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Do liquidity limits amplify money market fund redemptions during the COVID crisis?

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Abstract

Regulation of Money Market Funds (MMFs) in the EU requires some categories of MMFs to consider applying liquidity management tools if they breach a minimum 'weekly' liquidity requirement. Anticipation of the application of such tools is a plausible amplifier of run risks. Using a larger European dataset than previously studied, we assess whether proximity to liquidity thresholds explains differences in redemptions both at the start of the COVID-19 crisis and in the following months. We assess this effect for MMFs subject to and exempt from the liquidity regulation. The evidence shows that outflows can be robustly associated with proximity to minimum liquidity requirements in the peak of the crisis for funds required to consider suspending redemptions if breaches occur. In the post-crisis phase the redemption-liquidity relationship does not appear to be specifically related to mandated consideration of the suspension of redemptions. The evidence supports consideration of countercyclical liquidity requirements or buffers that are more usable in times of stress.

JEL classi ication: G01; G15; G23; G28; G18; G20; F30

Keywords: Money market funds; Liquidity limits

1 Non-Technical Summary

Runs on money market funds (MMFs) exacerbated the negative impact of the bankruptcy of Lehman Brothers in 2008 during the Global Financial Crisis (GFC). To avoid a repeat of this adverse scenario, policymakers in the US and the EU enacted a set of reforms designed to enhance MMF liquidity and enable the use of liquidity management tools in extreme circumstances. In spite of such regulatory efforts, the COVID-19 pandemic produced another historically large redemption event in the MMF sector coupled with an extraordinary liquidity contraction in commercial paper markets. While this event did not lead to breaching of liquidity thresholds or suspensions of redemptions it did require several public policy responses and subsequently has raised questions over the adequacy and effectiveness of previous MMF regulatory reforms. The core focus of this paper is an empirical assessment of one of the areas where the regulatory framework for MMFs may need to be reconsidered: the usability of liquid asset requirements.

In both the US and the EU, money market fund reforms imposed minimum liquidity requirements and encouraged the use of Liquidity Management Tools (also referred to as LMTs) that include gates, suspension and fees. The EU Money Market Fund Regulation (EU MMFR), requires money market funds to consider fees, gates or suspensions of redemptions, if two conditions apply: the proportion of weekly liquid assets (WLA) falls below a minimum requirement, and daily redemptions exceed 10% of fund net asset value. As argued by several authors (e.g., Li et al. (2020), Cipriani and La Spada (2020)), a possible unintended consequence of such reform is the creation of a potential self-fulfilling feedback loop between investor redemptions and the likelihood of liquidity breaches and suspensions. This could create runs even in reaction to random liquidity contractions (Schmidt et al. (2016)).

This paper assesses the effects of liquidity regulation in the European context in two periods. The first period (which, for convenience and to be consistent with existing literature, we refer to as the *run period*) includes the early part of the COVID-crisis in March 2020. While some categories of MMFs experienced unusually large outflows in this period it is important to highlight that they did not breach liquidity thresholds or suspend redemptions. The so-called 'run-period' has been the subject of analysis by other researchers but we generalise the approach to allow for dynamic liquidity and expand the sample used.

The second period (which, with some license, we call the *post-run* period) starts in April 2020 and focuses on the relatively less distressed phase of the crisis following the announcement and implementation of several public policy responses. In the post-run period there remained significant anxiety regarding redemptions despite the strong policy response and we assess whether the fear of breaches of liquidity thresholds still mattered for redemption dynamics in this period. Our post-run phase analysis explicitly addresses the interaction between redemptions and proximity to liquidity thresholds.

Our main evidence is that regulations that link breaches of liquidity thresholds with considerations around the imposition of fees, gates or suspensions can exacerbate outflows. This is clearly evident for the peak of the crisis. A weaker liquidity/redemption relation is also present in the post-run period and it cannot be attributed to liquidity regulation since it also arises in the case of exempted funds. The findings could be considered favourable to the implementation of countercyclical liquidity regulation with the objective of making liquidity buffer requirements for MMFs more usable in times of stress, to guard against potential first-mover advantage dynamics.

2 Introduction

The declaration of the COVID-19 pandemic by the World Health Organization in March 2020 was quickly followed by funding contractions in money (and commercial paper) markets and large redemptions from money market funds invested in private sector assets. These developments have raised doubts over the efficacy of regulation changes introduced after the Global Financial Crisis (GFC) intended to improve money market fund resilience in a crisis. In both the US and the EU, money market fund regulations were changed to impose liquidity requirements on funds and to encourage the use of Liquidity Management Tools (LMTs) including redemption gating, suspension and fees.[1] In the US, money market funds invested in private sector assets (also known as prime funds) had to float their net asset value to reflect the changing market valuations of their assets. These regulation changes altered the money-like features of shares in such funds which, as Cipriani and La Spada (2020) show, increased the premium investors required for holding shares of US prime funds and reduced the substitutability of investments in prime and non-prime money market funds.[2]

According to Money Market Fund Regulation (MMFR) in the EU, boards of management of money market funds must consider redemption fees, and the gating or suspension of redemptions, if the proportion of fund assets that comprise cash, assets that mature within a week, reverse repurchase agreements and liquid government securities (with a capped contribution) falls below a 'weekly' liquidity requirement at a time when daily redemptions exceed 10% of fund net asset value. As pointed out by Li et al. (2020) and others, this regulation sets-up a potential self-fulfilling feedback loop between investor withdrawals to avoid gating events and the conditions that lead to gating events. If investors have a sufficiently strong preference not to be present for a gating event, they

[1]The MMFs in the US and EU account for almost 80% of assets held by MMFs included in the Financial Stability Board's Global Monitoring Report of Non-Bank Financial Institutions in 2020)

[2]While Cipriani and La Spada (2020) focus on the move to a variable Net Asset Value (NAV) as the main contributor to reduced moneyness, the potential for gating is arguably just as relevant to investor perceptions of the liquidity of investments in prime fund shares. The SEC's 2014 reforms required most prime funds in the US to issue and redeem shares at a variable NAV based on mark-to-market valuation (funds servicing retail investors and tax-exempt retail investors were permitted to continue with issuance and redemption at constant NAV based on amortized cost accounting rules but with consideration of repricing when market-based NAV deviates by more than 0.05% from the stable NAV)

will fear redemption shocks that could cause a breach of liquidity requirements and a consideration of gating/suspension. These fears could generate redemptions in response to even random liquidity contractions as well as heightened sensitivity to the redemption actions of fellow investors (as described in the global games model of Schmidt et al. (2016)).

We assess the effects of liquidity regulation in the European context for two different periods: one that includes the significant outflows of March 2020 (which, for convenience and to be consistent with existing literature, we refer to as the *run-period*) and one that begins in April 2020 after several public policy responses were announced and implemented (which, with some license, we refer to hereafter as the *post-run period*). Our analysis is mostly, but not exclusively, based on data for Irish domiciled MMFs. The assets of Irish-domiciled Money Market Funds account for more than 40% of the assets held by the European Money Market Fund sector and roughly 10% of assets held by Money Market Funds globally. In addition to Irish-domiciled funds, we examine the funds covered by the Crane dataset that are based in Luxembourg and the UK (although the coverage of UK funds is very limited).[3] The sample covers the three macro-categories of MMFs, that is, Low-Volatility NAV (LVNAVs), Public-Debt Constant NAV (PDCNAVs) and Variable NAV (VNAVs), with funds being denominated in the three main currencies in the European MMF sector: USD, GBP and EUR. More institutional details on MMF macro-categories are provided in the next section.

The run-period analysis, broadly speaking, validates the findings by Cipriani and La Spada (2020). However, we expand and deepen that analysis in three main ways. Firstly, rather than assessing the effects of liquidity levels as of end-2019 on net-redemptions in March 2020, our specification assesses the ongoing impact of one-day lagged liquidity throughout the 'run' sample. This approach recognises the interaction between real-time liquidity developments and redemption flows. Second, to the best of our knowledge, ours is the

[3] https://cranedata.com/Crane Data Products collects and distributes money market and mutual fund news, information and daily fund characteristics such as Weekly Liquid Assets (WLA). Except for the case of French VNAV funds, the Crane dataset covers more than half of the European fund universe by number of funds and around 80% in terms of share of the total assets of the sector.

first empirical assessment, and comparison, of the effects of liquidity regulation both in the so-called run- and post-run phases. This is relevant from a policy perspective as our findings could be regarded as supporting a countercyclical approach to liquidity regulation. Third, we examine a wider sample of European funds (beyond those reporting in USD) and our analysis also benefits from the fact that we have access to fund-by-fund supervisory returns. Supervisors were monitoring fund characteristics during the COVID-19 episode ensuring that data was correctly reported. Where the two sources of data overlap we were able to check the accuracy of the data and, where necessary, omit unreliable cases. To the extent that the two data sets do not overlap, we achieve an increased coverage of the underlying population of funds.

Our analysis of the post-run period differs from that of the run period because it is not straightforward to create a run dummy in this case. Instead, in a fixed-effects panel-regression setting, we assess whether redemption dynamics become less stable near liquidity requirements by examining the difference in the autocorrelation of investment flows at these liquidity levels. This is meaningful if redemption gating becomes more likely as liquidity levels approach liquidity requirements. This would be true if net-redemption shocks are random and distributed with constant variance. If the likelihood of redemption gating itself affects the expected size, direction and variance of net-redemption shocks (due to investors' fears of suspensions), then the feedback effect on probability of suspensions would likely be magnified. In this case proximity to liquidity requirements would amplify redemptions and also lead to a positive autocorrelation of redemptions. If the tendency for large redemptions to be followed by more large redemptions increases at lower liquidity levels, then there is a risk that funds will start to experience destabilising net-outflows. We therefore assess whether incipient instability of investment flows is associated with a combination of larger outflows and significantly more positive autocorrelation of flows near liquidity requirements.

Our findings are suggestive of an effect stemming from proximity to regulatory thresholds during the peak of the turmoil. In the post-crisis period, despite the mitigating public sector policies and the increased prudence on the part of fund managers, we find evidence of increasingly positive redemption autocorrelation as liquidity requirements are approached for USD-focused LVNAV and VNAV fund categories. However, the magnitude of the effect is small and the elevation in autocorrelation at low liquidity levels is just as significant for the case of VNAV MMFs (these are not strictly subject to the regulation requiring considerations of suspension of redemptions). Liquidity regulations can therefore be implicated in exacerbating outflows during the run-period but this effect is not just related to the regulation in the post-run period and it is insignificant in economic terms. This findings could be considered favourable to the implementation of countercyclical liquidity regulation with the objective of making liquidity buffer requirements for MMFs more usable in times of stress, to guard against potential first-mover advantage dynamics.

3 Money Market Fund Regulation

The European Union Money Market Fund Regulations introduced in 2017 require funds to be designated as one of three general categories (LVNAVs, PDCNAVs and VNAVs), which generally differ along three features: (i) liquidity requirement enforced through LMTs, (ii) minimum compulsory investment in highly liquid assets, and (iii) redemption at par. The first one is the key characteristic in this paper as it assesses whether the proximity to liquidity requirement exacerbates redemptions when the requirements are linked to possible limitation of redemption rights. Regulation (EU) 2017/1131, obliges LVNAVs and PDCNAVs to consider limiting redemptions when a liquidity requirement is breached in the presence of large previous redemptions, while VNAVs are not exposed to this aspect of the regulation. In terms of the second feature, Public-Debt Constant NAV MMFs must invest at least 99.5% into highly liquid assets (i.e., government securities, cash or reverse repo secured with government securities), while LVNAVs and VNAVs do not have to comply with this requirement (they can generally invest in money market instruments, securitisations and ABCP, deposits, derivatives, repo, reverse repo, other MMFs). As to the third feature, shareholders of LVNAVs and PDCNAVs are generally allowed to redeem their shares at par value, rather than market value (under the condition that market valuations do not excessively deviate from par values).

As to the first feature, in detail, the European Union Money Market Fund Regulations forces boards of LVNAV and PDCNAV MMFs to consider redemption gating and suspension (or the imposition of fees) as a means to protect less active investors from the costs associated with selling into illiquid markets in order to fund the redemptions of impatient investors. Paragraph 48 of the regulation motivates this provision as a means to mitigate potential investor redemptions in times of severe market stress. Paragraphs 1(a) and 1(b) of Article 34 of the regulation outline the conditions that trigger consideration of redemption controls such as fees, gating and suspension.

Paragraph 34:1(a) describes a situation where the weekly maturing assets proportion falls below 30% of total assets of the fund and, at the same time, daily redemptions exceed 10% of total assets. The situation covered by paragraph 34:1(b) is one in which the weekly maturing assets proportion falls below 10% of total assets. Under the circumstances outlined in paragraph 1(a) boards are required to consider redemption controls (including fees, gating to allow no more than 10% redemptions each day, and suspension of redemptions for up to 15 days) but they can elect to take no specific action if that is deemed to be in investors' best interests. However, in the case of the circumstance described in paragraph 1(b), the fund board is required to implement one or more of the redemption controls for a period of up to 15 days. Paragraph 2 also clarifies how funds needing to suspend redemptions for more than 15 days in any 90-day period must cease to be public-debt/low-volatility funds (i.e., thereafter becoming 'variable' net asset value funds).

The situations triggering consideration of redemption limits described above are, in themselves, events that can be anticipated by sophisticated investors. This stems from the fact that the MMF regulation also contains a transparency provision (Article 36) requiring funds to provide detailed information about the maturity structure of the fund's portfolio of assets on a weekly basis to all its investors. In this context, it is likely that, for funds with a large proportion of sophisticated investors requiring a high degree of liquidity services, there would be pre-emptive redemptions in the proximity of the 30% liquidity requirement. Such investors are also likely to fear large redemptions since breaching of the 30% requirement must occur with a high level of redemptions (10%) before consideration of redemption controls is required.

Sophisticated investors may also fear a situation where there is a large decline in the proportion of weekly maturing assets without large redemptions (i.e., a decline in weekly maturing proportion to below 10%). This could be anticipated through information received about the maturity and credit quality of the portfolio combined with fear of a credit default event. Our analysis of the post-COVID period is mainly predicated on investors pre-emptively avoiding a breach of the 30% requirement combined with redemptions being greater than 10% (in our sample there were very few cases of funds' weekly maturing assets breaching the 30% requirement and all such breaches were small and short-lived so we do not consider breaches of the 10% requirement as a particular focus for investors in this period).

4 Literature

Much of the literature exploring episodes of runs on money market funds emerged after the 2008 Global Financial Crisis (for example, McCabe (2010) and Kacperczyk and Schnabl (2013)). From a game theoretic perspective, Schmidt et al. (2016) study investor sophistication and fund flows during the 2008 run. They find that sophisticated/institutional investors are very sensitive to the flows of fellow sophisticated investors. This relates to the first mover advantage issue. Other crisis periods studied in the extant literature include the Sovereign Debt Crisis in Europe (see, Li et al. (2020), Chernenko and Sunderam (2014) and Gallagher et al. (2020)) and the recent period of market turbulence following the declaration of the COVID-19 pandemic by the WHO last March (Li et al. (2020) and Cipriani and La Spada (2020)). The recent literature has addressed whether the regulation changes have exacerbated run risks. Hanson et al. (2015), for example, argue that regulating the consideration of redemption gating could be destabilising. They recommend requiring MMFs to hold capital buffers instead.[4]

To assess the effects of recent regulation changes, Li et al. (2020) compare the investment flows of prime US MMFs during the COVID-19 period with those during the 2008 and 2011 crises. They show that the COVID-19 run was very similar to 2008 in size, but they find that outflows were larger from funds with lower Weekly Liquid Assets (WLA) at the height of the COVID-19 crisis. A one standard deviation decrease in WLA is associated with a 0.9 percentage point increase in the daily flows between March 9th and 20th. They conclude that the MMF regulation linking WLA-requirement to redemption limitations (through LMTs) exacerbated the run risks to an economically significant extent.

Their findings suggest that the link between liquidity requirements and the probability of applying LMTs also contributed to the shorter term of reinvestment reducing CP market liquidity. They find that the MMLF was effective in stemming the flows disproportionately of the lower WLA funds and that the MMLF worked through a liquidity channel (there would be a buyer), an expectations channel (investors knew asset sales could be done) and by placing a floor on CP pricing (the Fed set a price at which it would buy CP). They also found that MMLF-eligible CP markets (and CP with predominantly prime-MMFs as holders) recovered more quickly than other CP markets.

Cipriani and La Spada (2020) also examine run behaviour of MMFs during the height of the COVID-19 pandemic according to investor type (institutional versus retail). They find that lower WLA implies more outflows from institutional prime funds during the COVID period. Retail investors follow the run behaviour of institutional investors where they are in the same fund family. Fund families with both Prime and Public-Debt funds had larger outflows than families without a Public-Debt fund.

An important overlap with our analysis is that part of the analysis by Cipriani and La Spada (2020) which makes use of offshore USD funds (mainly those domiciled in Ireland and Luxembourg). They use the offshore VNAV funds because they are not

[4] Similar reservations were expressed in a speech by the SEC Commissioner Kara Stein in 2014

subject to consideration of redemption controls when liquidity requirements are breached. They find that these funds do not have as large an outflow as onshore funds during the most stressed periods of the COVID-19 market turbulence. However, their analysis is mainly based on explaining the differences in flows across fund types on a small number of crisis days within March. Overall they find larger outflows among the onshore funds than the offshore (VNAV) funds and also that the offshore LVNAVs experience more outflows than the offshore VNAVs funds. They regard the differences as economically meaningful. Darpeix (2021) describes the redemption patterns of French VNAVs during the COVID-19 crisis, highlighting that outflows were not significantly correlated with fund liquidity. This finding is consistent with our hypothesis that the regulatory permission of redemption restrictions amplify outflows and our evidence that outflows are expected to be correlated with LVNAV and PDCNAV liquidity and uncorrelated with VNAV liquidity, since the EU-MMFR link redemption restrictions to liquidity breaches only for LVNAV and PDCNAV funds.

An additional evidence in our paper is that the amplification effect of the regulatory permission of LMTs is statistically robust in the run period, while it is less strong in the post-run period. This could support the introduction of countercyclical elements within the minimum liquidity regulation. This is in line with the stylized model in Baes et al. (2021) calibrated with EU data, which shows that adding a countercyclical liquidity buffer of 10% releasable during crises would enhance MMF resilience especially in times of stress, and the effect is larger than increasing liquidity requirements. Baes et al. (2021) also finds that the resilience of MMFs would substantially improve in response to an increase in funds' assets liquidity requirements or a widening of the collar, i.e., the maximum allowed deviation of market NAV from nominal NAV beyond which an LVNAV cannot allow for redemption at par any more.

5 Data

As described recently by Golden (2020), at the end of February 2020, the assets of Irish domiciled money market funds accounted for about 45% of the holdings of European MMFs. Irish money market funds are predominantly Low-Volatility funds (the LVNAV share was about 82% prior to the COVID-19 pandemic with 'Public-Debt' funds accounting for 12% and the remainder VNAVs). Irish funds can be further divided into groups depending on the currency in which they report and invest (our analysis focuses on funds reporting in USD, EUR and GBP). At the end of February 2020 the assets of Irish money market funds were distributed as follows by reporting currency: 47% USD, 37% GBP and 15% EUR. In terms of number of funds, there are 32 that report in USD, 22 that report in EUR and 24 that report in GBP.[5] Our daily supervision data sample runs from the start-of-April to mid-November 2020 and contains 126 daily observations of funds' redemptions and their liquidity characteristics (weekly and daily liquid assets).

Our pre-April 2020 data combines a number of sources. Supervision data reported to the Central Bank includes daily redemptions from all Irish-domiciled MMFs. Supervision data (including information on weekly liquid assets) is not collected with daily frequency in the pre-April period. However, supervision data contains monthly data on holdings such that weekly liquid assets can be estimated at a monthly frequency. We therefore combine the monthly WLA data with daily data from the Crane dataset (the Crane data source covers approximately half of all the Irish-domiciled funds). Where possible in the pre-April period we used the daily WLA from the Crane dataset. Where Crane data is unavailable pre-April, we make use of the end-of-month WLA from the monthly supervision data but only if this is deemed reliable. To assess whether the monthly supervision data is likely to provide an accurate estimate of WLA over the gaps in our daily coverage, we compare it with daily data where daily observations are available (i.e., for the post-March period).

We found that, for all but 8 cases out of a population of 79 funds, the monthly estimates

[5] Some Irish funds are not included due to incomplete coverage of the sample period in terms of liquidity data - hence only 77 of the 82 have been included in the regression analysis

of WLA was very close to the WLA in the daily data (observed at the end of the months starting in April 2020). The correspondence between the daily and monthly data diverged significantly for 7 of the funds and for these cases we used the WLA estimated for the end of 2019 to cover all of the pre-April periods (it is worth noting that Cipriani and La Spada (2020) used the end-December 2019 WLA in their study). For one fund we found a very low correlation between the monthly and daily WLA data sources over the post-March period and we decided to drop this fund from the analysis. After all such data management procedures we had 78 funds in the Irish-based run-period sample. Another 11 funds based in Luxembourg (that are present in the Crane data) were added to the sample to allow a broader scope in one of our empirical specifications (4 VNAVs and 7 LVNAVs).

6 Run-period analysis

6.1 Descriptive statistics - Run-period

Figures 1 to 3 highlight the extent of net-redemptions during the COVID-19 crisis by illustrating the time-series of assets under management for each category from July 2019 to July 2020. We notice that USD-LVNAVs and USD-VNAVs experienced run-like outflows in March 2020, losing 26% and 20% of their AUM, respectively. In contrast, the reaction to the COVID-crisis of LVNAVs and VNAVs denominated in EUR and GBP was less significant than that of the corresponding USD-focused fund categories. PDCNAVs denominated in USD, GBP and EUR generally experienced an increase in their total assets, with the inflow of USD-PDCNAVs being larger than other currency groups. Thus, the run period in March did not actually identify a negative shock to PDCNAVs' flows, albeit there is a remarkable variability within each category that could be linked to the large heterogeneity in terms of liquidity. In fact, low-WLA observations are associated with more negative inflows compared to others (as shown by Table 1 and Tables 3 to 5).

The run-period analysis involves the use of data from January to October 2020 covering not only funds from Ireland but also Luxembourg and UK funds if these are present in the Crane dataset (there are only two UK funds in the Crane dataset in this timeframe). Summary statistics in Table 1 provide a general description of investment flows and WLA for each fund category: LVNAV, PDCNAV and VNAV.[6] In Panel A, each fund category is divided into two WLA classes: (i) low WLA observations are in the proximity of the minimum WLA requirements, with a WLA at most 5% larger than the respective requirement (i.e., 30% for LVNAVs and PDCNAVs and 15% for VNAVs); (ii) higher WLA observations where WLA is more than 5% larger than WLA limits. The definition of the low WLA class is instrumental not only to the descriptive statistics but also to the regression analyses, which compare the run of liquid funds with that of funds in minimum meaningful distance from minimum WLA requirements. Table 1 shows a particularly low number of observations for VNAVs and PDCNAVs. This precludes the use of 5% as the minimum meaningful distance for the definition of low WLA for the regression analyses of the run-period analyses.[7] Thus, it is important to analyse larger distances from WLA requirements. In Panel B and C, MMF macro-categories are grouped into two WLA classes similar to Panel A but based on a distance from WLA requirements of 10% and 15%, rather than 5%. The main evidence from the three panels in Table 1 is that flows are positive when liquidity is distant from requirements, while they are overall negative when liquidity is in the proximity of WLA limits. Flows are significantly positive in the three panels for LVNAVs, PDCNAVs and VNAVs when their WLA is not in the proximity of regulatory limits. In panels B and C, average flows are significantly negative for LVNAVs and VNAVs when their WLA is close to regulatory thresholds. Table 1 also presents the average WLA for each macro-category, which gives an indication of proximity to liquidity requirements. Panel B suggests that, when funds are at most 15% far from the respective limit, the average distance from the limit was between 8% and 13%. Panel C indicates that, when funds are at most 10% far from the limit, all three macro-categories frequently

[6] Table 1 present a description of MMFs at macro-category level, rather than at category-level for sake of consistency with the run-period analyses, which require an aggregation of data macro-category level due to the low number of observations in specific instances

[7] Some Irish funds are not included due to incomplete coverage of the sample period in terms of liquidity data - hence only 77 of the 82 have been included in the regression analysis

came close to breaching liquidity requirements in that they were, on average, between 5% and 8% from the limit.

6.2 Regression models – Run period

To examine the COVID-crisis period, we employ a panel regression approach examining whether MMF's close to the minimum regulatory WLA on day $t-1$ (identified through the dummy variable) experienced larger redemptions on day t during the run events in March (identified through the dummy variable). The specification is:

$$flow_{it} = \delta + \delta_i + \delta_t + \beta_1(Run_{t-1}LowWLA_{it-1}) + \delta_1(LowWLA_{it-1}) + \varepsilon_{it} \tag{1}$$

The dependent variable is net investment flows, while the main independent variable is the interaction between two variables: $LowWLA$ and Run. $LowWLA$ is a dummy variable taking the value of one when WLA is at most 10% larger than the relevant WLA limits, which are 30% for LVNAVs and PDCNAVs and 15% for VNAVs. We also present regression results with an alternative maximal distance of 15% from the category–specific thresholds.[8] Run is a dummy variable identifying the run experienced by MMFs in March; it takes the value of 1 between March 6 and March 26, in line with Cipriani and La Spada (2020). Model (1) also addresses a reverse causality problem. We aim to gauge the impact going from liquidity to flows. However, data also contain an impact going from flows to liquidity, given that liquidity is mechanically positively driven by contemporaneous or lagged flows in that funds typically meet redemptions by disbursing cash, which is part of the liquid assets. The impact from liquidity to flows would be biased by the contemporaneous reverse causality relationship, unless lagged liquidity variables and covariates are included in the empirical approach, as in Model (1).

A negative coefficient for the interaction $(Run_{t-1}LowWLA_{it-1})$ indicates that the crisis-

[8] We cannot examine Model (1) using a definition of low-WLA with 5% distance from requirements because of the low number of observations among VNAVs and PDCNAVs.

induced run is more intense for MMFs close to the WLA limit than other MMFs in the same category. We test the hypothesis of a negative coefficient for LVNAVs and PDCNAVs and insignificant coefficients for VNAVs, which would corroborate the conjecture that the probability of redemption gates amplifies the redemption shocks of LVNAVs and PDCNAVs' during crises. However, we also acknowledge that the hypothesised effect is more ambiguous for PDCNAVs given that the *Run* dummy does not identify an actual run, on average, but rather an increase in their total assets (Figures 3, 6 and 9).

Standard errors are heteroskedasticity robust and clustered at the fund and date level to control for both autocorrelation and cross-correlation. Moreover, fund- and day-fixed-effects ensure that specifications control for fund characteristics or any average impact macroeconomic time-varying factors on funds (e.g., VIX, monetary policy and macroeconomic expectations). Model (1) is similar in many ways to Cipriani and La Spada (2020), except for the fact that they test whether the cross-sectional variability in WLA as of end-2019 influenced redemptions in March 2020, while our specification assesses the effects of cross-sectional and time-series variability of WLA from January to October 2020. This approach sheds light on the effects of the rich time-series heterogeneity of WLA experienced by MMF's during the COVID-19 crisis.

6.3 Discussion of results – Run period

Table 2 shows the estimated parameters of Model (1) for the three macro-categories and using two alternative distances from WLA limits (i.e., 10% and 15%). In line with the hypothesis on the regulatory-driven amplification, the parameters are negative for LVNAVs (Columns a and d) and insignificant for VNAVs (Columns c, and f), which indicates the possibility that the risk of suspensions exacerbates LVNAVs redemptions during market-wide distresses. The insignificant coefficient for PDCVNAVs (Column e) is likely linked to the fact that the run period in March did not actually identify a negative shock for this macro-category. Column b does not contain the parameter associated to the interaction variable of interest because PDCNAVs did not experience cases of WLA below 40% during the crisis.

In order to discuss the economic significance of these results we compare the coefficients of interest from Table 2 with relevant benchmarks (based on key descriptive statistics from Table 1). On the one hand, there appears to be substantial economic significance given that the flow reactions in Columns a and d (-1 and -1.3, depending on the definition of low liquidity) are equivalent to the average redemptions during the run period (-1.1 and -0.8 respectively, in the penultimate column of Table 1). On the other hand, these flow reactions appear small in magnitude when compare to the flow variability during the run-period: flow reactions are a third of the standard deviation of flows during the run-period (3.4 and 3.4, in the last column of Table 1). Low liquidity is therefore not the only important cause of redemptions in the run period as confirmed also by Rousová et al. (2021) ESRB (2020) who have pointed to margin calls and liquidity needs of investment funds as important contributing factors.

7 Post-run period analysis

7.1 Descriptive statistics - Post-run-period

The post-run period empirical analysis is based on an examination of investment flows when WLA is in the proximity of the minimum requirement. Descriptive statistics in Tables 3 to 5 show the average investment flows for each fund category conditional on the corresponding liquidity level of each fund being in the low-WLA class or not. Tables 3 to 5 use a definition of low-WLA class based on a maximal distance from WLA requirements of 5%, 10% and 15%, respectively, where the category-specific WLA requirements are 30% for LVNAVs and PDCNAVs and 15% for VNAVs.

The key evidence is that flows are overall positive when liquidity levels are not in the low-WLA class and negative for a number of fund categories for observations in low-WLA class. Overall, mean flows in the low-WLA class are statistically negative for USD-LVNAVs and EUR-LVNAVs when the low-WLA class is defined with a maximal distance of 5% and 10% (Tables 3 and 4). The descriptive tables also show the average WLA for each category, which indicates how close the liquidity observations in the low-WLA class are to the regulatory limit. For instance, in Table 1 the distance from limits ranges from the 2.1% of the USD-LVNAVs to the 4.2% of the USD-VNAVs.

7.2 Regression models – Post-run period

To assess whether investment flows become more unstable in the proximity of minimum liquidity requirements in the post-run period, we examine whether the autocorrelation of flows is larger for the low-WLA class, compared to other WLA levels. Thus, an "auto-correlation analysis" is applied to money market funds from April to October 2020. The intuition behind this analysis is that, when the likelihood of redemption gates increases as WLA levels approach their limits, MMF outflows could display a *destabilising dynamic* in which a redemption is more likely to be followed by another redemption, rather than an inflow. To study this phenomenon we focus on the autocorrelation of flows given that a positive autocorrelation indicates that flows tend to diverge from their long-run mean – thereby being more unstable, while a negative autocorrelation indicates that flows tend to converge to their long-run mean. To facilitate the interpretation of the "autocorrelation analysis" in Model (4), we gradually build-up the model by starting from a baseline specification, Model (2), which focuses on describing the relationship between flows and lagged WLA. Model (2) is then upgraded into Model (3), which adds a measurement of the average autocorrelation. Model (3) is then expanded into Model (4), which is the main specification as it measures whether the autocorrelation increases when a fund enters in the low-WLA class. Model (2) regresses daily investment flows of fund i in period t on a constant and a dummy variable indicating when liquidity is in the low-WLA class. This is:

$$flow_{it} = \delta + \delta_2(LowWLA_{it-1}) + \varepsilon_{it} \tag{2}$$

where $flow$ represents the daily investment flows as a percent of NAV of fund i at time t; δ and δ_2 are coefficients to be estimated; $LowWLA$ is a dummy variable equal to 1 if the lagged weekly maturing assets percent is within the low-WLA class and zero otherwise;

ε_{it} is a residual term. Standard errors are heteroskedasticity robust and clustered at the fund and date level to control for both autocorrelation and cross-correlation. If low liquidity is particularly associated with redemption activity then we would expect the coefficient on the low liquidity indicator to be negative (and that the sum of this coefficient and the constant to be overall negative). Model (2) is also important because the presence of negative flows is a condition that makes autocorrelation particularly concerning from a financial stability perspective because it implies that redemptions tend to lead to additional redemptions, thereby developing a destabilizing dynamic. The second specification for the post-run period (i.e., Model 3) adds a lagged dependent variable to the first specification as follows;

$$flow_{it} = \delta + \delta_2(LowWLA_{it-1}) + \delta_3(flow_{it-1}) + \varepsilon_{it} \tag{3}$$

The parameter δ_3 in Model (3) can be interpreted as the average autocorrelation within each category. We expect it to be overall negative, which would mean that redemptions are followed by inflows and vice versa. Model (4) extends the above model by including (on the right-hand side) an interaction term (i.e., lagged flows multiplied by the lagged dummy low-WLA). The model is as follows;

$$flow_{it} = \delta + \delta_i + \delta_t + \beta_1(flow_{it-1}LowWLA_{it-1}) + \delta_2(LowWLA_{it-1}) + \delta_3(flow_{it-1}) + \varepsilon_{it} \tag{4}$$

This specification allows autocorrelation of flows to be different in the presence of low-WLA. Such a more general specification also includes fund- and day-fixed-effects to control for fund characteristics or any average impact macroeconomic time-varying factors on funds. We analyse this specification under two perspectives. First, we test whether the parameter β_1 is positive because it would imply that redemption dynamics become more autocorrelated at low liquidity levels. Second, we also test whether the sum of the estimates of β_1 and δ_3 is significantly positive because it can reveal whether the larger autocorrelation even leads to a *positive* autocorrelation of redemptions at low-WLA levels.

The model can be expanded to include controls (we leave for future work the inclusion of the controls used by Kacperczyk and Schnabl (2013) and McCabe (2010)). A particular extension that we consider is the inclusion of daily maturing proportion of total assets (in addition to the weekly maturing proportion). Although the daily and weekly liquidity measures are strongly correlated, it is the weekly proportion that is referenced in the Money Market Fund Regulation pertaining to the consideration of redemption controls. We would therefore expect the weekly proportion to be more relevant for the instability of redemption dynamics and this is tested by the inclusion of both.

7.3 Discussion of Results – Post-run period

Previous descriptive statistics (Tables 3 to 5) indicate that low-WLA funds experienced redemptions on average in almost all fund categories. However, t-tests confirm statistically significant negative flows only for USD-LVNAVs and EUR-LVNAVs when the low-WLA class is defined as within 5 or 10 percentage points of the applicable liquidity threshold. On the other hand, almost all fund groups have positive flows when liquidity is not in the proximity of the regulatory requirement, with several categories exhibiting a significantly positive inflow.

Overall, it is interesting that there is a tendency for low liquidity to be associated with outflows for some of the largest fund groups, despite the fact that the post-run period has less extreme events than those in March. This can be taken as tentative evidence that liquidity levels may have retained their relevance in contributing to flight tendencies of investors. However, the descriptive statistics can only provide a rough indication of developments. The weekly liquidity and outflows could be contemporaneously correlated if some assets from the weekly maturing proportion are sold before their maturity to facilitate redemptions that exceed immediate liquidity.

To achieve a more reliable indication of the possible causal effects of proximity to minimum liquidity requirements, we move from descriptive analyses to the empirical examination of the relationship between redemptions and lagged liquidity. Specifically, we now consider the results from the Models (2) to (4). The results are shown in Table 6 where each panel relates to the three currency groups. For each currency group we present results for the three different fund types and the three models wherever applicable. We will first discuss the results for coefficients that reflect differences in flows at low liquidity levels (lagged). We then consider the evidence for instability of such flows based on the low-liquidity autocorrelation coefficient in Model (4).

Considering first the case of USD-LVNAV funds (top panel of Table 6), the regression result for Model (2) reveals the presence of significant negative relative flows when lagged weekly liquidity is in the proximity of the regulatory requirement (parameter δ_2). However, a test of the significance of the sum of coefficients (δ_2) and (δ) indicates that the flows are insignificantly negative for the low liquidity group. When lagged flows are included (USD-LVNAV Model (3)), the absolute size of the estimated coefficient (δ_2) increases and it becomes more significant. In Columns (d) and (e) of Table 6, Models (2) and (3) provide negative but insignificant results for the estimated coefficient on the low-WLA dummy in the case of USD-VNAVs. However, the sum of coefficients (δ_2) and (δ) are significantly negative in both models. Results of Models (2) and (3) for USD-PDCNAVs (Columns (g) and (h) of Table 6) reveal insignificantly positive flows when lagged weekly liquidity is in the proximity of the requirement. Overall, the results for Models (2) and (3) for USD-reporting funds are consistent with the message derived from the descriptive statistics and the PDCNAV case is consistent with flight to the safety of PDCNAVs generally in this period.

The middle panel of Table 6 displays the EUR-LVNAV and EUR-VNAV regression results (since there is only one EUR-PDCNAV fund, a panel estimation is not possible for this category). For the EUR-LVNAV group, Model (2) results imply positive, but statistically insignificant, flows in the low-WLA class (coefficient δ_2). The sum of the estimated constant and the coefficient on the low-WLA dummy (coefficients δ_2 and δ) is not significantly different from zero. Model (3) gives similar results. The EUR-VNAV results indicate less negative expected flows when weekly liquidity is close to the requirement. So overall, based on the level-effects (coefficients δ_2 and δ), there is very little evidence that lower liquidity is associated with more outflows from EUR-reporting funds. The results of Models (2) and (3) for GBP-LVNAV funds are similar to those for the EUR-LVNAV funds (no strong evidence that there is greater outflow at low weekly liquidity levels). While estimated flow at low liquidity levels in the GBP-VNAV case, Model (2), has a significantly negative coefficients, the low number of observations in the proximity of 15% (only 12 cases) hinders any strong conclusion from this estimation.

So far, considering Models (2) and (3), only USD-LVNAV and USD-VNAV fund categories provide evidence for the hypothesised amplification effect of low WLA on redemptions (i.e., negative flows). The weak evidence elsewhere probably reflects more cautious levels of liquidity in the post-run-period. To obtain additional evidence that liquidity affects redemption dynamics we turn to the autocorrelation analysis of Model (4). This is mainly of interest for the case where we already found evidence of outflows at low liquidity levels. Model (4) can help to uncover increased positive autocorrelation (AR) of redemptions at these low liquidity levels.

It is noteworthy that the autocorrelation of flows is generally negative or insignificant in the post-run sample. Focusing on the Model (4) results for the USD groups, we see that the low-liquidity AR coefficient (β_1) is significantly positive for the two categories exposed to redemption gates (LVNAV and PDCNAV). Thus, since flows tend to be negative for LVNAVs when liquidity is low, the larger autocorrelation indicated by coefficient β_1 implies that shocks to redemptions as liquidity approaches the regulatory minimum, may lead to instability through additional redemptions. This might be suggestive of an amplification effect due to the increased likelihood of gating and therefore caused by the MMF regulation. However, this tentative conclusion is conflicting with two facts: (i) VNAVs – which are not exposed to redemption gates – also have a significantly positive (δ_3) (although, admittedly, this is only marginally significant); (ii) for VNAVs alone, the sum of coefficients β_1 and δ_3 is positive and significant, which describe an overall positive autocorrelation at low liquidity which is not exhibited by LVNAVs.

Model (4) results for EUR-LVNAVs indicate significantly positive autocorrelation when liquidity is in the low-WLA state (the sum of β_1 and δ_3 is significantly positive). However, the lack of negative flows at low-WLA, suggests that this category is not subject to destabilising dynamics when liquidity is in the proximity of the minimum WLA requirement. Results for EUR-VNAVs and GBP-LVNAVs are generally insignificant. Estimates indicate a significantly negative autocorrelation for GBP-VNAVs. However, the low number of observations in this case reduces the relevance of this evidence.

Table 7 explores Model (4) using different definitions of low-WLA, with a maximal distance of 10 and 15 percentage points from the WLA regulatory limit. It is interesting to notice that only the USD-LVNAV results exhibit a larger autocorrelation at low-WLA levels, which would again suggest an amplification effect due to the MMF regulation. However, Wald-tests of the sum of the AR and low-liquidity-AR coefficients show that the autocorrelation for any category using these alternative distances from requirements is never significantly positive.

Thus, Table 6 and 7 generally show that several results hypothesised for USD-LVNAVs are also present among USD-VNAVs, which suggests that outside the run-period the fear of suspension itself (due to breaching weekly liquidity requirements) is not responsible for flow instability. The VNAV funds are not subject to the requirement to consider the imposition of fess or gating when liquidity requirements are breached. Clearly, investors in both LVNAV and VNAV funds face potential negative effects when liquidity is low. The LVNAV funds may have to suspend redemptions making the holdings of their investors suddenly illiquid. Likewise, investors in VNAV funds will be increasingly likely to make losses if they wait to redeem in a crisis because loss-inducing fire-sales may eventually be required. It is difficult to separate these two effects. The only indication that consideration of use of liquidity management tools may augment redemptions comes from the larger average outflows for the USD-LVNAV group relative to the USD-VNAV group. There is little evidence of any differences in the amplification of the instability of redemption dynamics near minimum liquidity requirements. The USD-LVNAV and USD-VNAV fund groups have similar autocorrelation at the lower liquidity level.

8 Robustness checks

In order to show that the main results (in Table 2) are not crucially determined by the two-way standard error clusterisation, the estimation behind Table 8 follows the same approach as in Table 2, except for the fact that it clusterises standard errors at fund level only. In line with the hypothesis and with the Table 2, the coefficients are significantly negative for LVNAVs (Columns a and d) and insignificant for PDCNAVs and VNAVs (Columns c, e, f), which indicates that the possibility of redemption suspensions exacerbates LVNAVs redemptions during crises. Also in this table, Column b cannot present the estimate of interest because was never equal to 1 for PDCNAVs during the crisis. We also explore whether the main estimates depend on the sample choice in terms of time-series. The estimation behind Table 9 truncates the time-series into a window from January to March, in order to ensure that the crisis dummy identifies the only real run experienced by MMF in the time-series under analysis. Corroborating the hypothesis, estimates are significantly negative for LVNAVs (Columns a and d) and insignificant for PDCNAVs and VNAVs (Columns c, e, f), which indicates that the possibility of redemption suspensions exacerbates LVNAVs redemptions during market-wide distresses.

9 Conclusions

The current MMF regulatory framework in both the US and the EU was designed in response to the Global Financial Crisis with the objective of enhancing MMFs' resilience in extreme episodes. In spite of such regulation, the COVID-19 pandemic produced another large redemption event in the MMF sector. This note contributes to the literature on the assessment of the EU MMF Regulation (EU MMFR) focusing on a key area that is currently at the centre of regulatory discussions: the requirement of minimum liquidity enforced through liquidity management tools (LMT).

LVNAV and PDCNAV MMFs are required to consider liquidity management tools if two conditions apply: the proportion of weekly liquid assets (WLA) falls below a minimum requirement, and excessive daily redemptions. On the other hand, for VNAV funds the minimum liquidity requirement is not linked to LMT. A possible unintended consequence of such a linkage between LMTs and breaches is the creation of a potential self-fulfilling feedback loop between investor redemptions and the likelihood of liquidity breaches and suspensions. This could create runs even in reaction to random liquidity contractions (Schmidt et al. (2016), Li et al. (2020), Cipriani and La Spada (2020)).

This paper evaluates the effects of liquidity regulation in two periods. The run period includes the peak of the COVID-crisis, which has been the subject of analysis by other researchers but we generalise the approach to allow for dynamic liquidity and expand the sample used. The second period starts in April 2020, a relatively less distressed phase, but still characterised by fear of liquidity breaches.

The key evidence in this paper is that the presence of WLA requirements linked to LMTs can amplify redemptions. This finding is statistically robust in the run period, while it is less strong in the post-run period as the amplification effect of liquidity regulation affects also VNAV funds, which are exempted from LMTs. Overall, the evidence could support the introduction of countercyclical elements within the minimum liquidity regulation with the objective of making liquidity buffer requirements for MMFs more usable in times of stress, to prevent the development of first-mover advantage dynamics. The latter finding is in line with the model by Baes et al. (2021) calibrated with EU data showing that adding a countercyclical liquidity buffer of 10% that is releasable during crises would enhance MMF resilience especially in times of stress, and the effect is larger than increasing liquidity requirements.

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Tables & Figures

Table 1: **Descriptive statistics regarding the run analyses**.

Category	WLA Class	N	Flows Mean	Flows SD	WLA Mean	Flows during run Mean	Flows during run SD
Panel A. Max Distance = 5%							
LVNAV	0-35%	982	-0.118	2.537	31.3%	-1.101	3.512
	36-100%	7,276	0.101***	2.330	49.0%	-0.468	3.362
PDCNAV	0-35%	135	0.03	1.864	32.9%		
	36-100%	2,476	0.122**	2.794	57.4%	0.969	3.957
VNAV	0-20%	1	-1.026		19.0%	-1.026	.
	21-100%	2,045	0.117**	2.602	44.5%	0.251	3.778
Panel B. Max Distance = 10%							
LVNAV	0-40%	2,172	-0.091*	2.414	35.1%	-1.086	3.443
	41-100%	6,086	0.133***	2.334	51.6%	-0.160	3.309
PDCNAV	0-40%	372	-0.087	2.014	36.5%		
	41-100%	2,239	0.151***	2.857	59.4%	0.969	3.957
VNAV	0-25%	11	-0.735	1.916	23.0%	-1.441	2.675
	26-100%	2,035	0.121**	2.605	44.6%	0.306	3.794
Panel C. Max Distance = 15%							
LVNAV	0-45%	3,690	-0.029	2.404	38.3%	-0.766	3.408
	46-100%	4,568	0.157***	2.315	54.5%	-0.177	3.362
PDCNAV	0-45%	727	-0.02	2.335	39.6%	0.780	2.970
	46-100%	1,884	0.171***	2.898	62.5%	0.996	4.088
VNAV	0-30%	104	-0.28	2.745	28.1%	-0.605	2.999
	31-100%	1,942	0.138***	2.593	45.4%	0.309	3.822

Data from January 2 to October 15, 2020, covering funds from Ireland, Luxemburg and UK. In Panel A, the two WLA classes identify: (i) observations where WLA is at most 5% larger than the respective WLA limit; (ii) observations where WLA is more than 5% larger than WLA limits. In Panel B and C, the two WLA classes are defined using a 10% and 15% distance, rather than 5%. 'Mean of Flows' is the average flows as % of NAV in the specific liquidity class. The mean flow is statistically compared to zero with a t-test. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

Table 2: **Run period regressions**.

	1 LVNAV	2 PDCNAV	3 VNAV	4 LVNAV	5 PDCNAV	6 VNAV
Run*LowWLA10	-1.043**		-0.949			
	[0.012]		[0.544]			
LowWLA10	0.106	-0.020	0.271			
	[0.279]	[0.927]	[0.770]			
Run*LowWLA15				-1.272**	-0.183	-0.512
				[0.018]	[0.889]	[0.759]
LowWLA15				0.215**	0.247	0.511
				[0.017]	[0.196]	[0.580]
Const	0.384**	0.398	-0.701	0.194	0.330	-0.699
	[0.038]	[0.328]	[0.192]	[0.286]	[0.390]	[0.195]
N	8212	2597	2036	8212	2597	2036
R-sq	0.07	0.10	0.09	0.07	0.10	0.09

Data from January 2 to October 15, 2020, covering funds from Ireland, Luxemburg and UK. LowWLA10 is a dummy variable taking the value of one when WLA is at most 10% larger than the relevant WLA limits. LowWLA15 is a dummy variable taking the value of one when WLA is at most 15% larger than the relevant WLA limits. Run is a dummy variable taking the value of one between March 6 and March 26. Fund- and day-fixed-effects are included. p-values for parameter estimates are provided in square brackets. All p-values are based on standard errors that are robust to heteroscedasticity and clustered at fund and date level. N is the total number of observations in each regression. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

Table 3: **Descriptive statistics regarding the post-run period. Low WLA defined with 5% maximum distance from WLA requirement.**

Category	WLA Class	N	Flows Mean	Flows SD	WLA Mean
USDLVNAV	0-35%	211	-0.409***	2.609	32.197%
	36-100%	2,437	0.157***	2.461	49.941%
USDPDCNAV	0-35%	209	-0.047	2.321	33.325%
	36-100%	1,501	0.015	2.112	49.265%
USDVNAV	0-20%	45	-0.371	1.695	19.249%
	21-100%	915	0.072	2.059	46.503%
EURLVNAV	0-35%	30	-2.215***	4.112	32.081%
	36-100%	1,616	0.184***	2.184	51.731%
EURPDCNAV	0-35%				
	36-100%				
EURVNAV	0-20%	54	0.203	1.726	18.669%
	21-100%	1,599	0.006	1.857	44.536%
GBPLVNAV	0-35%	131	-0.176	2.242	34.056%
	36-100%	2,282	0.107***	1.861	50.384%
GBPPDCNAV	0-35%				
	36-100%				
GBPVNAV	0-20%	12	-0.701	2.187	18.216%
	21-100%	747	0.048	1.655	43.703%

Data from January 2 to October 15, 2020, covering funds from Ireland, Luxemburg and UK. 'Mean of Flows' is the average flows as % of NAV in the specific liquidity class. The mean flow is statistically compared to zero with a t-test. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

Table 4: **Descriptive statistics regarding the post-run period. Low WLA defined with 10% maximum distance from WLA requirement.**

Category	WLA Class	N	Flows Mean	Flows SD	WLA Mean
USDLVNAV	0-40%	504	-0.379***	2.472	35.818%
	41-100%	2,144	0.227***	2.466	51.519%
USDPDCNAV	0-40%	531	-0.054	2.157	36.244%
	41-100%	1,179	0.035	2.130	52.301%
USDVNAV	0-25%	173	-0.017	1.353	21.988%
	26-100%	787	0.066	2.168	50.329%
EURLVNAV	0-40%	132	-0.642***	3.093	36.821%
	41-100%	1,514	0.208***	2.154	52.641%
EURPDCNAV	0-40%	5	-3.372*	4.337	38.516%
	41-100%	122	0.563*	3.239	53.476%
EURVNAV	0-25%	176	0.074	1.307	21.542%
	26-100%	1,477	0.005	1.908	46.328%
GBPLVNAV	0-40%	376	0.049	2.078	36.686%
	41-100%	2,037	0.099***	1.846	51.883%
GBPPDCNAV	0-40%	29	0.025	0.148	39.421%
	41-100%	480	0.143	2.339	67.424%
GBPVNAV	0-25%	18	-0.937	2.409	20.132%
	26-100%	741	0.060	1.639	43.862%

Data from January 2 to October 15, 2020, covering funds from Ireland, Luxemburg and UK. 'Mean of Flows' is the average flows as % of NAV in the specific liquidity class. The mean flow is statistically compared to zero with a t-test. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

Table 5: **Descriptive statistics regarding the post-run period. Low WLA defined with 15% maximum distance from WLA requirement.**

Category	WLA Class	N	Flows Mean	Flows SD	WLA Mean
USDLVNAV	0-45%	959	-0.085	2.464	39.093%
	46-100%	1,689	0.224***	2.479	53.884%
USDPDCNAV	0-45%	850	-0.032	2.153	38.681%
	46-100%	860	0.046	2.124	55.845%
USDVNAV	0-30%	317	-0.086	1.567	24.611%
	31-100%	643	0.119	2.241	55.375%
EURLVNAV	0-45%	416	-0.176	2.516	41.227%
	46-100%	1,230	0.247***	2.150	54.801%
EURPDCNAV	0-45%	15	0.241	4.865	41.262%
	46-100%	112	0.431	3.130	54.444%
EURVNAV	0-30%	352	-0.046	1.308	24.663%
	31-100%	1,301	0.028	1.975	48.832%
GBPLVNAV	0-45%	856	-0.039	1.799	40.198%
	46-100%	1,557	0.164***	1.926	54.631%
GBPPDCNAV	0-45%	103	-0.076	0.507	41.742%
	46-100%	406	0.191	2.529	71.941%
GBPVNAV	0-30%	111	-0.202	1.422	27.191%
	31-100%	648	0.078	1.702	46.059%

Data from January 2 to October 15, 2020, covering funds from Ireland, Luxemburg and UK. 'Mean of Flows' is the average flows as % of NAV in the specific liquidity class. The mean flow is statistically compared to zero with a t-test. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

Table 6: **Post-run period regression. Stability of investment flows**.

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
		USD-LVNAV			USD-VNAV			USD-CNAV	
L.LowWLA	-0.332**	-0.382**	-0.237	-0.095	-0.113	0.509	0.072	0.069	0.051
	[0.015]	[0.010]	[0.482]	[0.232]	[0.330]	[0.326]	[0.542]	[0.563]	[0.765]
L.Flow		-0.065**	-0.087**		-0.044	-0.065		-0.053	-0.099**
		[0.046]	[0.020]		[0.402]	[0.423]		[0.128]	[0.039]
L.(Flow*LowWLA)			0.263**			0.377*			0.246***
			[0.029]			[0.098]			[0.002]
Const	0.128**	0.135**	0.809***	0.049	0.052	1.065*	-0.011	-0.011	-0.083
	[0.012]	[0.012]	[0.002]	[0.504]	[0.535]	[0.069]	[0.862]	[0.875]	[0.742]
N	2629	2626	2626	953	952	952	1697	1696	1696
r2	0.001	0.005	0.074	0.000	0.002	0.150	0.000	0.003	0.103
$(\delta_2+\delta)$	-0.204			-0.046			0.061		
$(\beta_1+\delta_3)$			0.176	-0.046		0.312*	0.061		0.147**
Fund FE	NO	NO	YES	NO	NO	YES	NO	NO	YES
Day FE	NO	NO	YES	NO	NO	YES	NO	NO	YES
		EUR-LVNAV			EUR-VNAV			EUR-CNAV	
L.LowWLA	0.167	0.097	0.895*	0.102	0.107	0.455			
	[0.286]	[0.607]	[0.075]	[0.630]	[0.636]	[0.236]			
L.Flow		-0.031	-0.061		-0.033	-0.039			
		[0.223]	[0.133]		[0.136]	[0.226]			
L.(Flow*LowWLA)			0.275**			0.006			
			[0.026]			[0.904]			
Const	0.132**	0.138**	2.104***	0.006	0.008	-0.259			
	[0.049]	[0.040]	[0.000]	[0.857]	[0.825]	[0.103]			
N	1634	1633	1633	1641	1639	1639			
r2	0.000	0.001	0.124	0.000	0.001	0.076			
$(\delta_2+\delta)$	-0.299			-0.108					
$(\beta_1+\delta_3)$			0.214*			0.033			
Fund FE	NO	NO	YES	NO	NO	YES			
Day FE	NO	NO	YES	NO	NO	YES			
		GBP-LVNAV			GBP-VNAV			GBP-CNAV	
L.LowWLA	0.006	0.018	0.023	-1.603***	-1.658***	-1.931**			
	[0.955]	[0.880]	[0.907]	[0.000]	[0.000]	[0.048]			
L.Flow		0.016	-0.018		-0.073*	-0.081			
		[0.590]	[0.604]		[0.053]	[0.223]			
L.(Flow*LowWLA)			0.041			-0.195			
			[0.660]			[0.246]			
Const	0.071	0.070	1.201***	0.065	0.068	0.638*			
	[0.147]	[0.150]	[0.000]	[0.408]	[0.413]	[0.067]			
N	2328	2326	2326	753	753	753			
r2	0.000	0.001	0.124	0.000	0.001	0.076			
$(\delta_2+\delta)$	0.077			-1.538***					
$(\beta_1+\delta_3)$			0.023			-0.276*			
Fund FE	NO	NO	YES	NO	NO	YES			
Day FE	NO	NO	YES	NO	NO	YES			

Data from April 1 to October 15, 2020, covering funds from Ireland, Luxemburg and UK. LowWLA is a dummy variable taking the value of one when WLA is at most 5% larger than the relevant WLA limits. $\delta_2+\delta$ and $\beta_1+\delta_3$ are tested (through a Wald test) using the null hypothesis that they are equal to 0. p-values for parameter estimates are provided in square brackets. All p-values are based on standard errors that are robust to heteroscedasticity and clustered at fund and date level. N is the total number of observations in each regression. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

Table 7: **Post-run period regression. Other Low-WLA definitions**.

	(a)	(b)	(c)	(d)	(e)	(f)
	LowWLA with Max. distance = 10%			LowWLA with Max. distance = 15%		
	USD LVNAV	USD VNAV	USD CNAV	USD LVNAV	USD VNAV	USD CNAV
L.(Flow*LowWLA)	0.175**	0.092	0.104	0.105*	0.121	0.085
	[0.042]	[0.676]	[0.278]	[0.072]	[0.331]	[0.359]
L.LowWLA	0.368**	-0.146	-0.078	0.129	-0.207	0.225
	[0.042]	[0.686]	[0.504]	[0.388]	[0.465]	[0.166]
L.Flow	-0.101**	-0.061	-0.097**	-0.108**	-0.078	-0.104**
	[0.017]	[0.496]	[0.016]	[0.020]	[0.389]	[0.010]
_cons	0.717***	1.135*	-0.124	0.825***	1.396*	-0.087
	[0.001]	[0.082]	[0.607]	[0.000]	[0.079]	[0.730]
N	2626	952	1696	2626	952	1696
R2	0.075	0.146	0.099	0.073	0.147	0.099
(β_1+δ_3)	0.074	0.031	0.007	-0.003	0.043	-0.019
	(a)	(b)	(c)	(d)	(e)	(f)
	LowWLA with Max. distance = 10%			LowWLA with Max. distance = 15%		
	EUR LVNAV	EUR VNAV		EUR LVNAV	EUR VNAV	
L.(Flow*LowWLA)	0.153	0.001		0.008	0.009	
	[0.122]	[0.981]		[0.889]	[0.867]	
L.LowWLA	0.575*	0.057		0.401*	-0.114	
	[0.064]	[0.711]		[0.058]	[0.539]	
L.Flow	-0.066*	-0.037		-0.046	-0.038	
	[0.092]	[0.254]		[0.212]	[0.251]	
_cons	2.265***	-0.242		2.375***	-0.230	
	[0.000]	[0.118]		[0.000]	[0.127]	
N	1633	1639		1633	1639	
R2	0.125	0.075		0.123	0.075	
(β_1+δ_3)	0.087	-0.036		-0.038	-0.029	
	(a)	(b)	(c)	(d)	(e)	(f)
	LowWLA with Max. distance = 10%			LowWLA with Max. distance = 15%		
	GBP LVNAV	GBP VNAV	GBP CNAV	GBP LVNAV	GBP VNAV	GBP CNAV
L.(Flow*LowWLA)	0.057	-0.661*	4.006	0.068	-0.360	0.274
	[0.483]	[0.070]	[0.241]	[0.325]	[0.108]	[0.590]
L.LowWLA	0.092	-1.277*	-0.693	0.057	-0.324	-0.406
	[0.575]	[0.079]	[0.352]	[0.650]	[0.289]	[0.140]
L.Flow	-0.024	-0.051	0.016	-0.035	-0.042	0.010
	[0.370]	[0.362]	[0.807]	[0.325]	[0.482]	[0.876]
_cons	1.209***	0.659*	0.446	1.247***	0.694*	0.625
	[0.000]	[0.059]	[0.364]	[0.000]	[0.053]	[0.191]
N	2392	753	505	2392	753	505
R2	0.120	0.212	0.272	0.120	0.205	0.269
(β_1+δ_3)	0.033	-0.712	4.022	0.033	-0.402	0.284

Data from April 1 to October 15, 2020, covering funds from Ireland, Luxemburg and UK. LowWLA is a dummy variable taking the value of one when WLA is at most 5% larger than the relevant WLA limits. β_1+δ_3 are tested (through a Wald test) using the null hypothesis that they are equal to 0. p-values for parameter estimates are provided in square brackets. All p-values are based on standard errors that are robust to heteroscedasticity and clustered at fund and date level. N is the total number of observations in each regression. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

Table 8: **Run period regression, robustness check. One-way error clusterisation**.

	1 LVNAV	2 PDCNAV	3 VNAV	4 LVNAV	5 PDCNAV	6 VNAV
Run*LowWLA10	-0.938*** [0.007]		-1.305 [0.215]			
LowWLA10	0.101 [0.128]	0.008 [0.959]	-0.110 [0.866]			
Run*LowWLA15				-1.191*** [0.003]	-0.177 [0.856]	-1.814 [0.105]
LowWLA15				0.209*** [0.007]	0.287 [0.104]	0.407 [0.510]
Const	0.300 [0.612]	0.587 [0.703]	-0.559 [0.687]	0.111 [0.851]	0.505 [0.742]	-0.559 [0.687]
N	8212	2597	2036	8212	2597	2036
R-sq	0.07	0.10	0.10	0.07	0.10	0.10

Data from January 2 to October 15, 2020, covering funds from Ireland, Luxemburg and UK. LowWLA10 is a dummy variable taking the value of one when WLA is at most 10% larger than the relevant WLA limits. LowWLA15 is a dummy variable taking the value of one when WLA is at most 15% larger than the relevant WLA limits. Run is a dummy variable taking the value of one between March 6 and March 26. Fund- and day-fixed-effects are included. p-values for parameter estimates are provided in square brackets. All p-values are based on standard errors that are robust to heteroscedasticity and clustered at fund level. N is the total number of observations in each regression. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

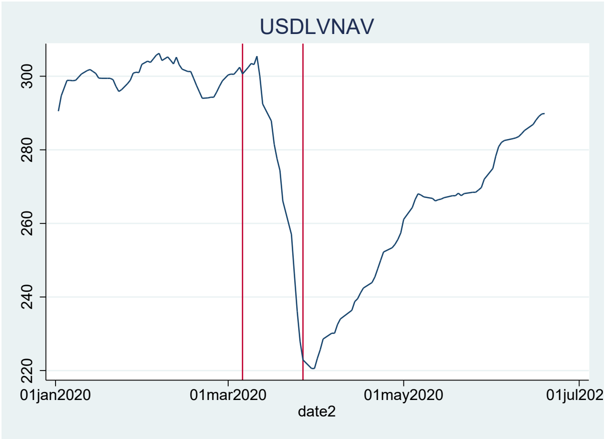
Table 9: **Run period regression, robustness check. Jan-Mar sample**.

	1 LVNAV	2 PDCNAV	3 VNAV	4 LVNAV	5 PDCNAV	6 VNAV
Run*LowWLA10	-0.788** [0.038]		-0.982 [0.484]			
LowWLA10	0.274 [0.149]	-0.052 [0.950]	-0.001 [0.999]			
Run*LowWLA15				-0.999* [0.078]	0.010 [0.991]	-2.178 [0.234]
LowWLA15				0.434* [0.088]	0.442 [0.610]	1.133 [0.451]
Const	0.844*** [0.000]	1.147*** [0.009]	-0.216 [0.702]	0.664*** [0.000]	0.949*** [0.007]	-0.213 [0.705]
N	2013	713	530	2013	713	530
R-sq	0.12	0.13	0.10	0.12	0.13	0.11

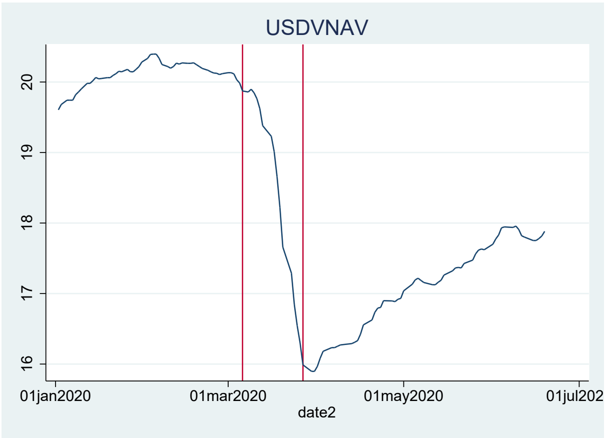
Data from January 2 to March 30, 2020, covering funds from Ireland, Luxemburg and UK. LowWLA10 is a dummy variable taking the value of one when WLA is at most 10% larger than the relevant WLA limits. LowWLA15 is a dummy variable taking the value of one when WLA is at most 15% larger than the relevant WLA limits. Run is a dummy variable taking the value of one between March 6 and March 26. Fund- and day-fixed-effects are included. p-values for parameter estimates are provided in square brackets. All p-values are based on standard errors that are robust to heteroscedasticity and clustered at fund and date level. N is the total number of observations in each regression. ***, **, and * indicate significance at the 1%, 5%, and 10% two-tailed levels, respectively.

Figure 1: **USD-focused Funds**.

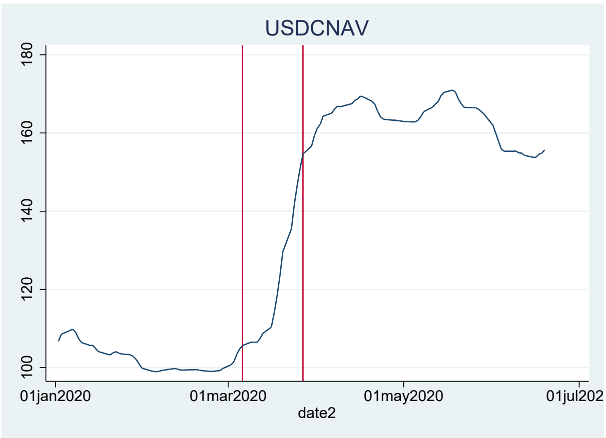
(a) Assets under management (€Bn) of USD-LVNAVs.



(b) Assets under management (€Bn) of USD-VNAVs.



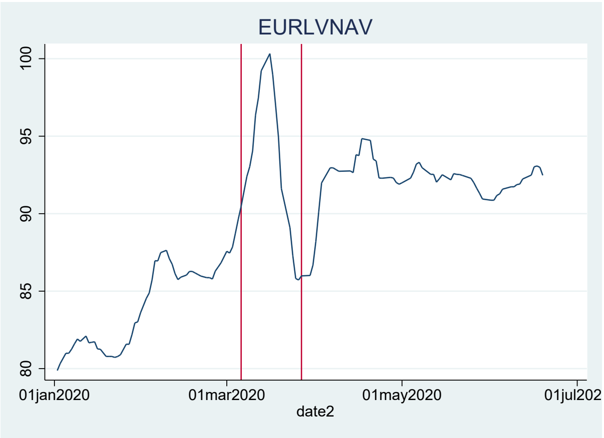
(c) Assets under management (€Bn) of USD-PDCNAVs.



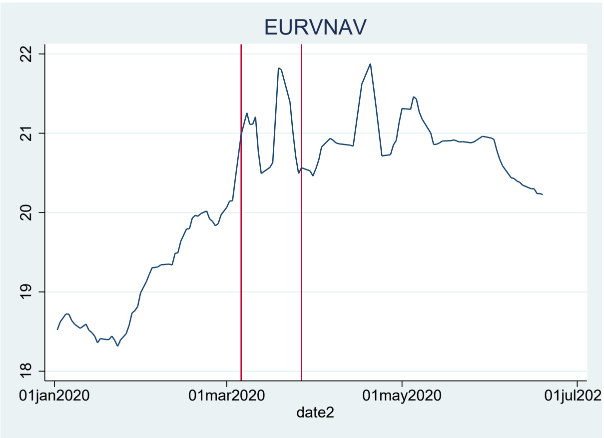
Data from July 1, 2019, to July 1, 2020, covering funds from Ireland, Luxemburg and UK. The y-axis describes the asset under management of each entire category (in billions of Euro). The two vertical lines demark the run period linked to the COVID-19, between March 6 and March 26, 2020.

Figure 2: **EUR-focused Funds**.

(a) Assets under management (€Bn) of EUR-LVNAVs.



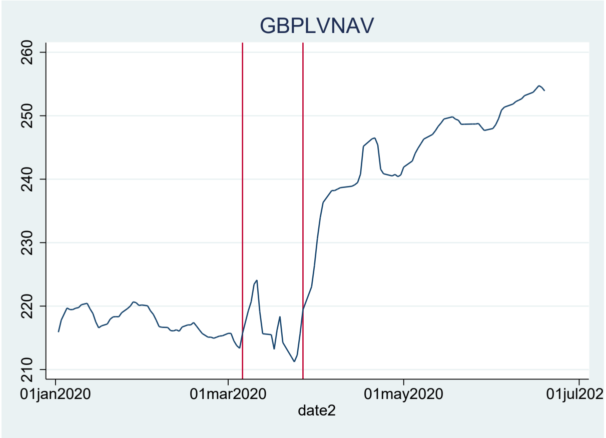
(b) Assets under management (€Bn) of EUR-VNAVs.



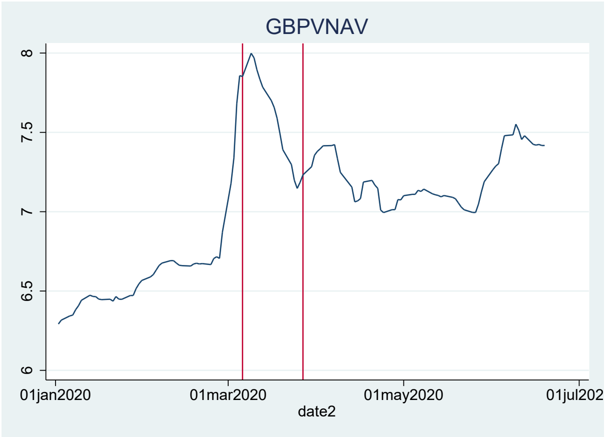
Data from July 1, 2019, to July 1, 2020, covering funds from Ireland, Luxemburg and UK. The y-axis describes the asset under management of each entire category (in billions of Euro). The two vertical lines demark the run period linked to the COVID-19, between March 6 and March 26, 2020.

Figure 3: **GBP-focused Funds**.

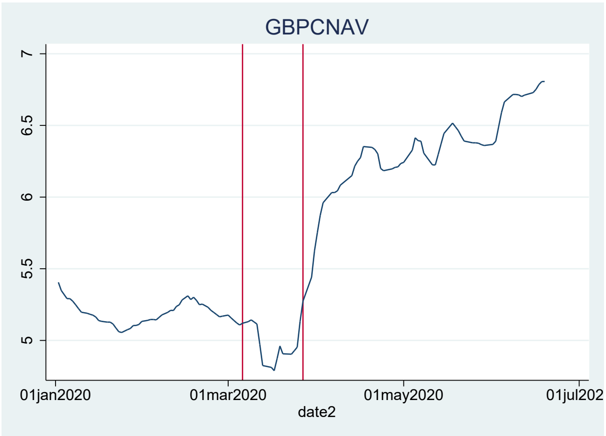
(a) Assets under management (€Bn) of GBP-LVNAVs.



(b) Assets under management (€Bn) of GBP-VNAVs.



(c) Assets under management (€Bn) of GBP-PDCNAVs.



Data from July 1, 2019, to July 1, 2020, covering funds from Ireland, Luxemburg and UK. The y-axis describes the asset under management of each entire category (in billions of Euro). The two vertical lines demark the run period linked to the COVID-19, between March 6 and March 26, 2020.

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