Do non-banks need access to the lender of last resort? Evidence from mutual fund runs*

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Abstract

When a liquidity crisis hits non-bank financial intermediaries, which central bank interventions help? We show that mutual funds faced unprecedented investor outflows as the COVID-19 shock hit and assess the effectiveness of central bank asset purchases and additional liquidity provision to banks in alleviating the crisis. We use detailed fund-level data and proprietary data on bank take-ups in liquidity-providing operations and bank-fund repo transactions. Analyzing asset purchases, we find that funds with higher shares of assets eligible for central bank purchases in their portfolio before the COVID-19 crisis saw their performance improve by 3.7% and outflows decrease by 66% relative to otherwise similar funds. Analyzing repo activity, we do not find that additional central bank liquidity provision to banks in March 2020 led to more lending to funds trading with their relationship banks. Rather, banks increased the maturity of their repo lending to funds in the weeks that followed the announcement and the implementation of additional asset purchases. Our results suggest that central bank asset purchases were effective in stopping fire-sale dynamics and staving off runs on non-bank financial intermediaries, even though funds did not have direct access to the lender of last resort.

Keywords: Mutual funds, COVID-19 liquidity crisis, lender of last resort, central bank liquidity provision, asset purchases

JEL Classification: E58, G01, G10, G21; G23

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1. Introduction

Non-bank financial intermediaries have been playing an increasing role in the financial system. Their assets almost doubled over the last decade, from 25 trillion EUR in December 2009 to 47 trillion EUR in December 2019 (euro area data; representing 56% of total financial sector assets currently).[1] Over this period, non-banks have become a significant source of funding for non-financial firms, accounting for around 20% of firms' total external credit. Non-banks are also closely connected with the banking sector through direct exposures, holdings of similar assets and ownership links.

Non-banks have therefore become important both from a monetary policy transmission perspective and from a financial stability perspective, as disruptions in the non-bank sector can have negative repercussions for financial market functioning, banking sector stability, and firm funding. Their importance was exemplified in the Spring of 2020, when the non-bank financial sector experienced severe stress induced by the COVID-19 shock. In particular, mutual funds suffered exceptionally large outflows at the onset of the pandemic (Falato, Goldstein, and Hortaçsu, 2020). These "runs" on mutual funds put strains on broader financial markets, as funds fire-sold assets, scrambling for liquidity (Ma, Xiao, and Zeng, 2020).

In this paper, we seek to understand whether central bank interventions employed in response to the Spring 2020 financial turbulence helped alleviate the liquidity crisis faced by mutual funds. We contribute to the literature by assessing the effects of two major interventions. First, we analyze central bank asset purchases, which might attenuate fire-sale dynamics and support market prices of assets held by mutual funds. Second, we examine central bank liquidity provision to banks, which might channel liquidity to mutual funds through money markets (short-term funding markets). We use detailed mutual fund-level data, as well as proprietary information on bank borrowing from the central bank matched with banks' lending to mutual funds in money markets. Our analysis sheds light on the question whether central bank interventions can mitigate a liquidity crisis in the non-bank sector via existing tools or whether central banks should consider becoming lenders of last resort to non-banks, to safeguard financial stability and preserve monetary policy transmission in a crisis.

Analyzing the impact of central bank asset purchases, we show that funds with higher shares of assets eligible for purchases in their portfolio before the COVID-19 crisis see their performance improve by 3.7% and their outflows decrease by 66% relative to otherwise similar

[1] At the same time, traditional banks have experienced a slowdown in balance sheet growth and/or a shedding of assets as a result of the Global Financial Crisis, stricter regulation and supervision, as well as weak growth.

funds following the announcement of the new large-scale asset purchase program by the European Central Bank (ECB). Analyzing money market activity, we do not find evidence that additional central bank liquidity provision to banks in March 2020 led to more lending to funds trading with their relationship banks. Rather, we find that in the weeks that followed the announcement and the implementation of the PEPP, banks with lower ex ante excess reserve holdings – arguably those more liquidity-constrained - increased the maturity of their repo lending to funds, compared to banks with higher ex ante reserve holdings. Our results suggest that central bank asset purchases were effective in stopping fire-sale dynamics in asset markets and staving off runs on non-bank financial intermediaries.

We begin our analysis by documenting that bond funds investing in euro area securities faced large outflows (a "run") in March 2020 (Figure 1). The outflows reached their peak in the week of March 16, 2020. The pattern of outflows is similar to the one documented by Falato, Goldstein, and Hortaçsu (2020) using US corporate bond funds data.

To generate liquidity and satisfy outflows, mutual funds attempted to sell off assets or pledge them as collateral in money (repo) markets. However, we document using proprietary transactions level data on money market trading that bank lending to funds dropped by 50% between early February and late March, from 30 billion EUR to 15 billion EUR a day (Figure 2). This further aggravated the liquidity shock faced by the mutual fund sector. To the best of our knowledge this fact has not been documented in the literature before.

We then proceed to the key contribution of our paper: an assessment of the effects of central bank interventions in alleviating liquidity strains in the mutual fund sector. We focus on two main policies employed by the ECB in March 2020 in response to the pandemic. First, on March 12, 2020, the ECB announced additional ("Bridge") Long-Term Refinancing Operations (LTROs), explicitly designed to "provide immediate liquidity support to banks and to safeguard money market conditions." These operations – satisfying bank demand for central bank liquidity without pre-set limits, against a large set of eligible collateral - were conducted on a weekly basis, with the first operation settled on March 18, 2020. All Bridge LTROs matured on June 24, 2020.[2] Second, on March 18, 2020 (after markets closed), the ECB announced the new Pandemic Emergency Purchase Programme (PEPP). The PEPP was initiated to "counter serious risks to the monetary policy transmission mechanism and the outlook for the euro area posed by the COVID-19 outbreak". The implementation of the PEPP

[2] On March 12, 2020, there was also an announcement of a marginal expansion of net asset purchases under the existing Asset Purchase Programme (APP), in place since 2015.

purchases began on March 26, 2020. The total purchase envelope was initially set at 750 billion EUR (expanded to 1,850 billion EUR by December 2020).

To assess the effects of asset purchases, we focus on bond funds that invest in investment grade securities and that hold a non-zero share of euro area securities in their portfolio. Using detailed fund-level data, we compare funds with higher (above-the-median) shares of assets eligible for PEPP purchases in their portfolio before the crisis hit with funds with lower (below-the-median) shares. These two groups of funds had the same performance and flow dynamics before the PEPP announcement on March 18, 2020.

We find that after the announcement of the PEPP, a significant performance gap emerges between the funds holding more PEPP-eligible bonds and funds holding less PEPP-eligible assets. In the week of the PEPP announcement, the gap is 3.7%. In the first week of the PEPP implementation, this gap remains at 2.7%, dropping to 2.1% in the second week. Thereafter, there is no significant difference between funds with more PEPP-eligible bonds and funds with less PEPP-eligible bonds. For the daily fund outflows, we find that funds with relatively more PEPP-eligible bonds had significantly lower outflows compared to funds holding less PEPP-eligible bonds following the announcement of the PEPP. By the end of March 2020, the run stopped, and the flows largely stabilized.[3]

To assess the effects of central bank liquidity provision by banks, we combine two proprietary datasets: 1) bank-level information on bank borrowing in ECB's Bridge LTROs and on bank excess reserve holdings[4] and 2) transactions-level data on bank lending to funds in the euro area secured (repo) money markets.[5] We focus on funds with two or more bank relationships prior to the pandemic so that we can control for observed and unobserved heterogeneity in repo demand using the Khwaja and Mian (2008) methodology. We then compare bank lending to funds, distinguishing between banks with relatively higher (above-the-median) and relatively lower (below-the-median) excess reserve holdings ex ante (January 2020). We conjecture that banks with relatively lower ex ante excess reserve holdings may be more affected by the liquidity-providing central bank operations, which aimed at alleviating banks' liquidity constraints. Importantly, we show that lending behavior of these two groups of banks followed a similar pattern before the announcement of the Bridge LTROs on March 12, 2020. We then test how their lending behavior changed: a) following the announcement of

[3] Interestingly, Falato, Goldstein, and Hortaçsu (2020) document that outflows from corporate-bond funds in the US only stop and reverse after April 9, 2020.
[4] That is, central bank reserve holdings in excess of the minimum reserve requirements.
[5] We focus on the secured (repo) money markets since secured transactions constitute more than 95% of all lending transactions in our dataset. Indeed, there is no unsecured lending from banks to funds in our sample.

the Bridge LTROs (compared to the previous week), and b) following the settlement of the first Bridge LTRO (compared to the previous week). The reason we focus on the first Bridge LTRO settlement is that additional measures were phased in as of March 25, 2020, making it hard to isolate the effects of the subsequent Bridge LTROs.[6]

We document that measures announced on March 12, 2020, notably the additional liquidity provision through the Bridge LTROs, had no significant effect on total bank repo lending to funds across the higher and lower excess reserves banks. The settlement of the first Bridge LTRO on March 18, 2020 did not translate into a significant effect on total repo lending either: we show that banks borrowing in this operation did not lend differently from banks that did not. We note that all banks in our sample had access to the Bridge LTROs. The decision on whether to borrow in an operation could be driven by a variety of factors, e.g., bank own liquidity needs. Overall, we do not find that central bank liquidity provision to banks through Bridge LTROs is associated with more bank repo lending to their relationship funds.

We further investigate whether central bank interventions changed the maturity distribution of bank repo lending to their relationship funds. To this end, we split the repo loans into two maturity buckets: short-term loans, defined as up to and including one-week (about 40% of total), and long-term loans, defined as those with maturity over one week. We find that in the week of March 18, 2020, in which the first Bridge LTRO was settled and the PEPP was announced, banks with lower ex ante excess reserve holdings increased their long-term loans to funds by 106% compared to banks with higher ex ante excess reserve holdings. At the same time, the actual LTRO take-up did not lead to a significant increase in long-term loans for lower excess reserves banks. This suggests that it was the PEPP announcement, rather than the LTRO, that relaxed the liquidity conditions of banks with lower ex ante excess reserve holdings. We also find that these banks extended relatively more long-term repos to their relationship funds in the six-week period that followed March 18 (this period also includes the start of the actual purchases under the PEPP on March 26, 2020).

The financial market turbulence in the Spring of 2020 rekindled the discussions on whether the existing monetary policy framework is effective in alleviating liquidity crises in the financial system increasingly driven by non-banks which do not have access to central bank operations. The questions of whether non-banks should have direct access to central bank

[6] On March 25, 2020, the second Bridge LTRO was settled. Also on that day, some banks got additional central bank liquidity via a settlement of a Targeted Long-Term Refinancing Operation (TLTRO, a "funding-for-lending" scheme of the ECB in place since 2014) for which banks submitted the required documentation already in February 2020. On March 26, 2020, asset purchases under the PEPP started.

liquidity facilities, at least in crisis times, or whether fund shares should be eligible for central bank purchases were back in the spotlight.

Our analysis provides an input into these discussions. Our results suggest that central bank asset purchases through the PEPP were effective in improving fund performance and stabilizing fund outflows. Asset purchases alleviated fire-sale pressures in key markets (sovereign and corporate bonds, as well as commercial paper) and played an important role in supporting values of assets held by mutual funds. In addition, in the weeks that followed the announcement and the implementation of the PEPP, banks with lower ex ante excess reserve holdings – arguably those more liquidity-constrained - increased the maturity of their repo lending to funds, compared to banks with higher ex ante reserve holdings. This suggests that bank liquidity constraints were alleviated, and banks could offer valuable longer-term repo funding to funds. In all, although the fund sector did not have a direct access to operations with the central bank, central bank asset purchases could alleviate liquidity strains in that sector in a severe crisis.

The remainder of the paper is organized as follows. In Section 2, we provide an overview of the related literature. In Section 3, we describe the events unfolding in the Spring of 2020, including the policy interventions employed by the ECB in March 2020. In Section 4, we describe the data we use and outline our empirical strategy. In Section 5, we present the results and discuss the policy implications. Section 6 concludes.

2. Related literature

Our paper is related to several strands of literature: 1) literature on mutual funds; 2) literature on the effectiveness of central bank interventions; and 3) literature on money market functioning.

Several recent papers investigated how mutual funds fared during the COVID-19 crisis, using US data. Falato, Goldstein, and Hortaçsu (2020) focus on the sources of fragility of mutual funds in this crisis episode, showing that the illiquidity of fund assets and the vulnerability to fire sales were important factors in explaining outflows. The exposure to sectors most hurt by the COVID-19 crisis mattered as well. Ma, Xiao, and Zeng (2020) link significant liquidity strains in Treasuries and high-quality bond markets during the pandemic to asset sales by funds trying to generate liquidity to satisfy investor redemptions (see also Haddad, Moreira, and Muir, 2020).[7] Li, Li, Machiavelli, and Zhou (2020) focus on money

[7] Pastor and Vorsatz (2020) analyze the performance and flows of actively-managed equity mutual funds during

market funds (MMFs).They argue liquidity restrictions on investors may have exacerbated the run on prime MMFs during the crisis and highlight the role of Money Market Mutual Fund Liquidity Facility (MMLF) set up by the Fed in stopping the run on prime MMFs.[8] Other papers in this branch of literature analyzed, for example, the financial fragility in the fund sector and the sensitivity of fund outflows to past performance (Franzoni and Giannetti, 2019; Goldstein, Jiang, and Ng, 2017; Chen, Goldstein, and Jiang, 2010); tools to mitigate fragility, like swing pricing (Jin, Kacperczyk, Kahraman, and Suntheim, 2020); fire-sale pressures in the fund sector (Falato, Hortacsu, Li, and Shin, 2020; Choi, Hoseinzade, Shin and Tehranian, 2019; Coval and Stafford, 2007); investors' evaluation of fund performance (Barber, Huang, and Odean, 2016; Giannetti and Laeven, 2016); and funds' liquidity management strategies (Morris, Shim, and Shin, 2017; Goldstein, 2017; Zeng, 2017; Chernenko and Sunderam, 2016).

Our contribution to this literature is two-fold. First, we document that there was an additional factor that aggravated liquidity positions of mutual funds during the crisis, namely that there was a dramatic decrease in money market lending to mutual funds in March 2020. Second, we provide a detailed analysis of the effectiveness of central bank asset purchases on mutual fund performance and outflows (exploiting fund-level differences in holdings of assets eligible for purchases). We also test whether central bank liquidity provision to banks helped stimulate banking lending to funds in money markets.

There is a vast literature – theoretical and empirical – examining the role of central banks in financial crises, including the role of central banks as lenders of last resort.[9] The recent literature explored, for example, the effects of central bank asset purchases on financial market functioning and bank lending (e.g., Chakraborty, Goldstein, and MacKinlay, 2020; Kandrac and Schlusche, 2020; Koijen, Koulischer, Nguyen, and Yogo, 2020; Darmouni and Rodnyansky, 2017; Krishnamurthy and Vissing-Jorgensen, 2011); and the effects of central bank liquidity provision on bank lending and risk-taking (e.g., Carpinelli and Crosignani, 2020; Jasova, Mendicino and Supera, 2020; Andrade, Cahn, Fraisse and Messonier (2019); Drechsler, Drechsel, Marques-Ibanez, and Schnabl, 2016). The strategy we employ to identify the effects of central bank purchases is similar in spirit to the one employed by Darmouni and Rodnyansky (2017) who investigated the effects of QE on bank lending. This literature focuses

the crisis, finding that funds with high sustainability ratings perform well.

[8] See also Schmidt, Timmermann, and Wermers (2016) who analyze runs on money market mutual funds during the September 2008 crisis.

[9] Seminal contributions include Diamond and Dybvig (1983), Holmström and Tirole (1998), Allen and Gale (2000), Freixas, Rochet and Parigi (2000, 2004), and Rochet and Vives (2004). Tucker (2014) presents some principles for a modern lender of last resort and discusses practical challenges.

largely on the transmission of central bank policies through banks. Our contribution relative to this strand of the literature lies in analyzing the effects of central bank crisis interventions on non-banks – that, unlike banks, do not have a direct access to the lender of last resort – and documenting through which channels central bank interventions helped alleviating the liquidity crisis in the non-bank sector.

Money markets were one of the first markets to malfunction at the start of the Global Financial Crisis. This spurred a large literature examining money market functioning in both normal and crisis times.[10] In contrast to the Global Financial Crisis, euro area short-term money markets functioned relatively smoothly in the Spring of 2020, also due to the large amounts of central bank liquidity outstanding at the onset of the pandemic. The dramatic decrease of bank lending to funds in the repo market we document underscores that the fund sector was under particular pressure during this period and therefore an interesting sector to study to assess the effects of central bank liquidity provision in March 2020, which was specifically designed to safeguard money market conditions.

3. Timeline of events and policy interventions

Table 1 provides and overview of key dates, events, and central bank policy interventions. In our analysis, we focus on the two main interventions employed by the ECB in March 2020: 1) the Pandemic Emergency Purchase Programme (PEPP), and 2) the additional ("Bridge") Long-Term Refinancing Operations (LTROs)[11]. A detailed timeline of all ECB monetary policy decisions is in the Appendix.

3.1 The liquidity crisis due to the pandemic

On January 31, 2020 the World Health Organization declared the COVID-19 outbreak as a public health emergency of international concern. Reports intensified in March following consecutive waves of infections at an increasing and tearing pace throughout February so that the WHO declared COVID-19 a global pandemic in the second week of March, expressing deep concern by the alarming levels of spread as well as worrying inaction and reticence. Synchronously, at the end of the week, on March 13, US governors announced states of emergency and a national emergency at the federal level in the US was declared.

[10] See, e.g., Corradin and Maddaloni (2020); Garcia-de-Andoain, Heider, Hoerova, and Manganelli (2016); Heider, Hoerova, and Holthausen (2015); Krishnamurthy, Nagel, and Orlov (2014), Afonso, Kovner, and Schoar (2011), Brunetti, Di Filippo, and Harris (2011), among many others.

[11] The ECB also activated swap lines with the Federal Reserve, enabling euro area banks to borrow US dollars. We do not consider these operations since money market transactions in our dataset can only occur in EUR.

Financial markets were quick to react and tumbled as these events took place. As equity and bond markets plummeted, the fund sector suffered large financial losses via rapidly declining asset prices, exceptionally large fund outflows and forced fire sales. Heightened uncertainty surrounding the real economic implications of the unfolding of the COVID-19 triggered a mass flight to safety, whereby institutional investors began unwinding their positions, particularly in risky and illiquid assets, which, in turn, put substantial pressure on funds' liquidity levels. In the week of March 12 to March 19, 2020 euro area funds experienced record withdrawals, surpassed only in September 2008, which were fueled by the increased demand for cash from end-investors (ECB Financial Stability Review, May 2020).

Figure 1 highlights increasing fund outflows at the onset of the pandemic while Figure 2 shows the drop of bank lending to funds in short-term money markets (repos). In Figure 3, declines in daily fund value, on average, amounted to between 7% and 10%, depending on portfolio eligibility composition, during the peak of the liquidity crisis in March 2020.

3.2 Expanded asset purchase program

Given the escalating financial market tensions, the ECB announced a package of monetary policy measures on March 12. Among the interventions was the expansion of the existing Asset Purchase Programme (APP) with a temporary envelope of additional net asset purchases of 120 billion EUR with the aim to induce favorable financing conditions to the real economy.

The following week, March 18 (after markets closed), the ECB announced the new Pandemic Emergency Purchase Programme (PEPP) whose goal was to counter serious risks to the monetary policy transmission mechanism and the outlook for the euro area posed by the coronavirus outbreak. The program was announced with an initial 750 billion EUR envelope, which was extended by an additional 600 billion EUR on June 4. Similarly to the APP, PEPP purchases are allocated to bonds issued by different euro-area countries according to the "capital key". A country's capital key weight is determined by the equally weighted average of its population and GDP shares. Differently from the APP, PEPP purchases are conducted in a flexible manner, which allows for fluctuations in the distribution of purchase flows over time, across asset classes and among jurisdictions.

The eligibility criteria are the identical to the asset eligibility for the APP. Specifically, a security needs to: a) be investment grade (i.e. have a minimum credit assessment of at least BBB-); b) have a yield greater than the deposit facility rate (DFR), which is the interest rate banks receive for depositing money with the ECB overnight; c) be issued by a private or public sector entity residing in the euro area; d) have a maximum residual maturity of 30 years and

264 days; e) be denominated in EUR; and f) the issuer cannot be a credit institutions, the issuer does not have any parent undertaking, which is a credit institution, and/or the issuer is not an asset management vehicle or national asset management and divestment fund established to support financial sector restructuring or resolution.

The legal documentation of the PEPP was published on March 25 and first purchases were conducted on March 26, 2020. Evidence on the effectiveness of the PEPP supports the notion that the announcement and subsequent implementation of the PEPP contributed significantly to the stabilization of market conditions, primarily through reducing default, redenomination and liquidity risk premia (Corradin, Grimm, and Schwaab, 2020).

On April 22, the ECB further decided to mitigate the impact of possible rating downgrades on collateral availability by grandfathering eligibility of marketable assets used as collateral in ECB credit operations falling below current minimum credit quality requirements.

3.3 Expanded liquidity provision

Among the intervention announced on March 12 were also the ("Bridge") Long-Term Refinancing Operations (LTROs) with the intention to provide immediate liquidity support to banks and to safeguard money market conditions. Participating banks obtain liquidity through a so-called "fixed-rate tender procedure with full allotment" (meaning: there are no pre-set limits; the central bank satisfies all liquidity demand by banks, as long as adequate collateral is posted; the interest rate is set equal to the average rate on the deposit facility and will be paid at the maturity date of the respective operation). The first Bridge LTRO was allotted on March 17 and settled on March 18. Over 110 credit institutions participated in this operation, borrowing over 100 billion EUR, which is suggestive of a strong demand for central bank liquidity at the onset of the pandemic. The subsequent twelve operations were executed on a week-by-week basis, featuring a progressively smaller number of banks and smaller amounts borrowed. All operation matured on June 24, 2020.[12]

4. Data and empirical methodology

This Section describes the databases we use and outlines our empirical strategy.

4.1 Data

[12] On March 25, 2020, 114 banks got additional 115 billion EUR in a TLTRO III operation operation (TLTRO-III.3). TLTRO III operations were in place pre-pandemic and the documentation necessary for participation in the operation which settled on March 25, 2020 had to be submitted already in February 2020.

We rely on four main data sources for our analysis: 1) the Refinitiv's Lipper for Investment Fund Management database which contains detailed mutual fund-level data including outflows, performance and ISIN-level portfolio holdings; 2) ECB market operation database (MOPDB) which contains data on the banks' excess reserve holdings as well as take-up in the ECB additional Long-Term Liquidity Operations (LTROs) announced in March 2020; 3) Individual balance sheet items (IBSI) database which contains bank-level balance sheet information; and 4) Money Market Statistical Reporting (MMSR) database which contains transactions-level data on money market trading between banks and funds. In what follows, we describe each data source in turn.

4.1.1 Refinitiv's Lipper for Investment Fund Management database

From Refinitiv's Lipper for Investment Management, we retrieve fund-level data on outflows, performance and ISIN-level portfolio holdings. We restrict our sample to open-end bond funds using information on the fund-type from (1) the closed-end flag available in Lipper, which indicates whether a fund has a fixed number of shares or units in issue; (2) the ECB's list of non-monetary investment funds; and (3) hand-collected data on the funds' legal structure.

Fund flow information, total net assets (TNA) and trading prices, are available at daily frequency. ISIN-level fund holdings information is available at monthly frequency. In some cases, reporting is quarterly. We observe the portfolio holdings at market valuation and also as shares of the fund's total holding. Lipper sources the portfolio holdings directly from the fund management companies. Unavailable fund holdings are typically linked to non-disclosure agreements and embargo periods.

We construct the daily fund flows variable as is standard in the literature (see, e.g., Falato, Goldstein and Hortaçsu, 2020, for a recent example):

$$flows_{\mathrm{i,t}} = (TNA_{\mathrm{i,t}} - (1 + \mathrm{r_{i,t}}) * TNA_{i,t-1}) \,/\, TNA_{i,t-1}$$

where $TNA_{\mathrm{i,t}}$ is total net assets of fund i at day t and $\mathrm{r_{i,t}}$ is the fund's daily return. We analyze flows on a fund-share level.

4.1.2 MOPDB database

From the ECB's market operation database (MOPDB), we construct, for each relevant banking group, their (daily) excess reserve holdings, where excess reserves are defined as holdings of central bank liquidity in excess of the minimum reserve requirements. In addition, we have information on the access and the liquidity take-up under the Bridge LTROs. For each

operation, we observe the outstanding amount and changes, as well as the information on the announcement, allotment, settlement and maturity date.

4.1.3 IBSI database

From the ECB's individual bank balance sheet items (IBSI) database, we construct, for each relevant banking group, their total assets, Tier 1 capital ratio, and their debt ratio (defined as a ratio of total liabilities to total assets). We use these variables as bank-level controls in our regressions investigating bank repo lending to funds in money markets. The frequency of this database is monthly.

4.1.4 MMSR database

The Money Market Statistical Reporting (MMSR) dataset provides transaction-by-transaction data on four money market segments: secured, unsecured, foreign exchange swap and overnight index swap euro money markets. Money market transactions have a maturity of up to and including one year. In our analysis, we focus on lending to and borrowing from non-MMF funds (all transactions are denominated in euro). The reporting population are euro area banking groups, which are required to disclose all deals that are booked in the headquarter and their euro area subsidiaries or branches. A transaction is subject to reporting as long as it is booked in the euro area, though it may be originated or executed elsewhere. Fund counterparties are observed at the LEI-level.

We construct outstanding amounts of repo loans at the bank-fund-day level. We consider total amounts as well as a split into two maturity buckets: short-term repos (up to and including one-week), and long-term repos (defined as those with maturity over one week).

We also construct bank-fund relationships prior to the pandemic by identifying all active bank-fund pairs in the MMSR dataset between January 1, 2019 and January 31, 2020, i.e., before the pandemic emergency began. For identification, we focus on funds with two or more bank relationships.

4.2 Empirical strategy

This subsection outlines our empirical strategy, starting with central bank asset purchases.

4.2.1 Central bank asset purchases

We focus on bond funds that invest in investment grade securities and that hold a non-zero

share of euro area securities in their portfolio. To assess the effects of PEPP purchases on fund flows and fund performance, we compare funds with higher shares of assets eligible for PEPP purchases in their portfolio before the crisis with funds with lower shares. Given that we consider investment grade funds, the difference in fund holdings of PEPP-eligible assets is driven by their differential holdings of securities issued by euro area credit institutions (e.g., high-quality bank bonds) and securities issued by non-euro-area issuers (e.g., US Treasuries). Such securities are not eligible for the PEPP (see Section 2.1.2).

We compare funds across time and across portfolio eligibility in a difference-in-difference set-up. Importantly, we show that these two groups of funds had the same performance and flow dynamics before the announcement of the PEPP on March 18, 2020 (Figure 3).

To assess the dynamics of fund performance, we estimate the following specification:

$$performance(cum)_{\,i,t} = \beta_0 + \int_{k=1}^{5} \beta_k \quad CrisisPeriod_{\,k,t} \times relMoreElig_i + \int_{k=1}^{5} \varphi_k \quad CrisisPeriod_{\,k,t} + \mu_i + \varepsilon_{i,t}$$

where $performance(cum)_{\,i,t}$ is the cumulative fund share performance, scaled to January 6, 2020. The dummy variables $CrisisPeriod_{\,k,t}$ take on the value of 1 for period *k* and zero otherwise. We consider 5 periods: a run-up period (March 9 – March 17), a PEPP announcement period (March 18 – March 25, 2020), and three PEPP implementation periods. The three implementation periods are week 1 (March 26 – April 1, week 2 (April 2 – April 8), and the periods thereafter (April 9 – June 30, 2020). The variable $relMoreElig_i$ is equal to 1 if a fund held, at the end of January 2020, above-the-median amounts in securities that became eligible for the PEPP later on. μ_i are fund fixed effects and $\varepsilon_{i,t}$ is the error term. Standard errors are clustered at the fund level.

Turning to fund flows, we use the following difference-in-differences set-up:

$$flows_{i,t} = \beta_0 + \int_{k=1}^{5} \beta_k \quad CrisisPeriod_{\,k,t} \times relMoreElig_i + \int_{k=1}^{5} \varphi_k \quad CrisisPeriod_{\,k,t} + \mu_i + \varepsilon_{i,t}$$

with the variables defined as above, except for the left-hand side variable $flows_{i,t}$. This variable stands for the daily fund share flow of fund share *i* at time *t*.

4.2.2 Central bank liquidity provision and money markets

To assess the effects of central bank liquidity provision by banks, we combine two proprietary

datasets: 1) bank-level information on excess reserve holdings as well as borrowing in Bridge LTROs and 2) transactions-level data on bank lending to funds in secured (repo) money markets.

In the repo transactions dataset, we identify all relationships a fund had with banks over the 13-month period prior to the pandemic (January 2019 – January 2020). We focus on a period spanning a year since the maturity of repo transactions we observe stays nearly always below 12 months. In our analysis, we include funds with two or more bank relationships so that we can control for observed and unobserved heterogeneity in repo demand and risk using the Khwaja and Mian (2008) methodology. Bank-fund relationships are sticky and do not change over time. A typical fund has two to three different bank relationships. With this ex ante classification of bank-fund pairs, we build a pair panel for the liquidity crisis period. In our sample, there are no new relationships formed during the crisis period.

We compare bank relationship lending to funds, distinguishing between banks with relatively higher (above-the-median) and relatively lower (below-the-median) excess reserve holdings ex ante (January 2020). As March 2020 was first and foremost a liquidity crisis, we conjecture that banks with relatively lower ex ante excess reserve holdings may be relatively more affected by the liquidity-providing central bank operations, which aimed at alleviating bank liquidity constraints.

We also investigate whether central bank interventions changed the maturity distribution of bank repo lending to their relationship funds. To this end, we split repo loans into two maturity buckets, with short-term loans defined as up to and including one-week, and long-term loans defined as those with maturity over one week. Short-term loans represent 41% while longer-term loans represent 59% of the total amount of repos outstanding in our sample (in January 2020).

Importantly, the lending behavior of the two groups of banks, across the two maturity buckets, followed a similar pattern before the announcement of the Bridge LTROs on March 12, 2020 (see Figure 4).

We then test how bank lending behavior changed: a) following the announcement of the Bridge LTROs (compared to the previous week), and b) following the settlement of the first Bridge LTRO (compared to the previous week). The reason we focus on the first Bridge LTRO is that multiple measures were phased in as of March 25, 2020, making it hard to isolate the effects of the subsequent Bridge LTROs.

Our regression model setup is as follows:

$$\Delta bank\ lending_{f,b} = \beta\ relLowReserves_b + \mu_f + X_b + \varepsilon_{f,b}$$

where $\Delta\ bank\ lending_{f,b}$ denotes the change of bank-fund outstanding repo amounts (daily average over a week). We consider total outstanding amounts, as well as amounts split by maturity, shorter-term (7 days or below) and longer-term (8 days or above). We examine the "Bridge announcement" effect (a change between the week starting March 11 and the previous week), the "First Bridge LTRO settlement" effect (a change between the week starting March 18 and the previous week) as well as a longer-term change (a change between the six-week period starting March 18 and the previous six-week period). The variable $relLowReserves_b$ is a dummy variable indicating below-the-median excess reserves for bank *b* ex ante (measured at the end of January 2020). The term μ_f takes out all variation across funds *f*. X_b are bank-level controls. Standard errors are clustered at the fund level.

To zoom in on the role of Bridge LTRO take-up as such, we also test whether banks with below-the-median excess reserves ex ante (in January 2020) who took up liquidity in the first Bridge LTRO (operation settled on March 18, 2020) lent more to funds compared to the other banks:

$$\Delta bank\ lending_{f,b} = \beta\ relLowReserves_b \times LTROdummy_b + \gamma\ relLowReserves_b + \delta\ LTROdummy_b + \mu_f + X_b + \varepsilon_{f,b}$$

where $\Delta\ bank\ lending_{f,b}$ denotes the change, between the week starting March 18 (first Bridge LTRO settlement, PEPP announcement week) and the previous week, of bank-fund outstanding repo amounts (daily average over a week), either total, short-term (7 days or below) or longer-term (8 days or above). The variable $LTROdummy_b$ is a dummy variable indicating that bank *b* borrowed liquidity in the first Bridge LTRO (settled on March 18, 2020). All other variables are as defined in the previous equation. Standard errors are clustered at the fund level.

5. Results

This section describes the results of our analysis, first for central bank asset purchases, and then for central bank liquidity provision.

5.1 Central bank asset purchases

Tables 2 and 3 present the results for fund performance and flows, respectively.

Table 2 shows the results for the impact of PEPP on daily cumulative fund performance.

Column 1 and column 2 provide estimates for the funds that have below-the-median holdings of the PEPP-eligible securities, while column 3 and column 4 consider funds that have above-the-median holdings of the PEPP-eligible securities. Column 5 and column 6 give differences between the funds with higher versus funds with lower PEPP-eligible holdings.

Table 2 documents that there is a large drop in the cumulative fund performance for both groups relative to the period before the run-up (columns 1 to 4). The key results are in the differential effects between the two groups (column 5 and column 6). There is no significant difference between the two groups in the run-up period. By contrast, a large gap between the two groups emerges after the PEPP announcement on March 18, 2020: funds holding more eligible bonds stabilized while funds holding less eligible bonds dropped further by an additional 3.7% (column 5 and column 6). In the first week of the PEPP implementation, this gap remained at 2.7%, dropping to 2.1% in the second week. Thereafter, there is no significant difference between funds with more PEPP-eligible bonds and funds with less PEPP-eligible bonds.

Table 3 gives the results of the impact of the PEPP on daily fund flows. Column 1 and column 2 provide estimates for the funds that have below-the-median holdings of the PEPP-eligible securities, while column 3 and column 4 consider funds that have above-the-median holdings of the PEPP-eligible securities. Column 5 and column 6 give differences between the funds with higher versus funds with lower PEPP-eligible holdings.

Table 3 documents that there are daily fund outflows for both groups in the run-up period, during the PEPP announcement period, and in the first week of the PEPP implementation period. Average daily outflows in the run-up period are between 0.27% for more PEPP-eligible and 0.45% for less PEPP-eligible funds (column 4 and column 2, respectively), or 1.35% and 2.25% on a weekly basis. There are still considerable outflows during the PEPP announcement period, and smaller outflows during the first week of the PEPP implementation. Crucially, with the PEPP announcement on March 18, 2020, funds with relatively more PEPP-eligible bonds had significantly lower outflows compared to funds holding less PEPP-eligible bonds. The difference is 0.35% of daily outflows or 1.75% over the week. This is equivalent to a decrease in outflows by 66% relative to their less PEPP-eligible counterparts.

Finally, we note that the fund performance and flows stabilized by the end of March of 2020, in line with the overall financial markets rebound.

Our analysis here is complementary to the analysis in Falato, Goldstein, and Hortaçsu (2020) who document that the illiquidity of fund assets was an important factor in explaining

fund outflows. Instead of comparing more and less liquid funds, we focus on an ex ante homogeneous subset of funds with liquid asset holdings (investment grade funds). Yet, we are still able to show that those funds that hold more PEPP-eligible assets see their performance and outflows stabilize.

5.2 Central bank liquidity provision and money market trading

Our regressions focus on funds borrowing from multiple banks, where banks differ in their ex ante (end-January 2020) excess reserve holdings. The sample contains 670 bank-fund relationship pairs, and 273 distinct funds.

Table 4 compares bank repo lending to funds in the week in which the Bridge LTROs were announced, relative to the previous week. We distinguish between changes in bank-fund outstanding repo amount totals (column 1 and column 4), short-term - 7 days or below - repos (column 2 and column 5), and longer-term – 8 days or above – repos (column 3 and column 5). Table 4 shows that measures announced on March 12, 2020, notably the additional liquidity provision through the Bridge LTROs, had no significant effect on bank repo lending to funds across the higher and lower excess reserves banks.

Table 5 compares bank lending in the week in which the first Bridge LTRO was settled and the PEPP was announced, relative to the previous week. The first Bridge LTRO settlement featured the largest take-up and the highest number of participating banks across all Bridge LTROs (see Section 3.3). Table 5 shows that below-the-median excess reserve holdings banks increased their longer-term repo lending to funds by 106% compared to banks with higher ex ante excess reserve holdings. There is no differential effect on short-term lending. In economic terms, an average bank-fund relationship has about 80 million EUR of longer-term repos outstanding over the February-April 2020 period. Therefore, funds borrowing from a bank with relatively lower excess reserve holdings increased their longer-term repos by roughly 80 million EUR relative to their repos from a bank with higher excess reserves.

Table 6 investigates whether it was the access to central bank liquidity through the first Bridge LTRO as such which is associated with an increase in longer-term repo lending by banks with lower excess reserves. The answer is negative. For banks that chose to take-up central bank liquidity in the first Bridge LTRO, there is no increase in the longer-term lending to funds, and there is a decline in short-term lending to funds. For banks with relatively lower ex ante excess reserve holdings, take-up is also not associated with increased lending, neither short- nor longer-term, compared to banks with lower excess reserve holdings that chose not to get additional central bank liquidity. Since all banks in our sample had access to the Bridge

LTROs, the decision on whether to borrow in an operation could be driven by other factors, such as the bank's own liquidity needs.

Finally, Table 7 explores the longer-term evolution of bank repo lending to funds. It considers the six-week period as of March 18, 2020, compared to the previous six-week period. It shows that banks with below-the-median excess reserve holdings extended relatively more longer-term repos to their relationship funds in the six-week period after March 18, 2020, compared to above-the-median excess reserve holdings banks. In particular, they increased their long-term loans to funds by 220% in the six weeks after March 18, 2020.

In all, we did not find evidence that either the announcement of Bridge LTROs, or the actual take-up in the first Bridge LTRO was associated with more bank repo lending to their relationship funds. Rather, in the weeks that followed the announcement and the implementation of the PEPP, banks with lower ex ante excess reserves holdings shifted the maturity of their repo loans relatively more towards longer-term lending.

5.3 Policy implications

The financial market turbulence in the Spring of 2020 rekindled the discussion of whether the existing monetary policy framework is effective in alleviating liquidity crises. The legal set-up of the ECB (Article 18.1 of the ESCB Statute) states that in order to achieve its objectives and to carry out its tasks, the ECB may "inter alia conduct credit operations with credit institutions and other market participants." However, since the outset, the ECB decided to work only with banks as counterparties due to their dominant role in the euro area financial system. Given the increasing importance of non-banks in monetary policy transmission and financial stability – non-banks currently represent 56% of total financial sector assets - the question arises whether non-banks should have direct access to central bank liquidity facilities and/or whether fund shares should be eligible for central bank purchases, at least in crisis times.

Our analysis provides an input into these discussions. Our results suggest that central bank asset purchases through the PEPP were effective in improving fund performance and stabilizing fund outflows. Asset purchases alleviated fire-sale pressures in key markets (sovereign and corporate bonds, as well as commercial paper) and played an important role in supporting values of assets held by mutual funds. In addition, in the weeks that followed the announcement and the implementation of the PEPP, banks with lower ex ante excess reserve holdings increased the maturity of their repo lending to funds, compared to banks with higher ex ante reserve holdings. This suggests that bank liquidity constraints were alleviated, and banks could offer valuable longer-term repo funding to funds.

6. Conclusion

When a liquidity crisis hits non-bank financial intermediaries, which central bank interventions help alleviate the crisis? We use the pandemic-induced financial market turbulence in March 2020 as a laboratory to answer this question. We document that open-end mutual funds faced a severe liquidity crisis in that period. We assess whether ECB's asset purchases through the PEPP as well as its liquidity provision to banks through the Bridge LTROs could alleviate the liquidity strains in the fund sector.

Analyzing asset purchases, we find that, following the PEPP announcement on March 18, 2020, mutual funds with higher shares of assets eligible for central bank purchases in their portfolio before the shock hit see their performance improve by 3.7% and their outflows decrease by 66% relative to their ex ante similar counterparts. Analyzing money market activity, we do not find evidence that additional central bank liquidity provision to banks in March 2020 is associated with more lending to funds trading with their relationship banks. Rather, we find that in the weeks that followed the announcement and the implementation of the PEPP, banks with lower ex ante excess reserve holdings – arguably those more liquidity-constrained - increased the maturity of their repo lending to funds, compared to banks with higher ex ante reserve holdings.

Our results suggest that central bank asset purchases were particularly effective in stopping fire-sale dynamics in asset markets and staving off runs on funds. This implies that even though the fund sector did not have access to the lender of last resort, central bank interventions were nevertheless able to reach that sector during a severe liquidity crisis.

References

Afonso, G., A. Kovner, and A. Schoar (2011). "Stressed, not frozen: the Federal Funds market in the financial crisis," Journal of Finance 66 (2011), 1109-1139.

Allen, F., and D. Gale (2000). "Financial Contagion," Journal of Political Economy 108 (1), 1–33.

Andrade, P., C. Cahn, H. Fraisse, and J.-S. Messonier (2019). "Can the provision of long-term liquidity help to avoid a credit crunch? Evidence from the Eurosystem's LTRO," Journal of the European Economic Association 17 (4), 1070-1106.

Barber, B. M., X. Huang, and T. Odean (2016). "Which factors matter to investors? Evidence from mutual fund flows," The Review of Financial Studies 29 (10), 2600-2642.

Brunetti C., Di Filippo M., Harris J.H. (2011). "Effects of central bank intervention on the interbank market during the subprime crisis," Review of Financial Studies 24, 2053-2083.

Carpinelli, L. and M. Crosignani (2020). "The design and transmission of central bank liquidity provisions," Journal of Financial Economics, forthcoming.

Craig, B.R., and Y. Ma (2020). "Intermediation in the interbank lending market," working paper, Working Papers 202009, Federal Reserve Bank of Cleveland.

Chakraborty, I., I. Goldstein, and A. MacKinlay (2020). "Monetary stimulus and bank lending," Journal of Financial Economics 136, 189–218.

Chen, Qi., I. Goldstein, and W. Jiang (2010). "Payoff complementarities and financial fragility: Evidence from mutual funds outflows," Journal of Financial Economics 97 (2), 239-262.

Chernenko, S., and A. Sunderam (2017). "Liquidity transformation in asset management: Evidence from the cash holdings of mutual funds," working paper, ESRB Working Paper Series 23.

Chevalier, J., and G. Ellison (1997). "Risk taking by mutual funds as a response to incentives," Journal of Political Economy 105, 1167–200.

Choi, J., S. Hoseinzade, S. Seunghun Shin, and H. Tehranian (2019). "Corporate bond mutual funds and asset fire sales," Journal of Financial Economics 138 (2), 432-457.

Corradin, S., and Maddaloni, A. (2020) "The importance of being special: repo markets during the crisis," Journal of Financial Economics, Vol. 137 (2), pp.392-429.

Coval, J., and E. Stafford (2007). "Asset fire sales (and purchases) in equity markets," Journal of Financial Economics 86 (2), 479–512.

Darmouni, O. M., and A. Rodnyansky (2017). "The effects of quantitative easing on banking lending behaviour," The Review of Financial Studies 30 (11), 3858-3887.

Diamond, D., and P. Dybvig (1983). "Bank runs, deposit insurance, and liquidity," Journal of Political Economy 91 (3), 401–19.

Drechsler, I., Drechsel, T., Marques-Ibanez, D. and Schnabl, P. (2016). "Who borrows from the lender of last resort?", The Journal of Finance 71(5), 1933-1974.

Falato, A., I. Goldstein, and A. Hortaçsu (2020). "Financial fragility in the COVID-19 crisis," working paper, NBER Working Papers 27559.

Falato, A., A. Hortaçsu, D. Li, and C. Shin (2020), "Fire-sale spillovers in debt markets," working paper, Journal of Finance, forthcoming.

Franzoni, F., and M. Giannetti (2019). "Costs and benefits of financial conglomerate affiliation: Evidence from hedge funds," Journal of Financial Economics 134 (2), 355-380.

Freixas, X., B. Parigi and J.-C. Rochet (2004). "The lender of last resort: a twenty-first century approach", Journal of the European Economic Association 2 (6), 1085–1115.

Freixas, X., B. Parigi and J.-C. Rochet (2000). "Systemic risk, interbank relations, and liquidity provision by the central bank," Journal of Money, Credit and Banking 32 (3), 611–638.

Garcia-de-Andoain, C., F. Heider, M. Hoerova, and S. Manganelli (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.

Giannetti, M. and L. Laeven (2016). "Local ownership, crises, and asset prices: Evidence from US mutual funds," Review of Finance 20 (3), 947-978.

Goldstein, I. (2017). "Comment on "Redemption risk and cash hoarding by asset managers" by Morris, Shim, and Shin," Journal of Monetary Economics 89, 88–91.

Goldstein, I., H. Jiang, and D. T. Ng (2017). "Investor flows and fragility in corporate bond funds," Journal of Financial Economics 126 (3), 592-613.

Haddad, V., A. Moreira, and T. Muir (2020). "When selling becomes viral: disruptions in debt markets in the COVID-19 and the Fed's response," working paper, NBER Working Papers 27168.

Heider, F., M. Hoerova, and C. Holthausen, C. (2015). "Liquidity hoarding and interbank market spreads: The role of counterparty risk", Journal of Financial Economics 118, 336-354.

Holmström, B. and J. Tirole (1998). "Private and public supply of liquidity," Journal of Political Economy 106 (1), 1–40.

Jasova, M., C. Mendicino, and D. Supera (2020). "Policy uncertainty, lender of last resort and the real economy," Journal of Monetary Economics, forthcoming.

Jin, D., M.T., Kacperczyk, B. Kahraman, and F. Suntheim (2020). "Swing pricing and fragility in open-end mutual funds," mimeo, University of Oxford.

Kandrac, J. and B. Schlusche (2020). "Quantitative easing and bank risk taking: Evidence from lending," Working Paper.

Kargar, M., B. Lester, D. Lindsay, S. Liu, P. O. Weill, and D. Zuniga (2020). "Corporate bond liquidity during the COVID-19 crisis," working paper, NBER Working Papers 27355.

Koijen, R. S. J., F. Koulischer, B. Nguyen, and M. Yogo (2020). "Inspecting the mechanism of quantitative easing in the euro area," working paper, Journal of Financial Economics, forthcoming.

Krishnamurthy, A., S. Nagel and D. Orlov (2014). "Sizing up repo," Journal of Finance 69 (6), 2381-2417.

Krishnamurty, A., and A. Vissing-Jorgensen (2011). "The effects of quantitative easing on interest rates: channels and implications for policy," Brookings Papers on Economic Activity.

Kwaja, A. I. and A. Mian (2008). "Tracing the impact of bank liquidity shocks: Evidence from

an emerging market," American Economic Review 98(4), 1413-1442.

Li, L., Y. Li, M. Machiavelli, and X. Zhou (2020). "Runs and interventions in the time of COVID-19: Evidence from money funds," working paper.

Ma, Y., K. Xiao, and Y. Zeng (2020). "Mutual fund liquidity transformation and reverse flight to liquidity," working paper.

Morris, S., I. Shim, and S.H. Shin (2017). "Redemption risk and cash hoarding by asset managers," Journal of Monetary Economics 89, 71–87.

Pastor, L., and M. Blair Vorsatz (2020). "Mutual fund performance and flows during the COVID-19 crisis," working paper, The Review of Asset Pricing Studies, forthcoming.

Rochet, J.-C. and X. Vives (2004). "Coordination failures and the lender of last resort: Was Bagehot right after all?" Journal of the European Economic Association 2 (6), 1116–1147.

Schmidt, L., A. Timmermann, and R. Wermers (2016). "Runs on Money Market Mutual Funds," American Economic Review, 106 (9), 2625–2657.

Tucker, P., "The lender of last resort and modern central banking: principles and reconstruction", contribution to Re-thinking the lender of last resort, BIS Papers, No. 79.

Vissing-Jorgensen, A., (2020), "The Case for Federal Reserve Corporate Bond Purchases," mimeo, University of California Berkeley.

Zeng, Y. (2017). "A Dynamic Theory of Mutual Fund Runs and Liquidity Management," mimeo, University of Washington.

Figure 1: Mutual fund flows, January 6 – June 30, 2020

This figure depicts the evolution of daily average fund flows before and after the initial COVID-19 shock in March 2020. Daily flows are calculated as

$$flows_{\mathrm{i,t}} = (TNA_{\mathrm{i,t}} - (1 + \mathrm{r_{i,t}}) * TNA_{i,t-1}) \,/\, TNA_{i,t-1}$$

where $TNA_{\mathrm{i,t}}$ is total net assets of fund i at day t and $\mathrm{r_{i,t}}$ is the fund's daily return. The vertical grey dotted lines depict key policy events: the run-up period (March 9 – March 17, 2020) refers to the 10 days before the ECB's announcement of its Pandemic Emergency Purchase Programme (PEPP); the announcement of the PEPP on March 18, 2020 (after markets closed, the grey dotted line is therefore drawn on March 19, 2020); and the start of PEPP purchases on March 26, 2020.

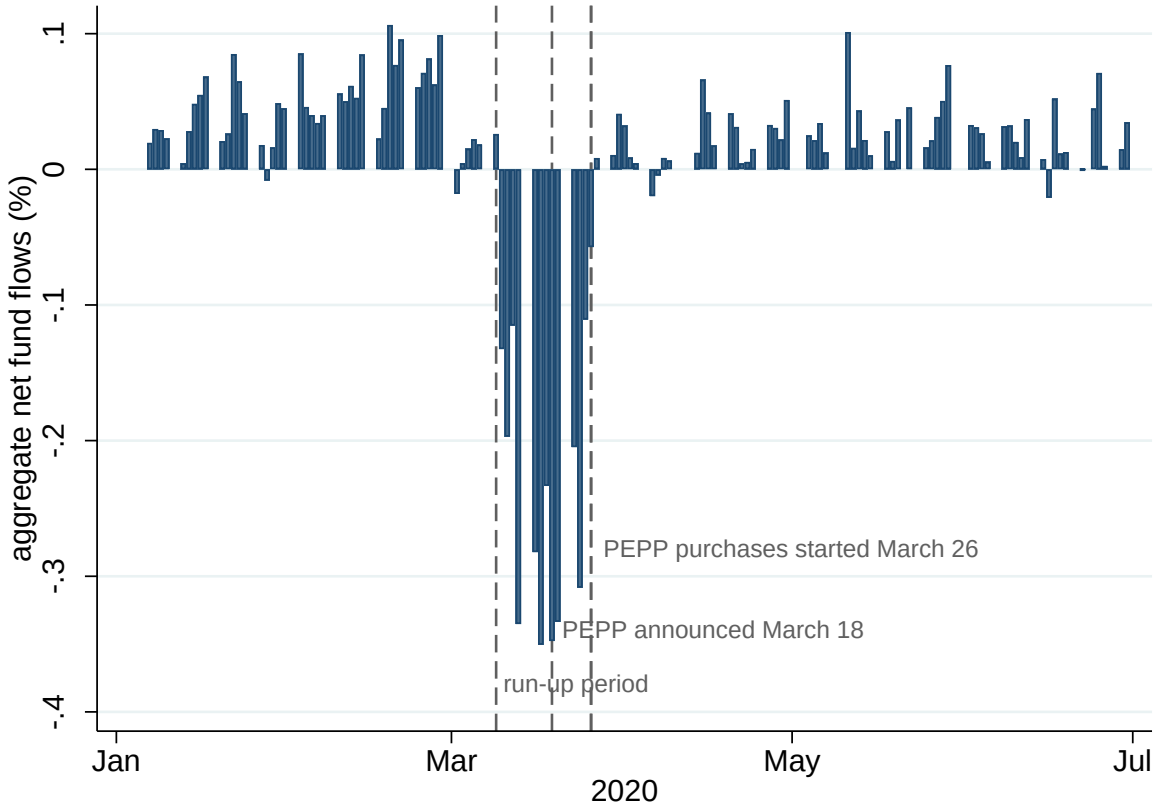

Figure 2: Bank lending to funds in the secured (repo) market, new transactions, February 4 – April 28, 2020

This figure depicts the evolution of weekly bank lending to funds in the euro area secured (repo) markets in terms of volumes of new transactions. The blue solid line gives daily averages over a week (in billion EUR). The vertical grey dotted lines refer to key policy events in the respective weeks: the announcement of Bridge LTROs on March 12, 2020; the setllement of the first Bridge LTRO on March 18, 2020; the announcement of the PEPP (announced March 18, 2020 after markets closed); and the package of measures settled / implemented on March 25-26, 2020 (settlement of the second Bridge LTRO, settlement of a TLTRO III operation, TLTRO-III.3, and the start of PEPP purchases).

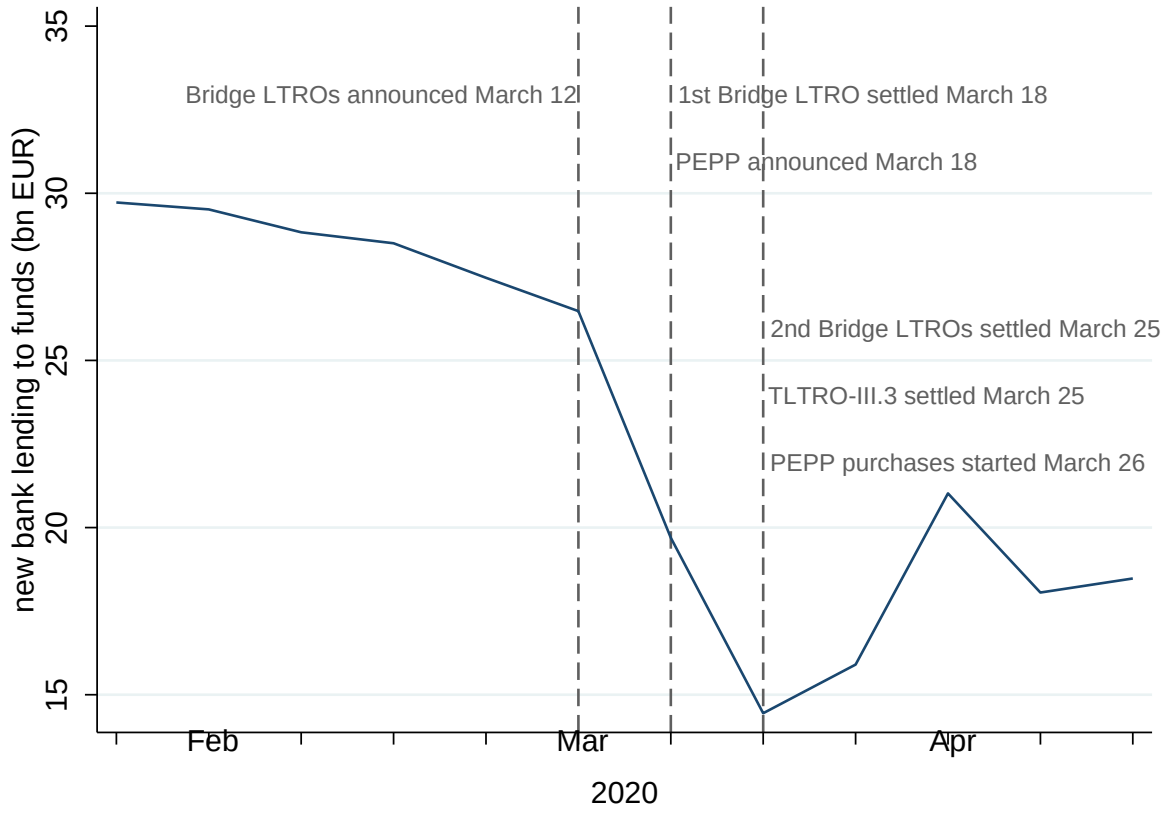

Figure 3: The effects of asset purchases - Fund performance across funds holding more/less PEPP-eligible securities, January 6 – June 30, 2020

This figure gives the evolution before and after the initial COVID-19 shock of March 2020 of daily average fund performance. The blue (red dotted) line depicts performance of mutual funds with more (less) assets eligible for central bank purchases in their portfolio before the shock. The vertical grey dotted lines depict key policy events: the run-up period (March 9 – March 17, 2020) refers to the 10 days before the ECB's announcement of its Pandemic Emergency Purchase Programme (PEPP); the announcement of the PEPP on March 18, 2020 (after markets closed, the grey dotted line is therefore drawn on March 19, 2020); and the start of PEPP purchases on March 26, 2020.

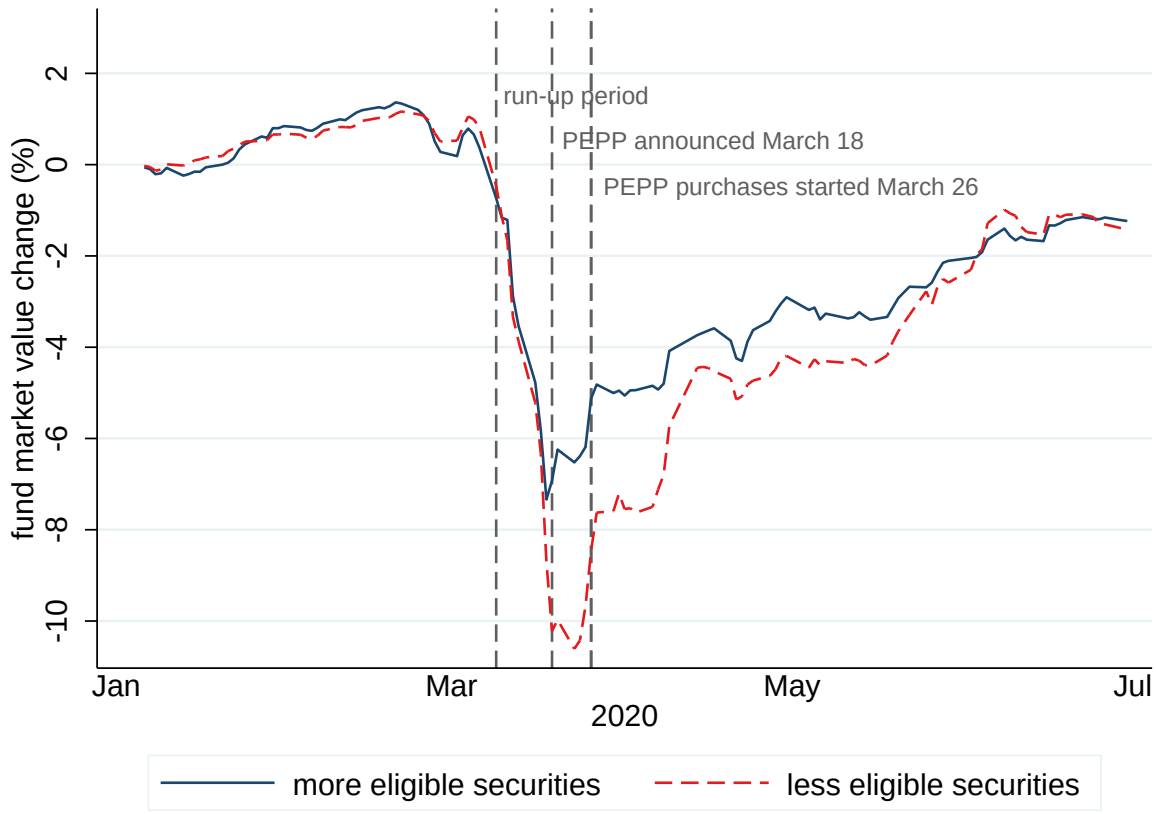

Figure 4: Bank lending to funds in the secured (repo) market, outstanding amounts (in logs), across higher- and lower-excess reserves banks and maturities, February 4 – April 28, 2020

This figure gives the evolution of weekly bank repo lending to funds (in logs) by comparing lending to funds borrowing from two types of banks: high and low excess reserve holdings banks, with the former defined as banks whose excess reserve holdings were above the median in January 2020, and the latter defined as banks whose excess reserve holdings were below the median. We further distinguish repo loans by maturity, with short-term (ST) defined as up to and including one week maturity and long-term (LT) defined as more than one week maturity. For each week, we compute daily average repo loans outstanding over a week for the high and low excess reserves banks and plot the time series in each of the two maturity buckets. To ease comparability, we normalize the y-axis so that the log of lending in each maturity bucket for both high and low excess reserves banks is forced to be zero in the first week of February. The y-axis values can then be readily interpreted as growth rates in bank lending to funds relative to the first February week. The vertical grey dotted lines refer to key policy events in the respective weeks: the announcement of Bridge LTROs on March 12, 2020; the setllement of the first Bridge LTRO on March 18, 2020; the announcement of the PEPP (announced March 18, 2020 after markets closed); and the package of measures settled / implemented on March 25-26, 2020 (settlement of the second Bridge LTRO, settlement of a TLTRO III operation, TLTRO-III.3, and the start of PEPP purchases).

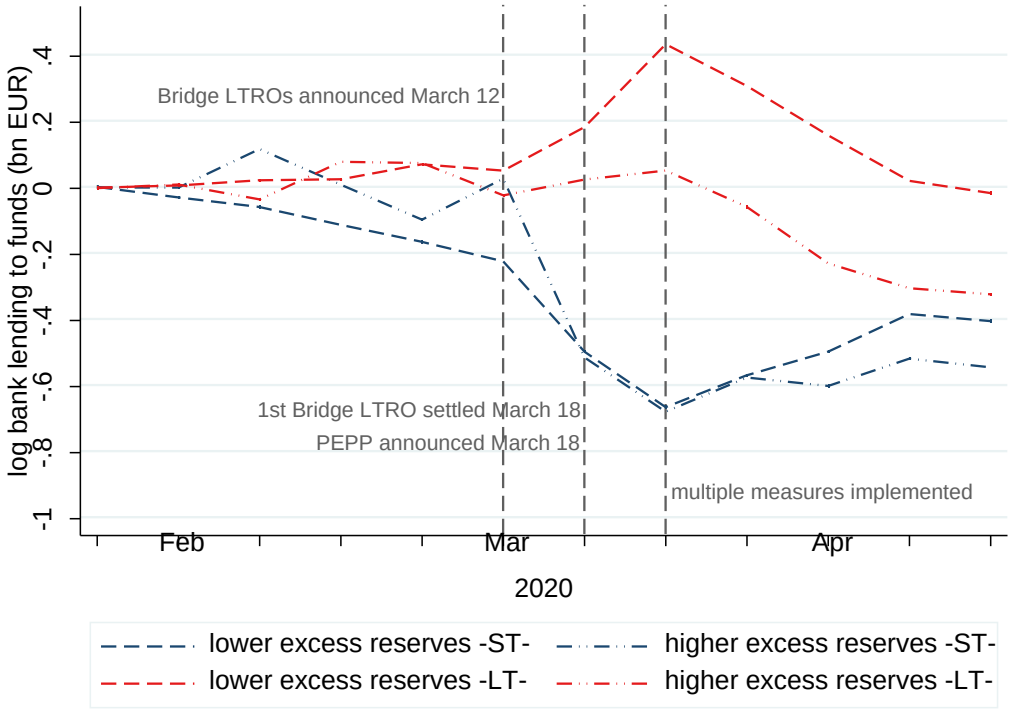

Table 1: Timeline of key events and policy announcements, January – April 2020

Date	Event
30-Jan-20	The World Health Organization (WHO) declared that the COVID-19 outbreak constitutes a Public Health Emergency of International Concern (PHEIC).
11-Mar-20	The WHO declares COVID-19 outbreak a global pandemic.
12-Mar-20	ECB announces a package of monetary policy measures: (1) Emergency ("Bridge") LTROs to provide immediate liquidity support to the euro area financial system, where each operation will be carried out through a fixed rate tender procedure with full allotment. (2) A temporary envelope of additional net asset purchases of 120 billion EUR added until the end of the year to support favorable financing conditions for the real economy in times of heightened uncertainty.
18-Mar-20	First Bridge LTRO settled. The remaining 12 operations follow a weekly schedule. All operations mature on June 24, 2020. After markets closed, the ECB decided the following policy measures: (1) Pandemic Emergency Purchase Programme (PEPP) with an overall envelope of 750 billion EUR. Purchases will be conducted until the end of 2020 and will include all asset categories eligible under the existing asset purchase program (APP). (2) Expansion of eligible assets under the corporate sector purchase program (CSPP) to non-financial commercial paper. (3) Easing of collateral standards.
25-Mar-20	Legal documentation for the PEPP published on ECB website. Settlement of a TLTRO III operation.
26-Mar-20	The ECB started conducted first asset purchases under the PEPP.
07-Apr-20	ECB announces package of temporary collateral easing measures to mitigate the tightening of financial conditions across the euro area.
22-Apr-20	ECB implements mitigation of the impact of possible rating downgrades on collateral availability.
23-Apr-20	European Union leaders agree to build a trillion EUR EU commission emergency fund using a new Multiannual Financial Framework (MFF). No agreement on loans vs grants. They endorse SURE, ESM, EIB's guarantee scheme. The three initiatives should be operational by June 1, 2020.

Table 2: The effects of central bank purchases - Fund performance

Using a difference-in-differences set-up,we estimate the following specification:

$$performance(cum)_{i,t} = \beta_0 + \int_{k=1}^{5} \beta_k \quad CrisisPeriod_{k,t} \times relMoreElig_i + \int_{k=1}^{5} \varphi_k \quad CrisisPeriod_{k,t} + \mu_i + \varepsilon_{i,t}$$

where $performance(cum)_{i,t}$ is the the cumulative fund share performance (scaled to January 6, 2020). The dummy variables $CrisisPeriod_{k,t}$ take on the value of 1 for period *k*. We consider 5 periods: a run-up period (March 9 – March 17), a PEPP announcement period (March 18 – March 25, 2020), and three PEPP implementation periods (week 1: March 26 – April 1, week 2: April 2 – April 8, and the period thereafter: April 9 – June 30, 2020). The variable $relMoreElig_i$ is equal to 1 if a fund held, at the end of January 2020, above-the-median amounts in securities that became eligible for the PEPP later on. μ_i are fund fixed effects and $\varepsilon_{i,t}$ is the error term. Standard errors are clustered at the fund level.

	(1)	(2)	(3)	(4)	(5)	(6)
	investment fund (IF) cumulative performance					
	IF less exposed to eligible bonds	IF less exposed to eligible bonds	IF more exposed to eligible bonds	IF more exposed to eligible bonds	diff (9) -(7)	diff (10) -(8)
*run-up period * eligible bond dummy (> median)*					0.419	0.402
					(0.742)	(0.738)
*PEPP announcement * eligible bond dummy (> median)*					**3.738****	**3.708****
					(1.457)	(1.448)
*PEPP impl. week 1 * eligible bond dummy (> median)*					**2.689****	**2.682****
					(1.168)	(1.168)
*PEPP impl. week 2 * eligible bond dummy (> median)*					**2.148***	**2.133***
					(1.108)	(1.102)
*PEPP impl. week 2 plus * eligible bond dummy (> median)*					0.493	0.484
					(0.778)	(0.778)
run-up period	-4.418***	-4.402***	-3.999***	-4.000***	-4.418***	-4.402***
	(0.583)	(0.576)	(0.463)	(0.465)	(0.580)	(0.574)
PEPP announcement	-10.764***	-10.732***	-7.026***	-7.023***	-10.764***	-10.732***
	(1.328)	(1.316)	(0.614)	(0.617)	(1.322)	(1.310)
PEPP implementation week 1	-8.239***	-8.232***	-5.550***	-5.549***	-8.239***	-8.232***
	(1.052)	(1.051)	(0.517)	(0.519)	(1.048)	(1.046)
PEPP implementation week 2	-7.385***	-7.372***	-5.237***	-5.238***	-7.385***	-7.372***
	(1.033)	(1.025)	(0.414)	(0.416)	(1.028)	(1.020)
PEPP implementation week 2 plus	-3.620***	-3.614***	-3.127***	-3.129***	-3.620***	-3.614***
	(0.728)	(0.726)	(0.285)	(0.287)	(0.725)	(0.723)
Observations	46,645	46,645	46,707	46,707	93,352	93,352
R-squared	0.4544	0.7111	0.3843	0.6890	0.4317	0.7047
-	-				-	-
Fund Share FE	NO	YES	NO	YES	NO	YES
-	-	-	-	-	-	-
Clustered Std. Err.	Fund	Fund	Fund	Fund	Fund	Fund

*** p<0.01, ** p<0.05, * p<0.1

Table 3: The effects of central bank purchases - Fund flows

Using a difference-in-differences set-up, we estimate the following specification:

$$flows_{\mathrm{i,t}} = \beta_0 + \int_{k=1}^{5} \beta_k \quad CrisisPeriod_{\,k,t} \times relMoreElig_i + \int_{k=1}^{5} \varphi_k \quad CrisisPeriod_{\,k,t} + \mu_i + \varepsilon_{i,t}$$

where $flows_{i,t}$ is the daily fund share flow of fund share *i* at time *t*. The dummy variables $CrisisPeriod_{\,k,t}$ take on the value of 1 for period *k*. We consider 5 periods: a run-up period (March 9 – March 17), a PEPP announcement period (March 18 – March 25, 2020), and three PEPP implementation periods (week 1 (March 26 – April 1, week 2 (April 2 – April 8), and the period thereafter (April 9 – June 30, 2020). The variable $relMoreElig_i$ is equal to 1 if a fund held, at the end of January 2020, above-the-median amounts in securities that became eligible for the PEPP later on. μ_i are fund fixed effects and $\varepsilon_{i,t}$ is the error term. Standard errors are clustered at the fund level.

	(1)	(2)	(3)	(4)	(5)	(6)
	investment fund (IF) daily flows					
	IF less exposed to eligible bonds	IF less exposed to eligible bonds	IF more exposed to eligible bonds	IF more exposed to eligible bonds	diff (1) -(3)	diff (2) -(4)
*run-up period * eligible bond dummy (> median)*					0.165	0.182
					(0.112)	(0.115)
*PEPP announcement * eligible bond dummy (> median)*					**0.324*** **	**0.353*** **
					(0.106)	(0.102)
*PEPP impl. week 1 * eligible bond dummy (> median)*					0.035	0.024
					(0.036)	(0.034)
*PEPP impl. week 2 * eligible bond dummy (> median)*					0.039	0.023
					(0.040)	(0.042)
*PEPP impl. week 2 plus * eligible bond dummy (> median)*					0.003	0.003
					(0.024)	(0.024)
run-up period	-0.368***	-0.445***	-0.203***	-0.267***	-0.368***	-0.446***
	(0.110)	(0.092)	(0.026)	(0.037)	(0.109)	(0.098)
PEPP announcement	-0.517***	-0.532***	-0.193***	-0.179***	-0.517***	-0.532***
	(0.103)	(0.099)	(0.029)	(0.031)	(0.102)	(0.102)
PEPP implementation week 1	-0.106***	-0.090***	-0.072***	-0.061***	-0.106***	-0.089***
	(0.027)	(0.024)	(0.023)	(0.023)	(0.027)	(0.024)
PEPP implementation week 2	-0.054	-0.026	-0.016	-0.003	-0.054	-0.025
	(0.035)	(0.050)	(0.019)	(0.021)	(0.035)	(0.042)
PEPP implementation week 2 plus	-0.018	-0.014	-0.015	-0.013	-0.018	-0.014
	(0.021)	(0.022)	(0.013)	(0.013)	(0.021)	(0.021)
fund share performance		-0.063		-0.065***		-0.061*
		(0.053)		(0.025)		(0.034)
Observations	46,252	46,252	46,316	46,316	92,568	92,452
R-squared	0.0244	0.0645	0.0090	0.0485	0.0189	0.0592
-	-	-	-	-	-	-
Fund Share FE	NO	YES	NO	YES	NO	YES
-	-	-	-	-	-	-
Clustered Std. Err.	Fund	Fund	Fund	Fund	Fund	Fund

*** p<0.01, ** p<0.05, * p<0.1

Table 4: The effects of central bank liquidity provision - Announcement of Bridge LTROs

Using the bank-fund relationship data and funds with two or more relationships only (Khwaja and Mian, 2008), this table presents results for the following specification:

$$\Delta bank\ lending_{f,b} = \beta\ relLowReserves_b + \mu_f + X_b + \varepsilon_{f,b}$$

where $\Delta\ bank\ lending_{f,b}$ denotes the change, between the week starting March 11 (Bridge LTRO announcement week) and the previous week, of bank-fund outstanding repo amounts (daily average over a week): total (column 1 and column 4), short-term - 7 days or below - (column 2 and column 5), and longer-term – 8 days or above – (column 3 and column 5). The variable $relLowReserves_b$ is a dummy variable indicating below-the-median excess reserves for bank b (measured at the end of January 2020). The term μ_f takes out all variation across funds *f*. X_b are bank-level controls. Standard errors are clustered at the fund level.

	(1)	(2)	(3)	(4)	(5)	(6)
	total	short term	long term	total	short term	long term
excess reserves dummy (< median)	-0.386	-0.593	-0.043	-0.386	-0.504	-0.039
	(0.419)	(0.434)	(0.402)	(0.458)	(0.495)	(0.441)
log(total bank assets)				-0.086	-1.740	0.749
				(0.773)	(1.210)	(0.846)
log(Tier 1 bank capital)				0.129	1.072	-0.533
				(0.846)	(0.915)	(0.761)
bank debt ratio				-4.529	-4.307	2.053
				(11.670)	(12.969)	(12.496)
Observations	670	670	670	670	670	670
R-squared	0.3956	0.3088	0.4372	0.3957	0.3149	0.4385
Fund FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered Std. Err.	Fund	Fund	Fund	Fund	Fund	Fund

*** p<0.01, ** p<0.05, * p<0.1

Table 5: The effects of central bank liquidity provision – Settlement of the first Bridge LTRO, PEPP announcement

Using the bank-fund relationship data and funds with two or more relationships only (Khwaja and Mian, 2008), this table presents results for the following specification:

$$\Delta bank\ lending_{f,b} = \beta\ relLowReserves_b + \mu_f + X_b + \varepsilon_{f,b}$$

where $\Delta\ bank\ lending_{f,b}$ denotes the change, between the week starting March 18 (first Bridge LTRO settlement, PEPP announcement week) and the previous week, of bank-fund outstanding repo amounts (daily average over a week): total (column 1 and column 4), short-term - 7 days or below - (column 2 and column 5), and longer-term – 8 days or above – (column 3 and column 5). The variable $relLowReserves_b$ is a dummy variable indicating below-the-median excess reserves for bank *b* (measured at the end of January 2020). The term μ_f takes out all variation across funds *f*. X_b are bank-level controls. Standard errors are clustered at the fund level.

	(1)	(2)	(3)	(4)	(5)	(6)
	total	short term	long term	total	short term	long term
excess reserves dummy (< median)	0.364	-0.388	**1.243*****	0.480	0.186	**1.064****
	(0.458)	(0.434)	(0.475)	(0.514)	(0.561)	(0.364)
log(total bank assets)				0.221	-0.306	-0.144
				(1.719)	(1.564)	(1.212)
log(Tier 1 bank capital)				0.099	-0.667	0.318
				(1.328)	(1.155)	(0.821)
bank debt ratio				-27.214	-3.916	4.281
				(19.740)	(21.907)	(10.705)
Observations	670	670	670	670	670	670
R-squared	0.3579	0.3794	0.3706	0.3628	0.3878	0.3718
Fund FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered Std. Err.	Fund	Fund	Fund	Fund	Fund	Fund

*** p<0.01, ** p<0.05, * p<0.1

Table 6: The effects of central bank liquidity provision – Settlement of the first Bridge LTRO, LTRO take-up

Using the bank-fund relationship data and funds with two or more relationships only (Khwaja and Mian, 2008), this table presents results for the following specification:

$$\Delta bank\ lending_{f,b} = \beta\, relLowReserves_b \times LTROdummy_b + \gamma\, relLowReserves_b + \delta\, LTROdummy_b + \mu_f + X_b + \varepsilon_{f,b}$$

where $\Delta\ bank\ lending_{f,b}$ denotes the change, between the week starting March 18 (first Bridge LTRO settlement, PEPP announcement week) and the previous week, of bank-fund outstanding repo amounts (daily average over a week): total (column 1 and column 4), short-term - 7 days or below - (column 2 and column 5), and longer-term – 8 days or above – (column 3 and column 5). The variable $relLowReserves_b$ is a dummy variable indicating below-the-median excess reserves for bank *b* (measured at the end of January 2020). The variable $LTROdummy_b$ is a dummy variable indicating that bank *b* borrowed liquidity in the first Bridge LTRO (settled on March 18, 2020). The term μ_f takes out all variation across funds *f*. X_b are bank-level controls. Standard errors are clustered at the fund level.

	(1)	(2)	(3)	(4)	(5)	(6)
	total	short term	long term	total	short term	long term
excess reserves dummy (< median) x LTRO take-up dummy	0.956	0.372	0.454	1.153	1.360	0.439
	(0.792)	(0.737)	(0.659)	(1.220)	(0.984)	(0.874)
excess reserves dummy (< median)	-0.261	-0.562	0.902	-0.142	-0.589	0.853
	(0.798)	(0.625)	(0.654)	(0.680)	(0.446)	(0.622)
LTRO take-up dummy	-0.759	-1.174	0.195	-0.719	**-1.514****	0.168
	(0.603)	(0.671)	(0.182)	(0.596)	(0.572)	(0.227)
log(total bank assets)				0.396	-0.238	0.015
				(1.644)	(1.570)	(1.005)
log(Tier 1 bank capital)				-0.364	-0.973	-0.019
				(1.167)	(1.351)	(0.648)
bank debt ratio				-20.401	4.224	6.812
				(24.938)	(27.976)	(12.133)
Observations	670	670	670	670	670	670
R-squared	0.3600	0.3870	0.3732	0.3648	0.3948	0.3736
Fund FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered Std. Err.	Fund	Fund	Fund	Fund	Fund	Fund

*** p<0.01, ** p<0.05, * p<0.1

Table 7: The longer-term effect of measures implemented as of March 18, 2020

Using the bank-fund relationship data and funds with two or more relationships only (Khwaja and Mian, 2008), this table presents results for the following specification:

$$\Delta bank\ lending_{f,b} = \beta\ relLowReserves_b + \mu_f + X_b + \varepsilon_{f,b}$$

where $\Delta\ bank\ lending_{f,b}$ denotes the change, between the six-week period starting on March 18 and the previous six-week period, of bank-fund outstanding repo amounts (daily average over the pre period and post period): total (column 1 and column 4), short-term - 7 days or below - (column 2 and column 5), and longer-term – 8 days or above – (column 3 and column 5). The variable $relLowReserves_b$ is a dummy variable indicating below-the-median excess reserves for bank *b* (measured at the end of January 2020). The term μ_f takes out all variation across funds *f*. X_b are bank-level controls. Standard errors are clustered at the fund level.

	(1)	(2)	(3)	(4)	(5)	(6)
	total	short term	long term	total	short term	long term
excess reserves dummy (< median)	1.081	-0.003	**2.144****	1.016	0.414	**2.199*****
	(0.895)	(0.256)	(0.778)	(0.763)	(0.275)	(0.711)
log(total bank assets)				-2.791*	-1.464	-2.060
				(1.346)	(0.908)	(1.511)
log(Tier 1 bank capital)				2.894*	0.820	1.857
				(1.452)	(0.719)	(1.350)
bank debt ratio				-59.634*	-33.321**	-36.967
				(30.566)	(11.946)	(27.629)
Observations	670	670	670	670	670	670
R-squared	0.3833	0.3459	0.4755	0.4000	0.3560	0.4822
Fund FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered Std. Err.	Fund	Fund	Fund	Fund	Fund	Fund

*** p<0.01, ** p<0.05, * p<0.1