera de Colombia). Together, these datasets offer security-level information on funds' portfolios, daily secondary-market transactions in bank-issued CDs, and full credit-registry records for bank–firm lending relationships. Across the datasets, we focus on a sample period ranging from 2019Q1 to 2021Q1.

First, we employ detailed information on funds registered in Colombia. As explained in section 2.1, funds subject to liquidity regulation report their high-quality liquid assets (HQLAs), including the amount, rate type (fixed or variable), and counterparty of each position in certificates of deposit, government securities, and other liquid bonds. These data are reported at a daily frequency; we aggregate them to weekly net holdings and treat funds that buy and sell the same CD within the week as having zero net exposure. A separate regulatory report provides daily inflows and outflows, from which we construct weekly net redemptions, as well as information on each fund's assets, liabilities, cash, and equity, enabling us to compute standard balance-sheet ratios used in the analysis.

Second, we use daily transaction-level data from the secondary market for CDs. These records identify the buyer and seller, the nominal and transaction values, and an instrument code that links each CD to its issuing bank. We focus on trades in which investment funds are either buyers or sellers and aggregate them to weekly net purchases or sales at the fund–bank

level. The data also capture central bank interventions, as transactions in which funds sell CDs to the Banco de la Republica are recorded starting on the intervention dates.

Third, we match funds' holdings of CDs with the balance sheet information of the banks issuing the CDs. These data are reported on a monthly frequency to the supervisory authority. We construct several control variables described above from this data source to use them in the analysis of loan terms recorded in the credit registry.

Our third data source is the Colombian credit registry, which records the universe of loans issued by commercial banks to non-financial firms. The registry contains detailed contract-level information, including the amount, interest rate, and maturity of each loan at origination. We focus on new loans, defined as loan contracts that appear in the registry for the first time on their reported origination date. This choice ensures that the outcome reflects banks' pricing and quantity decisions at the time of granting credit, rather than adjustments in outstanding credit lines or revolving facilities.

To maintain comparability and avoid mechanical dynamics inherent in high-frequency consumer lending, we exclude revolving consumer credit, overdrafts, and credit lines; this restriction allows us to work with loan types where changes in terms more plausibly capture banks' risk sensitivity. Although origination dates are observed at the daily level, much of our analysis uses a firm–quarter frequency. This aggregation is necessary to retain a sufficiently large sample when implementing firm–time fixed effects in Eq. 2, since firms must borrow from at least two banks within a fixed-effects period for the observation to remain in the estimation sample. The resulting panel provides a comprehensive and balanced view of new credit extended to firms across Colombian banks around the COVID-19 shock.

## 4.2 Sample

Based on the data described above, we work with a sample of 14 open-ended funds and 141 closed funds that are invested in 52 Colombian commercial banks by holding CDs issued by

Table 1: Summary statistics

| | Mean (1) | Median (2) | Std. Dev. (3) | Min (4) | Max (5) |
|---|---|---|---|---|---|
| **Panel A. Fund-bank level sample** | | | | | |
| Log CD holdings | 11.36 | 0.00 | 12.34 | 0.00 | 28.65 |
| Δlog CD | -0.02 | 0.00 | 1.18 | -26.61 | 24.64 |
| ΔCD purchases | -0.10 | 0.00 | 10.57 | -25.60 | 25.44 |
| ΔCD sales | -0.07 | 0.00 | 10.22 | -25.77 | 26.04 |
| Log Redemption | 25.08 | 25.45 | 1.60 | 13.65 | 26.11 |
| **Panel B. Bank-firm level sample** | | | | | |
| Loan volume | 16.67 | 16.81 | 2.87 | 8.79 | 21.85 |
| Log standardized | -0.03 | 0.02 | 1.01 | -2.80 | 1.78 |
| Maturity | 33.42 | 34.00 | 28.29 | 0.00 | 120.00 |
| Log standardized | -0.03 | 0.44 | 1.08 | -3.09 | 1.07 |
| Loan rate | 14.15 | 11.03 | 9.10 | 0.65 | 28.95 |
| Log standardized | 0.01 | 0.05 | 1.02 | -3.03 | 1.17 |
| Exposure = -Δlog CD | 0.01 | 0.00 | 0.01 | 0.00 | 0.03 |
| Standardized | 0.04 | -0.40 | 1.04 | -1.01 | 3.09 |

Notes: This table reports summary statistics for the main working samples. Columns (1)–(5) report the mean, median, standard deviation (Std. Dev.), minimum, and maximum of each variable. Panel A summarizes the fund–bank sample used to estimate Eq. 1, while Panel B summarizes the bank–firm sample used to estimate Eq. 2. "Standardized" indicates that the variable above is scaled by its standard deviation, as in the regressions. Variable definitions and data sources are provided in Table A1. Summary statistics for control and auxiliary variables are reported in Table A2.

them. During the sample period, neither the banks nor the funds experienced bankruptcy or acquisition. The sample is balanced, although not all funds hold CDs of all banks at all times.

Funds manage, on average, an asset volume of about COP 830 billion (bn) (aprox. USD 220 million (mn)), while the median fund manages only around COP 207 bn (aprox. USD 55 mn). We report summary statistics in Table 1. Banks hold an average of COP 15 bn (USD 3.8 mn) in assets. The banking market in Colombia is fairly concentrated among five banks that jointly account for about two-thirds of total assets.

The banks in the sample are commercial banks with traditional business models focusing

on loans and deposits. The average deposit-to-asset ratio is 61 percent, and the average loan-to-asset ratio is 65 percent. In addition to retail deposits, banks extensively use CDs as an additional wholesale funding source. CDs account, on average, for 34 percent of total assets at book value. The funds in our sample own CDs from an average of 8 banks. However, their portfolios can be concentrated on specific banks, especially when the fund is affiliated with the bank.

Overall, we observe 2,008 fund-bank CD contractual relationships during the sample period, 272 of which involve open-ended funds (OEFs), and 1,736 involve non-OEFs. We refer to one contractual relationship as a fund holding one or more CD instruments from the same bank.

In the credit registry data, we observe a total of 384,279 loans during the sample period to different firms operating in all sectors across the country. The average loan amount is COP 286 mn (USD 73 thousand), and the median loan amount is less than a tenth of the mean (COP 20 mn, corresponding to about USD 5,000). Interest rates are quite high and range between 7.73 (25th percentile) and 23 percent (75th percentile). Common maturities are 3, 6, 12, 24, 36, or 48 months. When reducing the sample to firms that borrow from more than one bank at the same time, we observe 8,865 different firms. This is only a fraction of the total universe of Colombian firms. Usually, these firms are larger than those operating with only one bank relationship.

# 5 Results

## 5.1 Effects of fund redemptions on banks' CD Funding

In this subsection, we examine whether the extraordinary redemption pressures faced by Colombian funds during the onset of COVID-19 translated into disruptions in banks' CD funding. We begin by reporting the estimates from equation 1, focusing on the behavior of

open-ended funds in the weeks following the initial wave of withdrawals. For each outcome, we compare the sensitivity of funds' CD positions to redemptions in normal vs. stressed periods. The normal period corresponds to the pre-COVID year 2019, while the stressed period covers the first three months of the COVID-19 shock (March–May 2020).

The results are reported in Table 2. Columns 1 and 2 show that redemptions in normal times have no discernible effect on funds' CD holdings. In contrast, the large redemptions observed in March 2020 are associated with a significant reduction in CD positions within the first three months of the shock. The estimates imply that a one-percent increase in redemptions reduces CD holdings by about 0.11 percent. For context, redemptions during the first two weeks of March averaged COP 245 billion – above the 75th percentile of the pre-COVID distribution and roughly two standard deviations (COP 123 billion) of typical weekly outflows. A redemption shock of this size would therefore translate into a decline in CD holdings of roughly 1.5 percent, or about 19 percent of the cross-sectional standard deviation in CD levels.

Columns 3 and 4 provide complementary evidence using the weekly log change in CD holdings as the dependent variable. While level estimates capture the cumulative adjustment in funds' CD portfolios, growth rates speak to the intensive-margin dynamics of how quickly funds rebalance their positions when facing large redemptions. This distinction is economically relevant: even if CD levels decline, persistent negative growth rates may indicate sustained selling pressure or a slowdown in rollover activity, both of which matter for banks' short-term funding conditions.

In normal periods, redemptions are unrelated to CD growth (column 3). However, during March–May 2020, funds more exposed to outflows exhibit significantly lower CD growth – by 0.06 percentage points – which amounts to just 5 percent of the cross-sectional standard deviation in pre-COVID weekly growth rates. However, the impact is comparable to a move from the median (which is 0) to the lower 5th percentile (-0.02) in the distribution

Table 2: Redemptions and adjustments in funds' CD holdings

| Market conditions: | Log CD holdings | | Δ log CD | | Δ CD sales | | Δ CD purchases | |
|---|---|---|---|---|---|---|---|---|
| | normal | stress | normal | stress | normal | stress | normal | stress |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Log redemptions | -0.01 | -0.11** | 0.01 | -0.06*** | 0.07 | 1.04*** | -0.26** | -0.62* |
| | (0.656) | (0.021) | (0.207) | (0.009) | (0.454) | (0.001) | (0.016) | (0.060) |
| Fund-bank and fund level controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Bank x Week, Fund Fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 21,987 | 6,370 | 21,987 | 6,370 | 9,245 | 3,307 | 9,245 | 3,307 |
| R2-within | 0.39 | 0.44 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 |

Notes: The table shows the effects of weekly redemptions on weeky log CD holdings in columns 1 and 2, the week-on-week change in funds' CDs held at banks in columns 3 to 4, on weekly changes in CD sale transaction volumes in columns 5 and 6, and on weekly changes in purchase transaction volumes in columns 7 and 8. The sample includes only OEFs. The pre-COVID period is defined as all weeks in 2019 and the post-COVID period is defined as all weeks in March to May 2020. All specifications include bank-week and fund fixed effects. Standard errors clustered at the fund-bank level and p-values are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

of CD growth rates before the shock. Given the inclusion of bank–time fixed effects, these patterns can be associated to a reductions in CD demand by investment funds in response to the unprecedented redemption pressures triggered by the COVID-19 shock.

Columns 5–8 examine how funds adjust their trading activity in the secondary CD market when facing redemption pressure. Funds can reduce their CD exposure either by cutting purchases of newly issued CDs or by selling outstanding CDs before maturity – a costlier option that reflects acute liquidity needs. The estimates show that, during the stress period, funds experiencing larger redemptions sell substantially more CDs in the secondary market, far more than in normal times: the stressed-period coefficient is roughly thirty times larger than its pre-COVID counterpart. At the same time, funds sharply reduce their secondary-market purchases, the only margin they adjust as well in normal times to service redemptions. These patterns indicate that redemption pressures trigger not only a decline in demand for newly issued CDs but also sizable liquidation activity in the secondary market, amplifying the funding strain transmitted to issuing banks through both lower rollover demand and increased secondary market sales.

To assess the persistence of these patterns, Table 3 reproduces the baseline specifications over longer horizons—six months after March 2020 in the upper panel, and twelve months in

Table 3: The Medium-term Effect of Redemptions on CD demand

| | (1) Log CD | (2) ΔLog CD | (3) ΔCD sales | (4) ΔCD purch |
|---|---|---|---|---|
| *6-months after March 2020* | | | | |
| Log redemptions | -0.10*** | -0.01 | 0.39* | -0.51** |
| | (0.001) | (0.345) | (0.075) | (0.041) |
| Fund x Week, Fund x Bank x Week Controls | Yes | Yes | Yes | Yes |
| Bank x Week, Fund Fixed effects | Yes | Yes | Yes | Yes |
| Observations | 12,600 | 12,600 | 6,572 | 6,572 |
| R2-within | 0.446 | 0.007 | 0.004 | 0.001 |
| *12-months after March 2020* | | | | |
| Log redemptions | -0.01 | -0.01 | -0.12 | 0.10 |
| | (0.341) | (0.130) | (0.368) | (0.451) |
| Fund x Week, Fund x Bank x Week Controls | Yes | Yes | Yes | Yes |
| Bank x Week, Fund Fixed effects | Yes | Yes | Yes | Yes |
| Observations | 25,350 | 25,350 | 13,231 | 13,231 |
| R2-within | 0.459 | 0.003 | 0.001 | 0.001 |

Notes: The table shows the effects of weekly redemptions on the week-on-week change in funds' CDs held at banks, CD sales, and CD purchases in the secondary market. The sample includes only OEFs. The post-COVID period is defined as all weeks from March to August 2020 in the upper panel and all weeks from March 2020 to March 2021 the lower panel. All specifications include bank-week and fund fixed effects. Standard errors clustered at the fund-bank level and p-values are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

the lower panel. Across both windows, the pass-through from redemptions to CD holdings, CD growth, and secondary-market trading dissipates quickly. With the exception of a temporary increase in the volatility of CD growth in the first six months, none of the point estimates remain economically or statistically significant. These results indicate that the effects documented in Table 2 were short-lived and concentrated in the immediate aftermath of the redemption shock, consistent with the transitory spike in outflows and the rapid stabilization of funds' liquidity conditions once emergency measures were enacted.

Table 4 explores whether the link between redemptions and CD reductions varies with fund characteristics by re-estimating the baseline specification on subsamples split at the median of each characteristic. All regressions include the full set of controls, as well as bank–week and fund fixed effects. The upper panel shows that the pass-through from redemptions to CD liquidations is concentrated among funds with weaker liquidity capacity

Table 4: Heterogeneity in fund-level responses to redemptions

| | (1) Fund size | | (2) CD Ratio | | (3) Cash Ratio | | (4) Distance to RLI limit | |
|---|---|---|---|---|---|---|---|---|
| | x < p50 | x ≥ 50 | x < p50 | x ≥ 50 | x < p50 | x ≥ 50 | x < p50 | x ≥ 50 |
| Log redemptions | -0.0026*** | 0.0021 | -0.0023*** | 0.0026* | -0.0025** | -0.0009 | -0.0024** | -0.0012* |
| | (0.0003) | (0.0025) | (0.0003) | (0.0015) | (0.0010) | (0.0007) | (0.0009) | (0.0006) |
| Observations | 6,341 | 8,976 | 6,783 | 8,517 | 7,599 | 7,633 | 7,922 | 7,344 |
| R-squared | 0.1418 | 0.1783 | 0.1577 | 0.1616 | 0.1577 | 0.1688 | 0.1530 | 0.1586 |
| | (5) Open-Ended Funds | | (6) Conglomerate | | (7) Portfolio share | | (8) Market share | |
| | x = 1 | x = 0 | x = 1 | x = 0 | x < p50 | x ≥ 50 | x < p50 | x ≥ 50 |
| Log redemptions | -0.0051* | -0.0019*** | -0.0093 | -0.0017*** | -0.0042 | -0.0008** | -0.0014*** | -0.0013 |
| | (0.0026) | (0.0004) | (0.0134) | (0.0004) | (0.0028) | (0.0003) | (0.0004) | (0.0014) |
| Observations | 4,097 | 11,118 | 15,232 | 119 | 10,081 | 5,151 | 1,275 | 13,974 |
| R-squared | 0.2395 | 0.1223 | 0.1233 | 0.8603 | 0.1433 | 0.1352 | 0.2436 | 0.1336 |

Notes: The table shows the effects of weekly funds' redemptions on the week-on-week change in funds' CDs held at banks. Each column runs the regression, breaking the sample according to different characteristics. For instance, column 1 divides the sample based on the fund size and shows the results for two subsamples; the first subsample comprises funds below the median of the funds' size distribution, whereas the second subsample includes funds equal to or above the median. Also, note there are some columns that split the sample based on a dichotomic condition. For example, column 5 displays the results for two subsamples: Open-Ended funds and Non-Open-Ended funds. All specifications include the set of controls as in the baseline specification and bank-week and fund fixed effects. Standard errors clustered at the bank level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

or a less central role in the CD market. Smaller funds (column 1) and those holding a below-median share of their portfolio in CDs (column 2) display markedly stronger reductions in CD positions following redemptions. Consistent with the notion that funds first draw down cash buffers before selling assets, the effects are also amplified among funds with low cash ratios (column 3). Moreover, funds operating closer to the regulatory liquidity-risk limit exhibit larger CD liquidations than those with more comfortable buffers (column 4), though the latter still display a significant but substantially weaker response.

The lower panel of Table 4 highlights additional dimensions of heterogeneity. Funds that hold only a small market share of a given bank's CDs (column 8) are more likely to withdraw, consistent with weaker relationship intensity. Conversely, funds tend to liquidate CDs for which they hold a relatively large share in their own portfolios (column 7), suggesting that redemptions first trigger sales of assets that represent a meaningful portion of the fund's balance sheet. Affiliation also matters: in line with evidence that banks and funds within the same financial conglomerate support each other in stressed conditions (Golez and Marin,

2015; Gil-Bazo et al., 2020; Bagattini et al., 2023), column 6 shows that the pass-through is stronger for non-affiliated funds. Finally, distinguishing by organizational structure, column 5 reveals that both open-end and closed-end funds reduce CD holdings, but the magnitude is almost three times larger for open-end funds – consistent with their exposure to immediate redemption risk.[16] Overall, the results indicate that fragilities in bank funding relationships are concentrated among peripheral funds with weaker liquidity management and limited importance in the CD market, whereas funds that constitute core providers of bank funding remained comparatively resilient during the redemption episode.[17]

The further results reported in the appendix, we examine whether the emergency liquidity facilities introduced by the Banco de la República during the shock period helped attenuate the link between redemption shocks and bank funding markets. Beginning in mid-March, the central bank enabled funds to sell CDs directly through secondary-market purchase operations, providing an alternative liquidity outlet at a time when private buyers were scarce. To assess the extent to which this support cushioned the impact of redemptions, we construct several measures of central bank assistance at the fund level based on the share of a fund's CD sales executed with the central bank in a given week, as well as weighted versions that allow support to scale with the size of redemptions. We then interact these measures with funds' redemption volumes to capture whether liquidity provision moderates the pass-through from redemptions to CD liquidations.

Across all specifications reported in Table C1, the interaction terms are positive and statistically significant, indicating that access to central bank liquidity materially weakens

[16] In unreported results (available upon request), we confirm that closed-end funds do not exhibit a statistically significant difference-in-differences effect around the shock.

[17] In additional heterogeneity analyses reported in Appendix Table A5, we examine which types of banks were more affected by redemption-driven CD liquidations. The results indicate that funds tend to sell CDs of banks with more liquid CD markets – larger banks and those with a high market share of total CDs – consistent with greater ease of finding buyers in deeper secondary markets. At the same time, funds disproportionately reduce exposures to riskier banks, particularly those with higher non-performing loan ratios and lower Tier 1 capital ratios, suggesting that wholesale investors actively monitor bank risk during periods of stress.

the negative link between redemptions and CD holdings. In economic terms, the mitigating effect of liquidity support is large enough to offset the direct pass-through of redemptions on average, as illustrated in Figure C1. The marginal effect of redemptions on CD holdings becomes small and statistically insignificant once funds channel a modest share of their CD sales through the central bank. These results underscore that emergency purchases played a meaningful stabilizing role by easing liquidity constraints on funds and thereby dampening the propagation of their redemption shocks to banks' short-term funding markets.[18]

## 5.2 Funding stress and banks' credit supply adjustments

Table 5 examines whether the funding stress transmitted from investment funds to banks is associated with adjustments in the terms of newly originated loans. The table reports estimates of Eq. 2 for three loan-level outcomes – loan size, loan rates, and loan maturity – using firm–bank matched data from 2019m1–2021m1. The exposure variable is the standardized log change in bank-level CD balances held by funds between March and May 2020 – constructed as a loss function such that larger values correspond to larger CD outflows – whereas the dependent variables are the log of loan volume, the loan rate, and the log of loan maturity in months. In columns (1), (3) and (5) we include quarter fixed effects along with bank and loan-level controls, whereas columns (2), (4) and (6) add firm–quarter and bank–firm fixed effects.

Across specifications, banks more exposed to the redemption shock exhibit systematic adjustments in their lending behavior during the post-COVID period. Columns 1–2 show that more-exposed banks originate smaller loans relative to less-exposed peers. Columns 3–4 indicate some evidence of a negative association with loan rates: in the simpler specification, exposed banks appear to offer slightly lower interest rates, although this relationship becomes

[18] As an additional robustness check, we assess whether our findings are sensitive to alternative fixed-effects structures and to a conventional difference-in-differences specification. Appendix Table A4 shows that the estimated effects of redemptions on CD holdings remain stable across these alternative designs, lending further support to the validity of our baseline results.

Table 5: Loan outcomes and banks' exposure to redemptions

| Dep. variable: | Log loan | | Loan rate | | Maturity (log months) | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Post × Exposure | -0.106* | -0.053** | -0.343* | -0.208 | -0.102** | -0.156*** |
| | (0.055) | (0.024) | (0.178) | (0.136) | (0.046) | (0.048) |
| Exposure | 0.092*** | - | 0.329*** | - | 0.123*** | - |
| | (0.031) | | (0.056) | | (0.035) | |
| Quarter FE | Yes | No | Yes | No | Yes | No |
| Firm x bank FE | No | Yes | No | Yes | No | Yes |
| Firm × quarter FE | No | Yes | No | Yes | No | Yes |
| Bank, loan and firm controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 36,996 | 36,996 | 36,996 | 36,996 | 36,996 | 36,996 |
| Within R-squared | 0.474 | 0.474 | 0.483 | 0.442 | 0.402 | 0.413 |

Notes: The table reports estimates of Eq. (2) relating banks' exposure to fund redemptions to loan-level outcomes. The sample includes newly originated loans in the credit registry between January 2019 and January 2021. The dependent variables are the logarithm of loan volume (cols. 1-2), the loan interest rate (cols. 3-4), and the logarithm of loan maturity in months (col. 5-6). Exposure is a time-invariant bank-level measure capturing the cumulative decline in CDs held by funds during the initial COVID-19 shock window in log changes. Post equals one for observations after March 2020 and zero otherwise. All regressions include firm–quarter and bank–firm fixed effects. The dependent variables and exposure measure are standardized, so estimates correspond to the effect of a one–standard-deviation increase in exposure. Loan-level controls comprise log loan volume, loan rate, loan maturity (when not used as the dependent variable), an indicator for A-rated borrowers, and an indicator for guaranteed loans. Bank-level controls include the log of CDs held by the central bank, log total assets, log equity, the non-performing loan ratio, return on equity, and the liquid-asset ratio, all lagged five weeks. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

statistically insignificant once firm–quarter fixed effects are introduced. This attenuation suggests that interest-rate adjustments are modest relative to the changes occurring on the quantity and maturity dimensions, possibly because pricing is subject to tighter firm-specific or contractual constraints than loan size or tenure. Finally, columns 5–6 show that exposed banks extend loans with significantly shorter maturities. Because these estimates absorb firm–quarter and bank–firm fixed effects, identification comes from comparisons across banks lending to the same firm at the same time. Taken together, the results suggest that stress in banks' wholesale funding markets is associated with meaningful adjustments in the scale and maturity of bank credit.

To illustrate the magnitude of these adjustments, consider the coefficient of –0.053 in column (2) on Table 5. Because variables are standardized, this estimate implies that a one–standard-deviation increase in CD losses is associated with a 5.3 percent reduction in loan size. Given that the mean loan in our sample is 286 million COP (or aprox. 76,000 USD), this corresponds to a decline of roughly 15 million COP (aprox. 4,000 USD). Thus, for an average-sized loan, banks more exposed to the redemption shock originate materially smaller credit volumes than less-exposed peers.

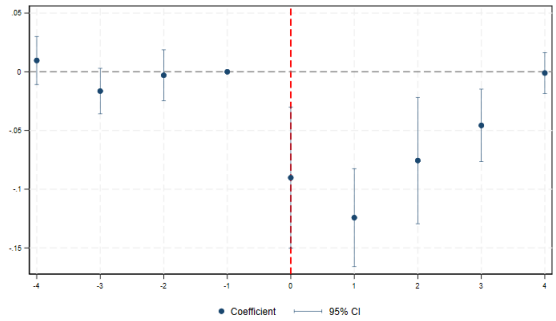
The effect on maturity is substantially larger. The coefficient of –0.156 in column (6) implies that a one–standard-deviation increase in exposure is associated with a 15.6 percent reduction in loan tenure. Given an average maturity of 33 months in our sample, this translates into a shortening of roughly 5.2 months. This sizable adjustment – nearly half a year – illustrates that funding stress transmitted from investment funds to banks can be associated with economically meaningful changes in the maturity structure of newly originated loans.

A plausible interpretation of these patterns is that funding stress may compress banks' willingness to commit liquidity over longer horizons, leading to sharper adjustments in quantities and maturities than in loan pricing. When a bank's short-term wholesale funding becomes less predictable, the marginal cost of extending long-term credit can rise disproportionately, making it more attractive to scale down loan sizes and shorten maturities while interest rates decrease. Pricing may react less both because contractual or competitive forces limit short-run adjustments and because the stress primarily affects banks' capacity to engage in maturity transformation rather than their overall pricing of risk.[19]

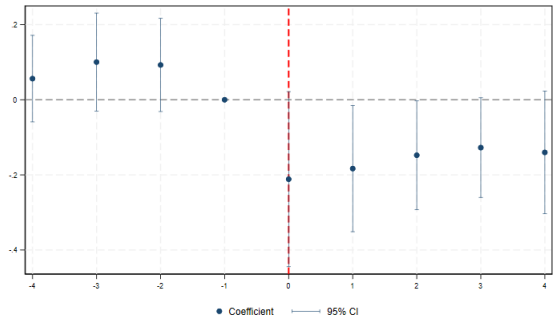
To complement the baseline estimates, we examine the dynamic evolution of lending behavior around the COVID-19 shock by estimating a time-varying version of Eq. 2. In this

[19]This interpretation is consistent with theoretical discussions on how funding constraints shape banks' maturity choices and the supply of long-term credit. See, for example, Stein (2012), and models of liquidity and maturity management in He and Krishnamurthy (2013).

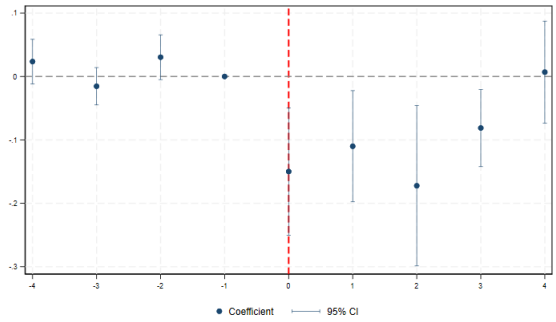
Figure 3: Time-variant effect of CD exposure on loan outcomes




(a) Effect on loan volume




(b) Effect on loan rate




(c) Effect on loan maturity

*Notes:* This figure plots time-varying estimates of Eq. 2, obtained by interacting the exposure measure with a series of quarter dummies. The sample period ranges from 2019Q1 to 2021Q1. Quarter 0 corresponds to the first quarter of 2020, and the figure reports coefficients for four quarters before and four quarters after this reference period. Quarter -1 serves as the omitted reference category, consistent with conventional event-study practice, so all coefficients are interpreted relative to lending behavior in the quarter immediately preceding the shock. All specifications include the same firm–quarter fixed effects, bank–firm fixed effects, and loan- and bank-level controls as in the baseline regressions. Standard errors are clustered at the bank level. Whiskers display 95% confidence intervals.

specification, banks' exposure is interacted with a series of quarter dummies, normalizing quarter 0 to the first quarter of 2020 and tracing coefficients for four quarters before and

after this period. This exercise serves two purposes. First, it provides a visual validation of the parallel-trends assumption: before the shock, more- and less-exposed banks exhibit no systematic differences in lending outcomes. Second, it allows us to assess how persistent the lending adjustments associated with funding stress are, using the same firm–quarter and bank–firm fixed effects and control set as in the baseline regressions.

The patterns in Figure 3 broadly reinforce the results from the average specifications. Both loan volume and loan maturity display a clear break beginning in quarter 0, followed by economically meaningful effects that persist for roughly four quarters after the shock, with no evidence of differential pre-trends. The coefficients for loan rates are negative and occasionally marginally significant in the post-shock quarters, though—as shown earlier—these pricing effects do not survive once firm–quarter fixed effects are imposed in the average specification. A plausible interpretation is that interest rates are more tightly anchored by firm-specific risk, contractual rigidities, or competitive conditions, whereas loan quantities and maturities give banks greater scope to adjust their exposure when facing funding stress. Taken together, the time-varying results strengthen the interpretation that funding-market disruptions primarily reshape the scale and horizon of new credit rather than its pricing.

To assess the stability of our baseline estimates, we re-estimate Eq. 2 under a series of alternative specifications reported in Table A6 in the Appendix. Across all tests, the core patterns remain unchanged: more exposed banks originate smaller and shorter-maturity loans at lower rates, on average. First, replacing our post-shock exposure measure with an ex-ante proxy based on the 2019 CD-to-liabilities ratio yields coefficients of comparable magnitude and significance. Second, a placebo exercise using only 2019 data generates no systematic pre-trend, reinforcing the timing-based identification. Third, excluding foreign-owned banks leaves the results virtually unchanged.[20] Finally, restricting the sample to firms borrowing

[20]Excluding foreign banks is relevant because subsidiaries of multinational groups may rely on internal liquidity support or centralized treasury management (Cetorelli and Goldberg, 2012; Eguren-Martin et al., 2024), making their response to domestic funding shocks structurally different from that of locally funded banks.

from at least two banks in both the pre- and post-periods - thereby tightening identification to within-firm, across-bank variation - produces very similar estimates. Together, these tests align with the notion that our findings are not driven by exposure measurement, sample composition, or pre-existing trends.[21]

A remaining concern is that our baseline exposure measure may proxy for broader balance-sheet adjustments rather than a disruption specific to wholesale funding from investment funds. To address this, we conduct a horse-race exercise in which we jointly include the baseline CD-loss exposure alongside alternative bank-level balance-sheet adjustments, namely changes in sight deposits and in total assets during the March–May 2020 shock window. These alternative measures capture, respectively, the reallocation of retail funding and overall balance-sheet expansion or contraction. As shown in Table A8, the interaction between post-shock exposure and CD losses remains stable and highly statistically significant across all loan outcomes, while the competing exposure measures carry no robust explanatory power. This evidence reduces concerns that our baseline results merely reflect generalized balance-sheet retrenchment.

## 5.3 Funding stress and borrower risk composition

One way to reconcile the pattern documented above — smaller loan volumes, shorter maturities, and lower loan rates among more exposed banks — is to consider how liquidity stress affects banks' screening and borrower selection. When funding becomes more uncertain, banks may reduce the size and duration of new lending while reallocating credit toward firms with lower expected loss. Under this mechanism, average interest rates fall not because lending conditions ease, but because the composition of borrowers shifts toward safer firms.

[21] Table A7 presents additional robustness tests that address concerns related to central bank intervention and the functional form of the exposure variable. Columns (1)–(3) exclude banks that received large liquidity injections — those for which the share of outstanding CD purchased by the central bank during the shock period was above the 75th percentile. Columns (4)–(6) replace the continuous exposure variable with a high-exposure dummy (above-median CD losses), ensuring that results are not driven by functional-form assumptions. Across specifications, the qualitative patterns remain unchanged.

Table 6: Banks' exposure to fund redemptions and shifts in borrower risk

| Dep. variable: | Credit risk | Credit risk | Z-score |
|---|---|---|---|
| | (1) | (2) | (3) |
| Post × Exposure | -0.123* | -0.308*** | -0.186*** |
| | (0.057) | (0.073) | (0.043) |
| Exposure | ΔCD | CD/Liabilities | ΔCD |
| Quarter FE | Yes | Yes | Yes |
| Bank FE | Yes | Yes | Yes |
| Bank and loan controls | Yes | Yes | Yes |
| Observations | 29,581 | 29,581 | 33,240 |
| Within R-squared | 0.0229 | 0.0268 | 0.122 |

Notes: The table reports regressions linking banks' exposure to fund redemptions to measures of borrower risk in newly originated loans from the Colombian credit registry (January 2019–January 2021). Column 1 uses as dependent variable a risk residual, constructed as the residual from a pre-COVID loan-level regression of interest rates on maturity, volume, borrower rating, guarantees, and bank controls, aggregated to the firm level as in Eq. 2. Exposure in Columns 1 and 3 is a time-invariant bank-level measure of the standardized log decline in CDs held by funds during March–May 2020, so higher values indicate larger funding losses. Column 2 uses the same dependent variable but replaces the exposure measure with an ex-ante proxy given by the 2019 CD-to-liabilities ratio. Column 3 uses a z-score of firm risk, defined as the standardized deviation of the firm's average loan rate from the bank-specific pre-COVID rate distribution. All regressions include bank and quarter fixed effects, and standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

This form of "flight-to-safety" behavior is consistent with theoretical models in which liquidity shocks lead banks to shorten asset duration and sharpen screening.[22]

To test this hypothesis, we further examine whether banks differentially adjust the composition of borrowers after the shock. We construct two pre-COVID firm-level measures of perceived borrower risk and test whether more exposed banks tilt their post-shock lending toward safer firms. The estimates, reported in Table 6, show a consistent pattern across specifications: the interaction of Post and Exposure is negative and statistically significant for both the risk-residual measure and a risk z-score index. This indicates that, relative to

[22]Theoretical frameworks linking liquidity stress to maturity shortening and borrower selection include, among others, Stein (1998) and Diamond and Rajan (2001). Furthermore, shorter-maturity loans carry lower contractual rates because the term structure of loan pricing is upward-sloping (see, for instance, Jiménez et al., 2014).

less-exposed peers, banks facing larger funding losses subsequently originate loans to firms that were priced as safer ex-ante. As an illustration, in column (1) the coefficient of –0.123 implies that a one–standard-deviation increase in a bank's exposure to CD losses is associated with a 0.12–standard-deviation decline in the average risk of its new borrowers. In underlying units, this corresponds to roughly a 10 basis points reduction in the residual component of loan rates — an economically meaningful shift consistent with a post-shock reallocation toward safer firms.[23]

# 6 Concluding remarks

Recent episodes of financial turmoil, including prominently the 2023 U.S. regional banking crises, have highlighted the financial-stability implications of wholesale funding markets. While the fragility of wholesale deposits has been a matter of ample discussion in policy and academic circles, any policy guidance to address related systemic vulnerabilities requires understanding the mechanisms linking wholesale depositors' fragility and banks' liquidity risk.

In this paper, we examine how disruptions in wholesale deposit markets – triggered by large-scale redemptions from investment funds during the COVID-19 shock in Colombia – propagated to bank funding conditions and, ultimately, to the supply of credit. Using novel microdata that link investment funds to banks through their holdings of certificates of deposit, we examine the transmission of redemption pressures to banks' wholesale funding and analyze how banks' exposure to this stress shaped the terms of newly originated loans.

[23]Table 6 presents three specifications using two alternative firm-level risk measures constructed from pre-COVID data. (i) The risk residual aggregates to the firm level the residuals from a 2019 loan-level regression of interest rates on loan maturity, volume, borrower rating, guarantees, and lagged bank balance-sheet controls (log assets, regulatory capital, NPL ratio, ROE, liquid-asset ratio). (ii) The z-score index measures a firm's standardized deviation from its lenders' pre-COVID rate distribution. Both risk measures and the exposure variables (the log decline in CDs held by funds between March–May 2020 in cols. 1 and 3 and the average ratio of CD to liabilities as of 2019 in col. 2) are standardized so coefficients reflect effects in standard-deviation units.

Although the pass-through to bank funding markets was short-lived, our results show that more-exposed banks adjusted their lending policies by originating smaller loans and shortening their maturities, with limited systematic effects on loan pricing. These adjustments suggest that episodes of funding stress can lead banks to retrench along the quantity and maturity dimensions of credit, reflecting a temporary reduction in their capacity or willingness to engage in maturity transformation even when overall funding remains sufficient at the aggregate level.

From a policy perspective, the results suggest that improving financial monitoring in the non-bank financial sector can strengthen supervisors' capacity to anticipate sources of banks' liquidity risk, which may impair credit market functioning in times of distress. Moreover, the documented effectiveness of central bank liquidity facilities in reducing funding market stress lends support to the idea that a timely intervention of central banks can mitigate the spread of liquidity risk. Finally, the fact that banks react to surges in liquidity risk by reducing loans' maturity means that borrowers requiring long-term funding – including large investment projects – can be particularly affected when wholesale deposit markets become disrupted, which could be considered in the design of public support measures and credit guarantees in times of crisis.

# 7 Bibliography


Acharya, V.V., Das, A., Kulkarni, N., Mishra, P., Prabhala, N.R., 2022. Deposit and credit reallocation in a banking panic: The role of state-owned banks. https://www.nber.org/papers/w30557. doi:10.3386/w30557. nBER Working Paper No. 30557. Revised February 2025.

Acharya, V.V., Mora, N., 2015. A crisis of banks as liquidity providers. Journal of Finance 70, 1–43.

Acharya, V.V., Richardson, M.P., Schoenholtz, K.L., Tuckman, B., Berner, R., Cecchetti, S.G., Kim, S., Kim, S., Philippon, T., Ryan, S.G., Savov, A., Schnabl, P., White, L.J., 2023. Svb and beyond: The banking stress of 2023. CEPR Press, Paris & London, Available at SSRN: https://ssrn.com/abstract=4513276 .

Aldasoro, I., Balke, F., Barth, A., Eren, E., 2022. Spillovers of funding dry-ups. Journal of International Economics 137(C), 103622.

Aldasoro, I., Doerr, S., Zhou, H., 2025. Non-bank lending during crises. Review of Finance 29, 1809–1832. doi:10.1093/rof/rfaf043.

Amiti, M., Weinstein, D.E., 2018. How much do idiosyncratic bank shocks affect investment? Evidence from matched bank-firm loan data. Journal of Political Economy 126, 525–587.

Garcia-de Andoain, C., Heider, F., Hoerova, M., Manganelli, S., 2016. Lending-of-last-resort is as lending-of-last-resort does: Central bank liquidity provision and interbank market functioning in the euro area. Journal of Financial Intermediation 28, 32–47.

Bagattini, G., Fecht, F., Maddaloni, A., 2023. Liquidity support and distress resilience in bank-affiliated mutual funds. ECB Working Paper Series 2799, European Central Bank .

Bechtel, A., Ranaldo, A., Wrampelmeyer, J., 2023. Liquidity risk and funding cost. Review of Finance 27, 399–422.

Breckenfelder, J., Hoerova, M., 2023. Do non-banks need access to the lender of last resort? evidence from fund runs. ECB Working Paper Series 2805, European Central Bank .

Brunnermeier, M.K., Oehmke, M., 2013. The maturity rat race. Journal of Finance 68, 483–521. doi:10.1111/jofi.12005.

Cetorelli, N., Goldberg, L.S., 2012. Banking globalization and monetary transmission. Journal of Finance 67(5), 1811–1843.

Chernenko, S., Sunderam, A., 2014. Frictions in shadow banking: Evidence from the lending behavior of money market funds. The Review of Financial Studies 137, 2343–2380.

Copeland, A., Martin, A., Walker, M., 2014. Repo runs: Evidence from the tri-party repo market. Journal of Finance 69, 2343–2380.

Cornett, M.M., McNutt, J.J., Strahan, P.E., Tehranian, H., 2011. Liquidity risk management and credit supply in the financial crisis. Journal of Financial Economics 101, 297–312.

Correa, R., Sapriza, H., Zlate, A., 2021. Wholesale funding runs, global banks' supply of liquidity insurance, and corporate investment. Journal of International Economics 133, 103519.

Covitz, D., Lian, L., Adrian, T., 2015. Financial stability monitoring. Annual Review of Financial Economics 7, 357–395.

Diamond, D.W., Rajan, R.G., 2001. Liquidity risk, liquidity creation, and financial fragility: A theory of banking. Journal of Political Economy 109, 287–327.

Drechsler, I., Savov, A., Schnabl, P., Wang, O., 2023. Banking on uninsured deposits. NBER Working Paper Series, National Bureau of Economic Research .

Eguren-Martin, F., Ossandon Busch, M., Reinhardt, D., 2024. Global banks and synthetic funding: The benefits of foreign relatives. Journal of Money, Credit and Banking 56(1), 115–152.

Elliott, D., Meisenzahl, R.R., Peydró, J.L., 2024. Nonbank lenders as global shock absorbers: Evidence from US monetary policy spillovers. Journal of International Economics 149, 103908.

Falato, A., Goldstein, I., Hortaçsu, A., 2021. Financial fragility in the COVID-19 crisis: The case of investment funds in corporate bond markets. Journal of Monetary Economics 123, 35–52.

FSB, 2023. Promoting Global Financial Stability: 2023 Annual Report. Financial Stability Board. Available at https://www.fsb.org/2023/10/promoting-global-financial-stability-2023-fsb-annual-report/.

Gebauer, S., Mazelis, F., 2023. Macroprudential regulation and leakage to the shadow banking sector. European Economic Review 154, 104404.

Gil-Bazo, J., Hoffmann, P., Mayordomo, S., 2020. Mutual funding. The Review of Financial Studies 33, 4883–4915.

Golez, B., Marin, J.M., 2015. Price support by bank-affiliated mutual funds. Journal of Financial Economics 115, 614–638.

Golez, B., Rizzo, A.E., Zambrana, R., 2024. Friendly investing and information sharing in the asset management industry. Journal of Financial and Quantitative Analysis 59, 2869–2898.

Gorton, G., Metrick, A., 2012. Securitized banking and the run on repo. Journal of Financial Economics 104, 425–451.

He, Z., Krishnamurthy, A., 2013. Intermediary asset pricing. American Economic Review 103, 732–770.

IMF, 2023. Nonbank financial intermediaries: Vulnerabilities amid tighter financial conditions. Chapter 2 in *Global Financial Stability Report*, International Monetary Fund.

Available at https://www.imf.org/-/media/files/publications/gfsr/2023/april/english/ch2.pdf.

Ippolito, F., Peydró, J.L., Polo, A., Sette, E., 2016. Double bank runs and liquidity risk management. Journal of Financial Economics 122, 135–154.

Irani, R.M., Iyer, R., Meisenzahl, R.R., Peydró, J.L., 2021. The rise of shadow banking: Evidence from capital regulation. The Review of Financial Studies 34, 2181–2235.

Ivashina, V., Scharfstein, D., 2010. Bank lending during the financial crisis of 2008. Journal of Financial Economics 97, 319–338.

Ivashina, V., Scharfstein, D.S., Stein, J.C., 2014. Dollar funding and the lending behavior of global banks. The Quarterly Journal of Economics 130, 1241–1281.

Jiménez, G., Ongena, S., Peydró, J.L., Saurina, J., 2014. Hazardous times for monetary policy: What do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking? Econometrica 82, 463–505.

Kapan, T., Minoiu, C., 2014. Liquidity shocks and the supply of credit after the 2007–2008 crisis. International Journal of Finance & Economics 19, 12–23.

Kashyap, A.K., Rajan, R.G., Stein, J.C., 2002. Banks as liquidity providers: An explanation for the coexistence of lending and deposit-taking. Journal of Finance 57, 33–73.

Khwaja, A.I., Mian, A., 2008. Tracing the impact of bank liquidity shocks: Evidence from an emerging market. The American Economic Review 98, 1413–1442.

Krishnamurthy, A., Nagel, S., Orlov, D., 2014. Sizing up repo. Journal of Finance 69, 2381–2417.

Li, L., Li, Y., Macchiavelli, M., Zhou, X., 2021. Liquidity restrictions, runs, and central bank interventions: Evidence from money market funds. The Review of Financial Studies 34, 5402–5437.

Li, Y., 2021. Reciprocal lending relationships in shadow banking. Journal of Financial Economics 141, 600–619.

Magnani, J., Wang, Y., 2023. Wholesale funding runs, spreads and central bank interventions. SSRN Working Paper. Available at https://ssrn.com/abstract=4268058.

Pinter, G., 2023. An anatomy of the 2022 gilt market crisis. Bank of England Working Paper 1019 .

Pratobevera, G., 2024. Bank-affiliated institutional investors and IPO syndicates formation. Journal of Corporate Finance 86, 102587.

Pérignon, C., Thesmar, D., Vuillemey, G., 2018. Wholesale funding dry-ups. Journal of Finance 73, 575–617.

Sarmiento, M., 2024. The transmission of non-banking liquidity shocks to the banking sector. Latin American Journal of Central Banking , 100139.

Stein, J.C., 1998. An adverse-selection model of bank asset and liability management with implications for the transmission of monetary policy. The RAND Journal of Economics 29, 466–486.

Stein, J.C., 2012. Monetary policy as financial stability regulation. Quarterly Journal of Economics 127, 57–95.

Vargas, H., Ospina, J.J., Romero, J.V., 2022. The COVID-19 shock and the monetary policy response in Colombia. BIS Paper No. 122, Bank for International Settlemenst, Basel .

Williams, T., 2018. Capital inflows, sovereign debt and bank lending: Micro-evidence from an emerging market. The Review of Financial Studies 31, 4958–4994.

# A Appendix

## A Additional tables

Table A1: Variable definitions

| Variable | Definition | Source |
|---|---|---|
| *BankExp* | Average characteristics of banks whose CDs are held by funds $k$. Bank characteristics include NPL ratio, capital ratio, deposit ratio, log assets, leverage ratio, and return on assets (RoA). Each characteristic is weighted by the share of bank $b$'s CDs in fund $k$'s total CD portfolio as of December 2019. | Own elaboration |
| *RED* | Log of weekly gross outflows from fund $k$, originally reported in millions of COP. | BdR |
| NPL ratio | The share of non-performing loans in a bank's total loan portfolio, measured at the bank–month level and capturing the credit risk and asset quality of a bank. | BdR |
| Capital–assets ratio | Ratio of a bank's regulatory capital to its total assets, measured at the bank–month level and originally reported in millions of COP; it captures the bank's solvency buffer. | BdR |
| Deposit ratio | Ratio of total deposits to total assets for each bank–month observation, reported in millions of COP, capturing the stability and composition of the bank's funding structure. | BdR |
| Log assets | Natural logarithm of a bank's total assets in a given month, originally reported in millions of COP, serving as a measure of bank size. | BdR |
| Leverage ratio | Ratio of regulatory capital to total liabilities at the bank–month level, reported in millions of COP, capturing the extent to which a bank relies on debt financing. | BdR |
| Return on assets (RoA) | Net income divided by total assets, measured monthly for each bank and reported in millions of COP, capturing the bank's profitability relative to its asset base. | BdR |
| Return on assets (RoA) | Net income divided by total assets, measured monthly for each bank and reported in millions of COP, capturing the bank's profitability relative to its asset base. | BdR |
| Log CD holdings | Natural logarithm of the total value of CDs held by fund $k$ at bank $b$ in week $t$, based on weekly portfolio positions reported by fund managers. | SFC |
| $\Delta$ log CD | Week-on-week log growth rate of CDs held by fund $k$ at bank $b$, capturing short-term adjustments in CD exposure. | SFC |
| SD($\Delta$ log CD) | Standard deviation of weekly log changes in CD holdings for fund $k$ at bank $b$, computed over a rolling window, capturing uncertainty and instability in CD demand. | SFC |

Notes: This table reports the definition and sources of the variables used in the empirical analysis. BdR corresponds to Banco de la Republica, the central bank of Colombia. SFC stands for the Superintendencia Financiera de Colombia, the Colombian financial supervisory authority.

Table A1: Variable definitions (continued)

| Variable | Definition | Source |
|---|---|---|
| $\Delta$ CD sales | Weekly change in the value of CDs issued by bank $b$ sold by fund $k$ in the secondary market. | SFC |
| $\Delta$ CD purchases | Weekly change in the value of CDs issued by bank $b$ purchased by fund $k$ in the secondary market. | SFC |
| Cash-to-asset ratio | Ratio of cash holdings to total assets of fund $k$, measured at $t-1$ based on weekly regulatory portfolio data. | SFC |
| CD-to-asset ratio | Ratio of the value of CDs held by fund $k$ to its total assets, measured at $t-1$ based on weekly regulatory portfolio data. | SFC |
| Portfolio share | Share of CDs issued by bank $b$ in the total portfolio of fund $k$, measured at $t-1$ based on weekly regulatory portfolio data. | SFC |
| Market share | Share of bank $b$'s total outstanding CDs that is held by fund $k$, measured at $t-1$ based on weekly regulatory portfolio data. | SFC |
| SD of log growth in treasuries | Standard deviation of the weekly log change in government treasuries held by fund $k$, computed up to $t-1$ using regulatory portfolio data. | SFC |
| SD of log growth in bonds | Standard deviation of the weekly log change in other bonds held by fund $k$, computed up to $t-1$ using regulatory portfolio data. | SFC |
| Log N° of investors | Logarithm of the number of investors in fund $k$, measured at $t-1$ using weekly regulatory reports. | SFC |
| LCR 30-day | Regulatory 30-day liquidity coverage ratio of fund $k$, measured at $t-1$ based on supervisory liquidity reports. | SFC |
| Share of fixed rate investments | Share of fund $k$'s portfolio invested in fixed-rate instruments, measured at $t-1$ using weekly regulatory portfolio data. | SFC |
| Share of CD trades with the central bank | Share of CD sales by fund $k$ in week $t$ executed with the central bank, relative to its total CD sales, measured at $t-1$. | SFC |
| Fund log assets | Logarithm of total assets of fund $k$, measured at $t-1$ based on weekly regulatory reports. | SFC |
| Log redemptions | Natural logarithm of weekly outflows from fund $k$ based on regulatory flow reports. | SFC |

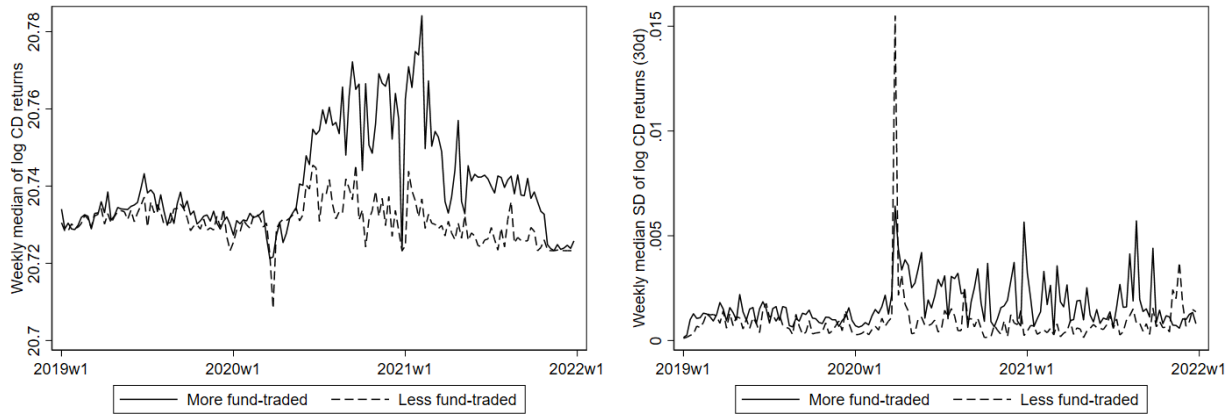
Notes: This table reports the definition and sources of the variables used in the empirical analysis. BdR corresponds to Banco de la Republica, the central bank of Colombia. SFC stands for the Superintendencia Financiera de Colombia, the Colombian financial supervisory authority.

Table A1: Variable definitions (continued)

| Variable | Definition | Source |
|---|---|---|
| Fund size (dummy) | Equals 1 if fund $k$'s log total assets are above the December 2019 median. | SFC |
| CD ratio (dummy) | Equals 1 if the share of CDs in fund $k$'s total portfolio is above the December 2019 median. | SFC |
| Cash ratio (dummy) | Equals 1 if fund $k$'s cash-to-assets ratio is above the December 2019 median. | SFC |
| Distance to RLI limit (dummy) | Equals 1 if fund $k$'s distance to the regulatory liquidity requirement is above the December 2019 median. | SFC |
| Open-ended fund (dummy) | Equals 1 if the fund is classified as an open-ended fund under regulatory definitions. | SFC |
| Conglomerate (dummy) | Equals 1 if fund $k$ belongs to the same financial conglomerate as the bank issuing the CDs in its portfolio. | SFC |
| Portfolio share (dummy) | Equals 1 if the share of CDs issued by bank $b$ in fund $k$'s portfolio is above the December 2019 median. | SFC |
| Market share (dummy) | Equals 1 if the share of bank $b$'s outstanding CDs held by fund $k$ is above the December 2019 median. | SFC |
| Post | Dummy equal to 1 for loan observations dated after March 2020 (sample: 2019m1–2021m1), and 0 otherwise. | Own elaboration |
| Exposure | Loss function capturing the bank-level funding shock: defined as the log change in total CDs outstanding for bank $b$ between March and May 2020, with higher values indicating larger decreases in CD funding. | Own elaboration |
| Log loan volume | Natural logarithm of the amount of the newly originated loan between bank $b$ and firm $f$, originally reported in millions of COP. | BdR |
| Loan rate | Contractual annual interest rate of the newly originated loan between bank $b$ and firm $f$, as reported in the credit registry. | BdR |
| Log loan maturity | Natural logarithm of the contractual maturity of the loan between bank $b$ and firm $f$, measured in months at origination. | BdR |
| Log CB purchases | Logarithm of the value of CDs sold by fund $k$ to the central bank in week $t$. | BdR |
| Weighted CB purchases | Log CB purchases for fund $k$ multiplied by its log redemptions in week $t$, capturing the relevance of central bank support when funds face outflows. | BdR |
| CB liquidity support index | Ratio of the amount of CDs sold by fund $k$ to the central bank in week $t$ to the total amount of CDs sold by fund $k$ in that week, normalized to construct an index of central-bank absorption. | BdR |
| Weighted CB liquidity support index | CB liquidity support index for fund $k$ multiplied by its log redemptions in week $t$, capturing the intensity of support relative to the fund's redemption pressure. | BdR |

Notes: This table reports the definition and sources of the variables used in the empirical analysis. BdR corresponds to Banco de la Republica, the central bank of Colombia. SFC stands for the Superintendencia Financiera de Colombia, the Colombian financial supervisory authority.

Figure A1: Return and volatility in the secondary CD market.

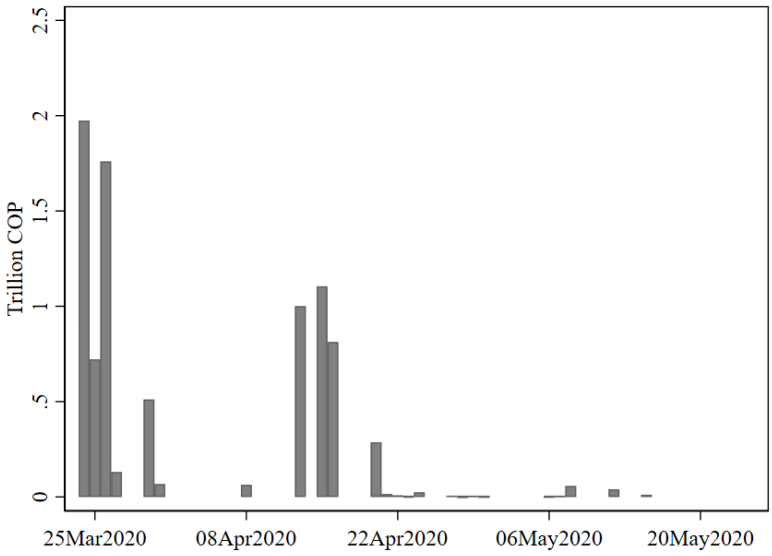



(a) Log returns.

(b) Standard deviation of log returns.

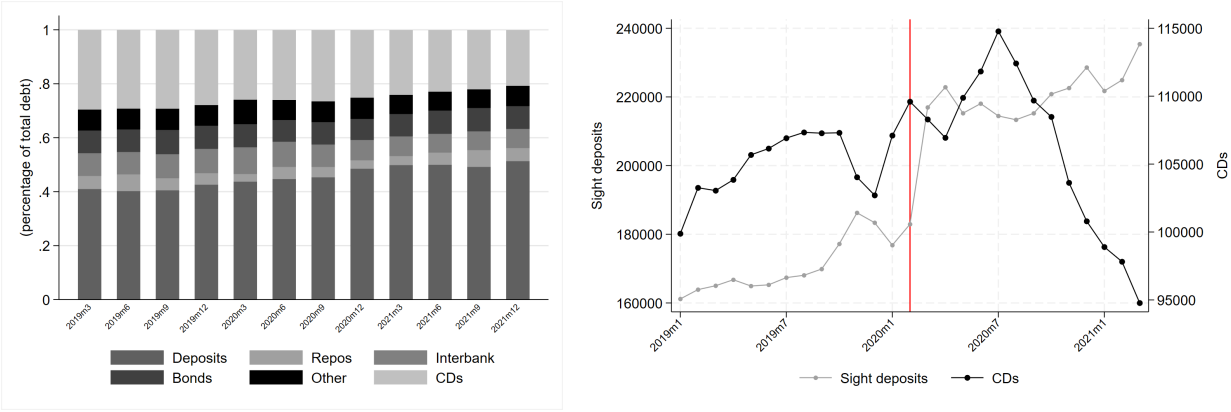
Notes: Panel (a) reports median log CD returns and Panel (b) the median 30-day moving standard deviation of log returns. CDs are classified as more or less fund-traded based on the median number of secondary-market transactions involving funds (as buyers or sellers) in 2019.s

Figure A1: Central bank CD purchases.




Notes: The figure shows the daily total CDs purchased by the central bank. Values in the figures are expressed in trillion COP.

Figure A1: Aggregate CDs and deposit volumes.




(a) Funding sources.

(b) Funding structure of banks.

Notes: The figure shows in panel (a) the share of different funding sources to total liabilities of the aggregate banking sector. Panel (b) shows the monthly aggregate volume in COP billion of sight deposits (left axis) and CDs (right axis).

Table A2: Complementary summary statistics

| | Mean (1) | Median (2) | Std. Dev. (3) | Min (4) | Max (5) |
|---|---|---|---|---|---|
| **Panel A. Fund-bank level sample** | | | | | |
| **Controls:** | | | | | |
| Log assets | 28.67 | 28.66 | 0.56 | 27.47 | 30.14 |
| Cash ratio | 32.39 | 31.15 | 8.51 | 0.00 | 57.71 |
| CD ratio | 59.22 | 60.53 | 9.01 | 0.00 | 79.49 |
| Portfolioshare | 2.83 | 0.00 | 5.07 | 0.00 | 27.61 |
| Marketshare | 2.26 | 0.00 | 3.55 | 0.00 | 13.40 |
| Central bank CD share | 0.05 | 0.00 | 1.64 | 0.00 | 62.28 |
| Log number investors | 9.61 | 9.27 | 1.89 | 5.38 | 13.30 |
| LCR funds | 42.45 | 39.62 | 13.42 | 0.00 | 96.95 |
| Share of fixed rate investments | 0.13 | 0.00 | 0.46 | 0.00 | 5.19 |
| **Panel B. Bank-firm level sample** | | | | | |
| **Controls:** | | | | | |
| A rating dummy | 0.94 | 1.00 | 0.23 | 0.00 | 1.00 |
| Public guarantee | 0.61 | 1.00 | 0.49 | 0.00 | 1.00 |
| Central bank CD share | 0.02 | 0.00 | 0.07 | 0.00 | 1.00 |
| Log assets | 24.71 | 24.99 | 1.25 | 19.04 | 25.99 |
| Capital ratio | 0.16 | 0.15 | 0.03 | 0.11 | 0.34 |
| NPL ratio | 0.11 | 0.10 | 0.03 | 0.02 | 0.17 |
| Cost-Income-Ratio | -10.50 | -7.03 | 11.99 | -89.05 | 28.77 |
| RoE | 0.12 | 0.13 | 0.05 | -0.30 | 0.22 |
| Liquidity ratio | 0.12 | 0.11 | 0.05 | 0.03 | 0.63 |
| **Alternative exposures:** | | | | | |
| Exposure = CD/Assets | 0.26 | 0.25 | 0.16 | 0.05 | 0.67 |
| Standardized | -0.08 | -0.13 | 1.04 | -1.44 | 2.66 |
| Exposure = $\Delta$log deposit | 0.01 | 0.01 | 0.02 | -0.02 | 0.17 |
| Standardized | -0.12 | -0.23 | 0.97 | -2.03 | 8.04 |
| Exposure = $\Delta$log asset | 0.02 | 0.03 | 0.03 | -0.01 | 0.13 |
| Standardized | -0.09 | 0.24 | 1.04 | -1.24 | 4.01 |
| **Borrower risk:** | | | | | |
| Interest rate residual | 0.03 | 0.05 | 0.63 | -1.80 | 1.25 |
| Log standardized | 0.02 | 0.05 | 0.97 | -2.77 | 1.89 |
| Z-score | 0.22 | 0.33 | 0.73 | -1.74 | 1.12 |
| Standardized | 0.03 | 0.19 | 1.00 | -2.64 | 1.26 |

Notes: This table reports summary statistics for the main working samples. Columns (1)–(5) report the mean, median, standard deviation (Std. Dev.), minimum, and maximum of each variable. Panel A summarizes the fund–bank sample used to estimate Eq. 1, while Panel B summarizes the bank–firm sample used to estimate Eq. 2. "Standardized" indicates that the variable above is scaled by its standard deviation, as in the regressions. Summary statistics for the main variables of interest are reported in Table 1. Variable definitions and data sources are provided in Table A1.

## Table A3: Fund redemptions and pre-COVID bank characteristics

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| NPL ratio | 1.401** | 0.856 | 0.856 | 0.625 | 0.233 | 0.233 | 0.500 | 0.017 | 0.018 |
| | (0.678) | (0.797) | (0.791) | (0.659) | (0.675) | (0.670) | (0.466) | (0.607) | (0.603) |
| Capital–assets ratio | 0.141 | 0.373 | 0.373 | 0.642* | 0.561 | 0.561 | 0.276 | 0.250 | 0.248 |
| | (0.343) | (0.369) | (0.367) | (0.352) | (0.404) | (0.401) | (0.170) | (0.289) | (0.286) |
| Deposit ratio | 0.027 | 0.016 | 0.016 | 0.161 | -0.115 | -0.115 | -0.000 | -0.190 | -0.190 |
| | (0.320) | (0.329) | (0.327) | (0.187) | (0.280) | (0.278) | (0.165) | (0.219) | (0.217) |
| Log assets | -0.009 | -0.006 | -0.006 | -0.002 | 0.002 | 0.002 | -0.003 | 0.001 | 0.001 |
| | (0.010) | (0.010) | (0.010) | (0.007) | (0.008) | (0.008) | (0.005) | (0.005) | (0.005) |
| Leverage ratio | -0.042 | -0.052 | -0.052 | -0.275 | -0.105 | -0.105 | -0.122 | 0.013 | 0.013 |
| | (0.249) | (0.249) | (0.247) | (0.183) | (0.218) | (0.217) | (0.158) | (0.182) | (0.181) |
| RoA | -0.570 | -1.987 | -1.987 | -2.363 | -3.952 | -3.952 | -0.401 | -1.815 | -1.810 |
| | (2.145) | (2.234) | (2.217) | (2.344) | (2.858) | (2.837) | (0.813) | (1.557) | (1.545) |
| Constant | 0.126** | 0.116** | 0.116** | 0.100* | 0.104* | 0.104* | 0.117** | 0.115** | 0.115** |
| | (0.056) | (0.058) | (0.057) | (0.051) | (0.053) | (0.053) | (0.048) | (0.051) | (0.050) |
| Obs. | 689 | 689 | 689 | 689 | 689 | 689 | 1,360 | 1,360 | 1,360 |
| R-squared | 0.076 | 0.116 | 0.098 | 0.074 | 0.127 | 0.098 | 0.061 | 0.107 | 0.083 |
| FE | None | Week | Month | None | Week | Month | None | Week | Month |
| Period | Dec19-Feb20 | Dec19-Feb20 | Dec19-Feb20 | Mar20-May20 | Mar20-May20 | Mar20-May20 | Mar20-Aug20 | Mar20-Aug20 | Mar20-Aug20 |

Notes: The table reports regressions of fund-level redemptions on weighted averages of banks' pre-COVID balance-sheet characteristics. For each fund $k$, the bank-level characteristics are aggregated using the fund's CD holdings in December 2019 as weights; specifically, the weight for bank $b$ equals the share of bank $b$'s CDs in fund $k$'s total CD portfolio. Bank characteristics include the NPL ratio, capital ratio (capital-to-assets), leverage ratio (capital-to-liabilities), deposit ratio (deposits-to-assets), log assets, and return on assets (ROA). All explanatory variables are measured at $t-1$. Columns (1)–(3) use the full panel of weekly observations for 2019–2021, while columns (4)–(6) restrict the sample to the main shock period (March–May 2020). Columns (7)–(9) replicate the COVID-period specifications on an expanded window through August 2020. Columns (1), (4) and (7) include no fixed effects; columns (2), (5) and (8) include week fixed effects; and columns (3), (6) and (9) include month fixed effects. The dependent variable is weekly redemptions, defined as the log change in a fund's assets under management (AUM) from week $t-1$ to week $t$. Standard errors are clustered at the fund level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table A4: Robustness to the Specification of Fixed Effects.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | OLS | | | | DiD | | | |
| Log redemptions | -0.0036* | -0.0031 | -0.0042** | -0.0051* | | | | |
| | (0.0020) | (0.0033) | (0.0019) | (0.0026) | | | | |
| High Redemptions | | | | | 0.0203*** | | 0.0094** | |
| | | | | | (0.0041) | | (0.0042) | |
| High Redemptions × Post | | | | | -0.0174*** | -0.0248*** | -0.0094* | -0.0155*** |
| | | | | | (0.0041) | (0.0044) | (0.0048) | (0.0047) |
| Log total assets (t-1) | 0.0164*** | 0.1311*** | 0.0110*** | 0.1082*** | 0.0082*** | 0.0902*** | 0.0029 | 0.0932*** |
| | (0.0039) | (0.0187) | (0.0038) | (0.0328) | (0.0025) | (0.0125) | (0.0027) | (0.0178) |
| Cash-to-assets ratio (t-1) | 0.0029*** | 0.0032*** | 0.0010*** | 0.0015*** | 0.0024*** | 0.0027*** | 0.0010*** | 0.0012*** |
| | (0.0004) | (0.0006) | (0.0003) | (0.0005) | (0.0003) | (0.0005) | (0.0002) | (0.0004) |
| Share of CDs per bank (t-1) | -0.0924** | -0.0807** | -0.2450*** | -0.2347*** | -0.0611** | -0.0541** | -0.1383*** | -0.1311*** |
| | (0.0436) | (0.0345) | (0.0698) | (0.0590) | (0.0253) | (0.0220) | (0.0492) | (0.0450) |
| CDs held at different banks (t-1) | 0.0018*** | -0.0330*** | 0.0011*** | -0.0222*** | 0.0007** | -0.0178*** | 0.0005* | -0.0128*** |
| | (0.0004) | (0.0053) | (0.0004) | (0.0050) | (0.0002) | (0.0024) | (0.0003) | (0.0023) |
| Log change Government Treasuries (t-1) | -0.0018 | -0.0033 | -0.0036 | -0.0036 | -0.0009 | -0.0008 | -0.0012** | -0.0010* |
| | (0.0023) | (0.0023) | (0.0024) | (0.0024) | (0.0005) | (0.0005) | (0.0005) | (0.0005) |
| Log change Bonds (t-1) | 0.2090*** | 0.1478*** | 0.1391** | 0.1165* | 0.1064*** | 0.0854*** | 0.0725** | 0.0557* |
| | (0.0521) | (0.0539) | (0.0607) | (0.0651) | (0.0250) | (0.0241) | (0.0295) | (0.0301) |
| Fund FE | No | Yes | No | Yes | No | Yes | No | Yes |
| Bank-time FE | No | No | Yes | Yes | No | No | Yes | Yes |
| Observations | 4,284 | 4,284 | 4,097 | 4,097 | 7,560 | 7,560 | 7,230 | 7,230 |
| R-squared | 0.0422 | 0.0892 | 0.2242 | 0.2395 | 0.0364 | 0.0649 | 0.2186 | 0.2293 |
| R-squared within | .042 | .085 | .013 | .028 | .036 | .062 | .009 | .019 |

NOTES: The table shows the effects of weekly redemptions on the week-on-week change in funds' CDs held at banks. The sample includes only OEFs. The pre-COVID period is defined as all weeks in 2019, and the post-COVID period is defined as all weeks in the first 3 months after the shock. The Post dummy is zero in the pre-COVID period and equals one in the post-COVID period. High Redemptions is a dummy equal to one for fund weeks with redemptions above the pre-COVID median of redemptions. Standard errors clustered at the bank level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A5: Amplifying Bank Characteristics

| | (1) Bank size | | (2) CD market size | | (3) NPL Ratio | | (4) Tier 1 Ratio | |
|---|---|---|---|---|---|---|---|---|
| | x < p50 | x ≥ 50 | x < p50 | x ≥ 50 | x < p50 | x ≥ 50 | x < p50 | x ≥ 50 |
| Log redemptions | -0.0044 | -0.0018*** | 0.0055 | -0.0011*** | -0.0009 | -0.0012** | -0.0012*** | 0.0004 |
| | (0.0051) | (0.0004) | (0.0052) | (0.0003) | (0.0006) | (0.0004) | (0.0003) | (0.0014) |
| Observations | 833 | 12,733 | 1,139 | 10,336 | 5,270 | 7,735 | 9,435 | 2,108 |
| R-squared | 0.1885 | 0.1229 | 0.2104 | 0.1076 | 0.0992 | 0.1267 | 0.0974 | 0.1374 |

Notes: The table shows the effects of weekly funds' redemptions on the week-on-week change in funds' CDs held at banks. Each column runs the regression breaking the sample according to different characteristics. For instance, column 1 divides the sample based on the bank size and shows the results for two subsamples; the first subsample comprises banks below the median of the banks' size distribution, whereas the second subsample includes banks equal to or above the median. All specifications include the set of controls as in the baseline specification and bank-week and fund fixed effects. Robust standard errors clustered at the bank level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A6: Robustness of credit effects to alternative specifications

| | Test: Ex-ante exposure | | | Test: Placebo shock | | |
|---|---|---|---|---|---|---|
| Dep. variable: | Log loan | Loan rate | Maturity | Log loan | Loan rate | Maturity |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Post × Exposure | -0.205*** | -0.215** | -0.685** | 0.026 | -0.057 | -0.039 |
| | (0.059) | (0.104) | (0.237) | (0.028) | (0.049) | (0.078) |
| Constant | -19.149** | -110.446* | -9.211 | -14.384 | -178.386 | 2.236 |
| | (8.327) | (54.222) | (30.098) | (13.276) | (104.770) | (19.016) |
| Firm x bank FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm × quarter FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Bank, loan and firm controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 35,360 | 35,360 | 35,360 | 21,505 | 21,505 | 21,505 |
| Within R-squared | 0.474 | 0.440 | 0.358 | 0.535 | 0.480 | 0.450 |
| | Test: Excl. foreign banks | | | Test: Multiple-bank firms | | |
| Dep. variable: | Log loan | Loan rate | Maturity | Log loan | Loan rate | Maturity |
| | (10) | (11) | (12) | (13) | (14) | (15) |
| Post × Exposure | -0.090*** | -0.141*** | -0.347*** | -0.094*** | -0.176*** | -0.333*** |
| | (0.025) | (0.031) | (0.085) | (0.023) | (0.034) | (0.089) |
| Constant | -10.343 | -106.241** | 6.389 | -32.339*** | -134.099*** | -45.894 |
| | (10.311) | (47.100) | (44.998) | (8.160) | (41.275) | (38.129) |
| Firm x bank FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm × quarter FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Bank, loan and firm controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 33,575 | 33,575 | 33,575 | 26,030 | 26,030 | 26,030 |
| Within R-squared | 0.481 | 0.452 | 0.373 | 0.464 | 0.429 | 0.342 |

Notes: This table reports robustness checks for the baseline credit regressions, re-estimating Eq. 2 under alternative exposure definitions and sample restrictions. Each specification is estimated separately for the three standardized dependent variables: the log of loan volume, the log of a loan interest rate, and the log of loan maturity in months. Exposure is defined as the standardized log change in CDs held by funds between March–May 2020 unless otherwise indicated. Columns (1)–(3) replace this measure with a pre-COVID exposure proxy given by the average 2019 ratio of CDs to total liabilities. Columns (4)–(6) implement a placebo design, redefining the "shock" period as September–December 2019 and the corresponding pre-period as January–August 2019. Columns (10)–(12) re-estimate the baseline excluding all foreign-owned banks. Columns (13)–(15) retain only firms with lending relationships to at least two distinct banks in both the pre- and post-shock periods. All regressions include the same firm–bank and firm–quarter fixed effects and the full set of bank, loan, and borrower controls as in the baseline. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Table A7: Additional robustness tests

| | Test: Central bank intervention | | | Test: Exposure dummy | | |
|---|---|---|---|---|---|---|
| Dep. variable: | Log loan | Loan rate | Maturity | Log loan | Loan rate | Maturity |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Post × Exposure | -0.103** | -0.193*** | -0.531*** | -0.226*** | -0.459*** | -1.015*** |
| | (0.037) | (0.034) | (0.111) | (0.065) | (0.094) | (0.114) |
| Constant | -12.595 | -106.668** | 10.107 | -23.189** | -114.320* | -22.075 |
| | (13.627) | (43.331) | (53.277) | (9.017) | (55.433) | (29.744) |
| Firm x bank FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm × quarter FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Bank, loan and firm controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 29,143 | 29,143 | 29,143 | 35,360 | 35,360 | 35,360 |
| Within R-squared | 0.493 | 0.463 | 0.388 | 0.474 | 0.442 | 0.363 |

Notes: This table reports robustness checks for the baseline credit regressions, re-estimating Eq. 2 under alternative specifications. Each specification is estimated separately for the three standardized dependent variables: the log of loan volume, the log of a loan interest rate, and the log of loan maturity in months. Exposure is defined as the standardized log change in CDs held by funds between March–May 2020 unless otherwise indicated. Columns (1)–(3) exclude banks reporting a share of outstanding CDs purchased by the central bank above the 75th percentile during the March–May 2020 shock window. Columns (4)–(6) replace the continuous exposure measure with a high-exposure dummy equal to one for banks whose CD losses during the shock period were above the sample median, allowing for a non-parametric assessment of the baseline patterns. All regressions include the same firm–bank and firm–quarter fixed effects and the full set of bank, loan, and borrower controls as in the baseline. Standard errors are clustered at the bank level. *** p<0.01, ** p<0.05, * p<0.1.

Table A8: Wholesale CD outflows vs. alternative balance-sheet shocks

| | Alternative exposure: ΔDeposit 2020m2-2020m5 | | | Alternative exposure: ΔAsset 2020m2-2020m5 | | |
|---|---|---|---|---|---|---|
| Dep. variable: | Log loan | Loan rate | Maturity | Log loan | Loan rate | Maturity |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Post × Exposure | -0.087*** | -0.148*** | -0.364*** | -0.089*** | -0.156*** | -0.369*** |
| | (0.019) | (0.034) | (0.096) | (0.021) | (0.031) | (0.103) |
| Post × Alt. exposure | -0.042 | 0.167 | -0.271 | -0.029 | 0.067 | -0.173 |
| | (0.059) | (0.167) | (0.186) | (0.039) | (0.121) | (0.120) |
| Constant | -22.273** | -124.286* | -13.414 | -22.413** | -120.593* | -15.570 |
| | (10.479) | (62.530) | (31.961) | (10.235) | (61.498) | (32.195) |
| Firm x bank FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm × quarter FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Bank, loan and firm controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 35,360 | 35,360 | 35,360 | 35,360 | 35,360 | 35,360 |
| Within R-squared | 0.474 | 0.442 | 0.359 | 0.474 | 0.442 | 0.359 |

Notes: This table reports horse-race regressions that assess whether the baseline effects of wholesale funding stress on bank lending are driven specifically by fund-induced CD outflows, as opposed to concurrent changes in other bank-level balance-sheet components. Each column reports estimates from Eq. 2, estimated separately for the three standardized dependent variables: the log of loan volume, the log of the loan interest rate, and the log of loan maturity (in months). The baseline exposure measure is the standardized bank-level change in certificates of deposit (CDs) held by investment funds during the March–May 2020 shock window. In Columns (1)–(3), this baseline exposure is jointly estimated with an alternative exposure defined as the standardized change in banks' sight deposits over the same period. In Columns (4)–(6), the baseline exposure is jointly estimated with an alternative exposure defined as the standardized change in banks' total assets over the same period. The coefficient reported on *Post* × *Exposure* captures the effect of fund-driven wholesale funding withdrawals, while the coefficient on *Post* × *Alternative exposure* estimates the independent contribution of retail deposit inflows or overall balance-sheet growth. All regressions include firm–bank and firm–quarter fixed effects, as well as the full set of bank, loan, and borrower controls used in the baseline specification. The single coefficients for *Post*, *Exposure*, and the alternative exposure measures are absorbed by the firm–quarter and bank fixed effects. Standard errors are clustered at the bank level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

## B Central bank measures to stabilize bank funding markets

As mentioned in section 2, the BdR enacted several emergency measures as early as in the second week of March to support banks and non-bank financial intermediaries with liquidity. Among these, starting on March 23, the central bank started to buy CDs from market participants, including funds, in the secondary market. In the following, we analyse if and how these transactions helped funds to satisfy the redemptions they faced and how it affects the transmission of the shock faced by funds to bank funding markets.

First, we construct a measure of central bank support at the fund level. For each fund, we relate the number of transactions in which the fund could sell a CD to the central bank to the total number of sales the fund did during a given week, i.e.,

$$\text{CB purchases}_{i,t} = \frac{\#\text{ sales from fund } i \text{ to the CB in week } t}{\#\text{ sales from fund } i \text{ in week } t} \tag{A.1}$$

We further weight this measure by the importance the potential support from the central bank might have for a fund by multiplying it with the logarithmized redemptions.

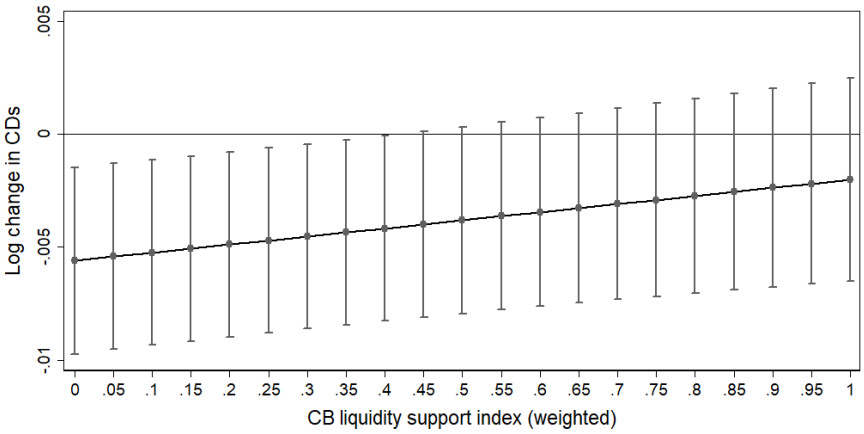
To analyze whether the central bank support had a mitigating effect on the transmission of redemptions, we interact the afore-described measures with the redemption volume. The results are reported in table C1 and show that the coefficient of the interaction is positive and significant, independent of which specification of central bank support we use. Importantly, the results highlight that, on average, the central bank support outweighs the negative pass-through of redemptions on CD holdings. This is illustrated in figure C1, which shows the marginal effect of redemptions on CD holdings depending on the level of liquidity support by the central bank. As can be seen, the transmission quickly becomes insignificant as funds make more use of central bank liquidity.

Table C1: Central Bank Liquidity Support After the Liquidity Shock

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Log change in CDs | | | |
| Log redemptions | -0.006** | -0.006** | -0.006** | -0.006** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| Log redemptions × CB purchases | 0.018** | | | |
| | (0.008) | | | |
| Log redemptions × Weighted CB purchases | | 0.449** | | |
| | | (0.186) | | |
| Log redemptions × CB liquidity support index | | | 0.004** | |
| | | | (0.002) | |
| Log redemptions × Weighted CB liquidity support index | | | | 0.004** |
| | | | | (0.001) |
| Log total assets (t-1) | 0.116*** | 0.115*** | 0.116*** | 0.115*** |
| | (0.031) | (0.031) | (0.031) | (0.031) |
| Cash-to-assets ratio (t-1) | 0.001*** | 0.001*** | 0.001*** | 0.001*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Share of CDs per bank (t-1) | -0.258*** | -0.258*** | -0.258*** | -0.258*** |
| | (0.063) | (0.063) | (0.063) | (0.063) |
| CDs held at different banks (t-1) | -0.020*** | -0.020*** | -0.020*** | -0.020*** |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| Log change Government Treasuries (t-1) | -0.003 | -0.003 | -0.003 | -0.003 |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Log change Bonds (t-1) | 0.130** | 0.130** | 0.130** | 0.130** |
| | (0.061) | (0.061) | (0.061) | (0.061) |
| Observations | 4,097 | 4,097 | 4,097 | 4,097 |
| R-squared | 0.244 | 0.244 | 0.244 | 0.244 |
| R-squared within | .032 | .032 | .032 | .032 |

NOTES: The table shows the effects of weekly funds' redemptions on the week-on-week change in funds' CDs held at banks. Each column includes an interaction of the funds' redemptions and central bank liquidity support measures specified in subsection 2. All specifications include bank-week and fund fixed effects. Standard errors clustered at the bank level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Figure C1: Marginal Effects of Funds' Redemptions on the Percentage Change in CDs.




Notes: The Figures show the marginal effects of funds' redemptions on the log change in funds' CDs held at banks conditional on the central bank liquidity support weighted index surrounded by 95% confidence intervals.