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Mitigating fragility in open-ended investment funds: the role of redemption restrictions

by
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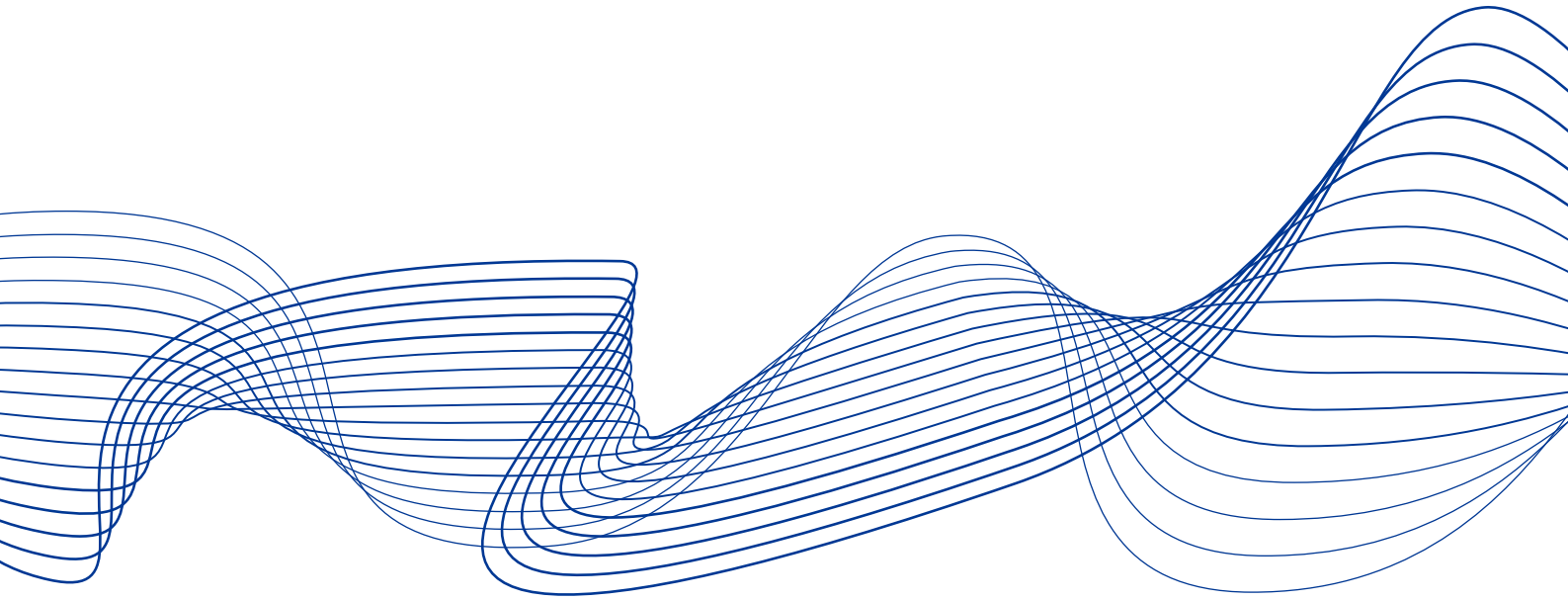


ESRB
European Systemic Risk Board
European System of Financial Supervision

Abstract

Using supervisory data of alternative investment funds investing in bonds, I exploit the COVID-19 crisis to examine the effectiveness of redemption restrictions. First, I find that redemption restrictions reduced outflows during the March 2020 market turmoil but did not result in higher outflows in the periods following the crisis episode. Second, I find that funds with higher redemption restrictions engaged less in procyclical cash hoarding during the COVID-19 crisis period, even after controlling for the size of their outflows. Third, I find that redemption restrictions do not have a significant impact on the sensitivity of investor inflows to good performance, but they significantly reduce the sensitivity of outflows to bad performance. These findings suggest that redemption restrictions can mitigate fragility in open-ended investment funds.

Keywords: bond funds, redemption restrictions, notice period, financial fragility

JEL Codes: G11, G15, G23

Non-Technical Summary

Research Question

This paper investigates whether redemption restrictions, such as notice periods or reduced redemption frequency, can mitigate fragility in open-ended bond funds. Specifically, I examine whether these restrictions reduce investor outflows and mitigate fund managers' procyclical liquidity management during periods of market stress, focusing on the COVID-19-induced market turmoil in March 2020.

Contribution

Open-ended bond funds typically offer daily liquidity while investing in less liquid assets or assets that can become illiquid in stress periods. This can create fragility and the potential for large-scale redemptions. During the COVID-19 crisis, open-ended bond funds' outflows reached unprecedented levels, surpassing those observed during the height of the Global Financial Crisis of 2007/08. In response, policymakers have proposed measures to address these vulnerabilities, including anti-dilution tools (for instance through swing pricing) and stricter redemption restrictions. While there is, by now, an extensive literature on the effectiveness of anti-dilution tools in bond funds, little is known about bond funds' use of redemption restrictions and their efficacy during crises. This paper fills this gap by analysing supervisory data from 2,174 bond funds under the Alternative Investment Fund Managers Directive (AIFMD), managing around EUR 1.2 trillion in total assets. It provides new evidence on how redemption restrictions impact investor behaviour and fund managers' liquidity management, during both stressed and normal periods.

Results

I find that redemption restrictions, in particular the notice period, significantly reduced investor outflows during the March 2020 stress period. Based on a multivariate regression

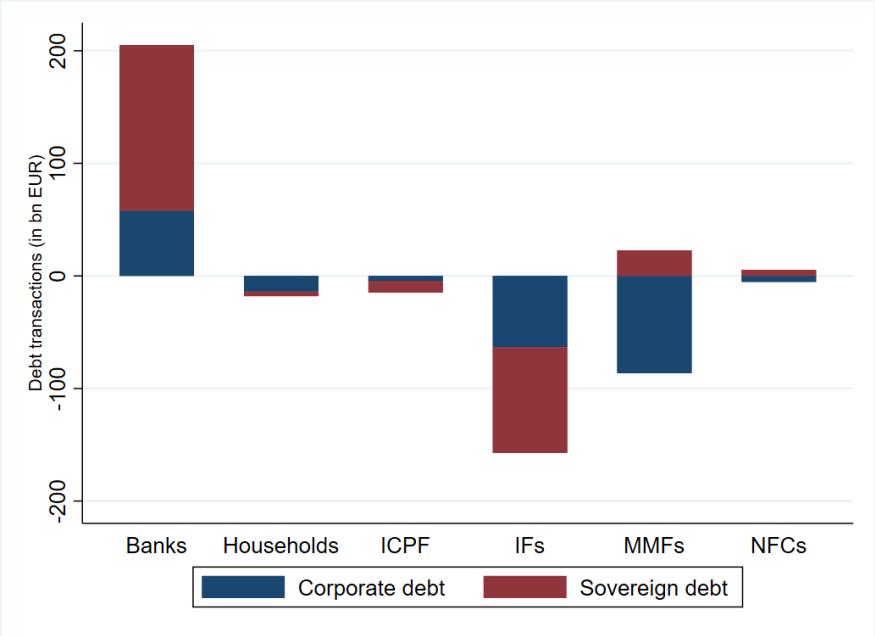
model, an additional week of notice period reduced outflows during the first quarter of 2020 by approximately 1.3 percentage points, nearly eliminating the average additional outflows observed during the crisis. Importantly, this reduction was not associated with higher outflows after the crisis, suggesting that redemption restrictions disincentivised withdrawals rather than merely postponing them. Second, I find that funds with redemption restrictions were less likely to hoard cash to meet redemption requests than funds without redemption restrictions. Instead, they drew more on their liquidity buffers, reducing the need for procyclical asset sales. Third, over the entire sample period, I find that redemption restrictions reduce the sensitivity of outflows to poor performance without significantly affecting inflows during periods of good performance, suggesting that the restrictions address the fragility arising from investor withdrawals. These findings highlight the potential of redemption restrictions to enhance the resilience of open-ended bond funds. By mitigating investor outflows and fund managers' procyclical liquidity management, redemption restrictions can play a crucial role in reducing fund fragility and supporting financial stability during episodes of market stress.

1 Introduction

Open-ended investment funds often promise their investors the possibility to redeem on a daily basis while investing in less liquid assets or assets that can become illiquid in stress periods. This has the potential to create run dynamics across investors encouraging them to withdraw before others (Chen et al., 2010; Goldstein et al., 2017). Following the onset of the COVID-19 crisis, open-ended bond funds faced unprecedented outflows which exceeded the amount observed during the peak of the Global Financial Crisis of 2007/08 (Falato et al., 2021; Lewrick and Schanz, 2023). To meet these redemption requests, funds often responded by selling bonds. In the euro area, for instance, investment funds were the largest net sellers of debt securities during the first quarter of 2020 (see Figure 1). This procyclical response further amplified valuation losses and fragility in underlying bond markets (Jiang et al. (2022)), highlighting the systemic risks that can emanate from the bond fund sector.

Figure 1: Transactions of debt securities during the March 2020 market turmoil

This figure shows the aggregate transactions in debt securities by euro area investors, broken down by the different investor types during the first quarter of 2020. Investor types include banks, households, insurance companies and pension funds (ICPF), investment funds (IFs), money market funds (MMFs) and non-financial corporations (NFCs). Source: Securities Holdings Statistics (SHS).



Policymakers and academics around the world have investigated ways to address the risk of large-scale redemptions and associated procyclical asset sales. For instance, the Financial Stability Board (2023) recommended that funds investing in assets that are susceptible to illiquidity in times of stress, such as certain corporate bonds, should either (i) implement anti-dilution tools, for instance through swing pricing, or (ii) introduce higher redemption restrictions, through higher notice periods or reducing the redemption frequency.[1] While there is a growing and, by now, relatively large literature on the effectiveness of anti-dilution tools in bond funds,[2] little is known regarding the extent to which bond funds utilise redemption

[1]Similarly, the European Systemic Risk Board (2023) highlighted that an enhanced framework for investment funds could require funds to have minimum notice periods.

[2]See Jin et al. (2022); Capponi et al. (2020); Malik and Lindner (2017); Capponi et al. (2023); Lewrick and Schanz (2023).

restrictions and their efficacy during a period of market stress.

I fill this gap in the literature by studying the impact of redemption restrictions on investor outflows and asset managers' liquidity management strategies, focusing on the March 2020 market turmoil. My empirical tests are based on the population of open-ended bonds funds reporting under the Alternative Investment Fund Managers Directive (AIFMD), covering a panel of 2,174 funds with approximately EUR 1.2 trillion in assets under management. This dataset provides granular information on the type and duration of redemption restrictions at the individual fund level, including notice period, lockup period and redemption frequency. Unlike hedge funds, where redemption restrictions are common and often last several months, most bond funds do not employ such restrictions, and when they do, the duration is often limited to a few days and thus shorter than many crisis episodes.[3] In this context, the market turmoil following the onset of the COVID-19 crisis offers a unique laboratory to evaluate the effectiveness of redemption restrictions in open-end bond funds during a stress period.

I first examine whether redemption restrictions mitigated investor runs during the March 2020 market turmoil. While the effects of lower redemption frequencies and lockup period are statistically insignificant, I find that the notice period significantly reduced outflows in the stress period. Based on a multivariate regression model, an additional week of notice period reduced outflows in the first quarter of 2020, on average, by around 1.3 percentage points (in terms of lagged total assets). This means that a one-week notice period would have nearly eliminated the average additional outflows during this stress episode, suggesting a large mitigating impact. This effect is robust to including a wide set of control variables, including the liquidity of the funds' assets and the investor composition, as well as matching funds with redemption restrictions to funds without redemption restrictions based on pre-crisis

[3]For the literature on redemption restrictions in hedge funds see, for instance, Hombert and Thesmar (2014); Liang et al. (2019); Aiken et al. (2015); Agarwal et al. (2009).

covariates. Importantly, I do not find evidence that redemption restrictions resulted in higher outflows in the periods following the crisis episode. This suggests that redemption restrictions disincentivised withdrawals rather than merely postponing them, thereby resulting in lower overall outflows for funds with higher redemption restrictions.

Second, I assess whether redemption restrictions mitigated procyclical behaviour through fund managers' liquidity management strategies to meet redemption requests during the March 2020 market turmoil. I find that funds with redemption restrictions engaged less in cash hoarding than funds without redemption restrictions. Instead, they used more of their cash holdings to accommodate outflows during the March 2020 market turmoil, suggesting less procyclical asset sales and lower fire-sale externalities. This effect is mainly driven by the notice period and is economically meaningful. I find that one additional week of notice period is associated with an average additional decrease in cash holdings of around 2 percentage points (in terms of the funds' lagged total assets). In other words, a fund with a one-week notice period would have used around 22% more of its cash buffers to accommodate the outflows during the crisis, relative to a fund without redemption restrictions. Crucially, I control for the magnitude of outflows in this period to exclude the possibility that funds with redemption restrictions simply acted less procyclically because they experienced lower outflows. This finding suggests that redemption restrictions did not only affect funds' liquidity management strategies through lowering outflows, but also had a direct effect on fund managers providing them with more time and thereby mitigating the pressure to engage in procyclical cash hoarding behaviour.

Finally, I examine the impact of redemption restrictions on the flow-performance relationship, analysing the entire sample period between 2016-Q1 and 2023-Q2. Based on a multivariate flow-performance regression model, in which I interact negative relative returns with funds' redemption restrictions, I find that an additional week of notice period reduces

outflows by nearly one third. I do, however, not find evidence that redemption restrictions have a significant impact on the sensitivity of investor inflows to good performance. This asymmetric response supports the interpretation that redemption restrictions reduce fragility arising from costly asset liquidations, thereby disincentivizing investor withdrawals. These findings highlight the potential of redemption restrictions in mitigating fragility in open-ended bond funds.

This paper is related and contributes to the literature on financial stability risks in open-ended investment funds and tools to mitigate those risks. First, I contribute to the literature considering the negative externality in the context of strategic complementarities in investment funds. Chen et al. (2010) demonstrate the process of self-fulfilling runs, where the anticipation of other investors withdrawing prompts further withdrawals. They also show that the flow-to-performance relationship is more pronounced in funds that invest in less liquid assets. Consistent with the existence of a negative externality in investors' redemption decisions, Goldstein et al. (2017) find that corporate bond funds exhibit a concave flow-to-performance relationship. Similarly, Falato et al. (2021) show that bond funds with relatively less liquid portfolios faced larger outflows during the COVID-19 episode.[4] My paper supports this mechanism by highlighting the importance of the first-mover advantage in bond funds through studying the role of redemption restrictions, both in stressed and in normal periods.

Second, I contribute to the literature on liquidity management strategies of bond funds. Chernenko and Sunderam (2016) and Jiang et al. (2021) find that funds use liquidity buffers to meet redemptions, suggesting a "pecking-order" of liquidation where funds first draw down on their cash reserves to meet redemptions. Morris et al. (2017) and Shek et al. (2018), however, suggest that bond funds often engage in cash hoarding behaviour, meaning that

[4]Coval and Stafford (2007); Chernenko and Sunderam (2020); Barucca et al. (2021); Fricke and Fricke (2021); Lou (2012); Jiang et al. (2022) provide evidence that this mechanism can lead to spillover effects to the underlying asset markets through fire-sale externalities.

they increase their cash holdings in the face of investor redemptions and sell more of the underlying assets than is necessary to meet investor redemptions. Focusing on the COVID19 crisis, Ma et al. (2022) find that funds followed a pecking order by first selling their liquid assets. Schrimpf et al. (2021), however, find that a large number of funds hoarded cash to prepare for future outflows. Consistent with this, my findings suggest that cash hoarding behaviour was a common strategy to meet outflows during the March 2020 market turmoil, while funds with redemption restrictions used substantially more of their cash holdings to meet investor withdrawals during this period.

This paper also contributes to a related literature discussing possible remedies to fragility in open-ended investment funds, focusing largely on the role of liquidity buffers and anti-dilution tools. Jiang et al. (2022) and Choi et al. (2020) find that higher liquid asset holdings alleviate flow-induced selling pressure. Consistent with this, Dekker et al. (2024) find that higher ex-ante liquidity buffers reduced the need for fund managers in bond funds to engage in procyclical cash hoarding behaviour during the COVID-19 crisis. Other studies have focused on the role of anti-dilution tools in alleviating fragilities in the investment fund sector. For instance, swing pricing (Jin et al. (2022); Capponi et al. (2020); Malik and Lindner (2017); Capponi et al. (2023); Lewrick and Schanz (2023)), anti-dilution levies (Dunne et al. (2022)) and redemptions in kind (Agarwal et al. (2023)) aim to ensure that redemption costs are borne by redeeming investors, thus weakening the negative externality in investors' redemption decisions.[5] I assess an alternative way to address the first-mover advantage in redemption decisions in open-ended investment funds, by directly limiting the ability of investors to redeem their shares and thus mitigating the pressure on fund managers to engage in procyclical cash hoarding behaviour during periods of stress.

[5]Other tools that may reduce fire-sale externalities resulting from large-scale redemptions include access to interfund lending (Agarwal and Zhao (2019)) and liquidity provision by affiliated funds of funds (Bhattacharya et al. (2013)).

2 Hypotheses

I hypothesise that redemption restrictions discourage investor redemptions and mitigate procyclical liquidity management among fund managers to meet redemption requests. Open-ended investment funds typically allow investors to redeem their shares on a short notice, often within one day, which can create a first-mover advantage among investors. As Chen et al. (2010) demonstrate, early redeemers can benefit by avoiding the transaction costs associated with asset sales, as these costs are not immediately reflected in the fund's net asset value (NAV). Since NAVs are calculated at the end of the trading day but the actual liquidation of assets occurs later, investors who redeem first do not bear the full impact of transaction costs. Redemption restrictions can reduce this first-mover advantage by delaying withdrawals and creating an additional burden on investors in need of cash. Furthermore, redeeming investors in funds with redemption restrictions have a higher uncertainty regarding the future NAV relative to investors in funds without redemption restrictions, in particular during stress market periods, which may disincentivise investors from withdrawing from these funds. This leads to my first hypothesis.

Hypothesis 1. *Redemption restrictions disincentive investor outflows during stress periods and after negative fund performance.*

Fund managers may respond to outflows by hoarding cash in order to preserve the liquidity of their portfolio to prepare for future outflows, in particular during crisis periods (see Morris et al. (2017); Shek et al. (2018)). By limiting the possibility of short-term withdrawals, redemption restrictions alleviate the pressure on managers to sell assets quickly and accumulate large cash buffers. This enables fund managers with higher redemption restrictions to maintain more stable and efficient portfolio allocations relative to funds with no or lower

redemption restrictions.

Hypothesis 2. *Redemption restrictions mitigate cash hoarding behaviour among fund managers during crisis periods.*

3 Data

3.1 Sample construction and measures

My empirical tests are based on a survivorship-free panel of bond funds under the Alternative Investment Fund Managers Directive (AIFMD). The sample covers the period from 2016-Q1 to 2023-Q2 including quarterly observations for each fund. I retrieve the following variables from the supervisory reporting under the AIFMD: primary asset type, in- and outflows, returns, portfolio liquidity, cash holdings, investor composition, leverage, NAV and age. As standard practice in the literature, I normalise in- and outflows by the last period's fund size and winsorise the variables to account for outliers. I augment the AIFMD primary asset type classification by merging the AIFMD data with information from the ECB fund registry and Refinitiv Lipper. Based on Q4-2022 data, the dataset comprised a panel of 2,174 open-ended bond funds with approximately EUR 1.2 trillion in assets under management. All variables are defined in the Appendix.

A key feature the data is that it includes granular data on the type and duration of redemption restrictions at the individual fund level, including notice periods, redemption frequency and lockup period. I use two main measures in this regard. The first measure is the duration of combined redemption restrictions, taking into account the information on the lockup period, redemption frequency and the notice period to calculate a single measure of duration of the redemption restrictions. Following Hombert and Thesmar (2014), I define duration the minimum time an investor must wait in order to withdraw the average euro

invested in a fund:

$$\text{Duration}_{i,t} = \text{Notice}_{i,t} + \frac{\text{RedFreq}_{i,t}}{2} + \frac{1}{AuM}_{i,t} \sum_{s=0}^{\text{Lockup}_{i,t}} \text{Inflow}_{i,t-s} \times \text{I}_{\{Inflow>0\}} \times (\text{Lockup}_{i,t} - \text{s}) \quad (1)$$

As a second measure, I assess the individual effects of notice period, redemption frequency, and lockup period to gauge their respective impact.

3.2 Summary statistics

Table 1 presents the summary statistics. Panels A and B show the descriptive statistics for funds with redemption restrictions and funds without redemption restrictions, respectively. Overall, around 30% of funds have redemption restrictions, with a median duration among those funds of around one week and a mean of 12 days (Row 1). Among funds with redemption restrictions, the notice period is the most common contractual impediments to withdrawals, followed by the redemption frequency. Around 90% of funds with redemption restrictions have at least one day of notice period, while the median is 2 days and the average is 6 days. Around half of the funds with redemption restrictions have daily redemption frequencies, while the other half has redemption frequencies of a week or lower. The average is around 11 days, which is driven by a few funds that have quarterly redemption frequencies.[6] Only around 9% of funds with redemption restrictions have a lockup period.

[6] As robustness, for the assessment of redemption restrictions during the March 2020 turmoil, I exclude funds with a duration of 5 weeks or higher to alleviate the possibility that investor withdrawal decisions during March 2020 are only observable in the next quarter.

Table 1: Summary Statistics

This table shows the summary statistics of the bond funds in my sample from 2014-Q1 to 2023-Q2. Panel A shows the descriptive statistics for funds with redemption restrictions of at least two days. Panel B shows the descriptive statistics for funds without redemption restrictions. All variables are defined in the Appendix.

Panel A: Funds with redemption restrictions

	Mean	Std.Dev.	P25	P50	P75	Observations
Duration	11.72	15.45	3.00	6.50	14.00	10558
Notice	6.05	10.63	1.00	2.00	7.00	10558
RedFreq	11.27	17.73	0.00	7.00	14.00	10558
Lockup	2.84	109.57	0.00	0.00	0.00	10558
Inflows	0.03	0.15	0.00	0.00	0.01	10558
Outflows	0.04	0.12	0.00	0.00	0.02	10558
Return	0.00	0.05	-0.01	0.00	0.02	10558
Cash	0.05	0.14	0.00	0.02	0.04	10558
LnNAV	18.06	1.84	16.75	18.24	19.30	10558
LnAge	3.26	0.78	2.71	3.22	3.87	10558
PortIlliq	23.34	61.91	1.48	3.00	7.79	10558
Leverage	1.47	1.66	1.00	1.09	1.48	10558
LnLeverage	0.25	0.39	0.00	0.09	0.39	10558
InvBanks	21.50	39.90	0.00	0.00	1.67	10558
InvGovernment	1.74	12.29	0.00	0.00	0.00	10558
InvHouseholds	17.54	36.27	0.00	0.00	0.00	10558
InvInsurance	19.06	38.13	0.00	0.00	0.00	10558
InvNFC	7.79	24.80	0.00	0.00	0.11	10558
InvFunds	1.35	9.17	0.00	0.00	0.00	10558
InvOther	4.72	19.93	0.00	0.00	0.00	10558

Panel B: Funds without redemption restrictions

	Mean	Std.Dev.	P25	P50	P75	Observations
Duration	0.28	0.45	0.00	0.00	1.00	24548
Notice	0.28	0.45	0.00	0.00	1.00	24548
RedFreq	0.00	0.00	0.00	0.00	0.00	24548
Lockup	0.04	0.30	0.00	0.00	0.00	24548
Inflows	0.04	0.17	0.00	0.00	0.01	24548
Outflows	0.04	0.11	0.00	0.00	0.03	24548
Return	0.00	0.06	-0.01	0.00	0.01	24548
Cash	0.05	0.13	0.01	0.02	0.04	24548
LnNAV	18.53	1.81	17.43	18.50	19.57	24548
LnAge	3.61	0.76	3.09	3.69	4.20	24548
PortIlliq	10.16	29.13	1.15	2.96	6.76	24548
Leverage	1.38	1.06	1.00	1.04	1.35	24548
LnLeverage	0.22	0.37	0.00	0.04	0.30	24548
InvBanks	15.43	35.42	0.00	0.00	0.00	24548
InvGovernment	4.04	19.43	0.00	0.00	0.00	24548
InvHouseholds	16.13	35.10	0.00	0.00	0.00	24548
InvInsurance	13.82	33.97	0.00	0.00	0.00	24548
InvNFC	12.26	30.86	0.00	0.00	2.10	24548
InvFunds	5.68	22.53	0.00	0.00	0.00	24548
InvOther	10.86	30.52	0.00	0.00	0.00	24548

In terms of key explanatory variable such as inflows, outflows, return and cash holdings, funds with redemption restrictions appear to be similar to those without redemption restrictions (see Rows 5-8). However, funds with redemption restrictions tend to be younger, smaller and more leveraged than funds without redemption restrictions.[7] In addition, the investor composition between the two groups is different. While the share of household investors is similar across the groups, funds with redemption restrictions are more often held by banks and insurance corporations whereas funds without redemption restrictions are more often held by non-financial corporations, other investment funds, and other investors. The ownership structure is important because investors with different levels of sophistication are likely to internalise the negative externality from redemption decisions differently (Goldstein et al. (2017)), which can result in different run dynamics (Fricke and Wilke, 2023; Allaire et al., 2023). Finally, funds with redemption restrictions tend to hold more illiquid assets than funds without redemption restrictions. While for the median fund in both groups it takes around 3 days to liquidate the portfolio, the average portfolio liquidity for funds with redemption restrictions is higher than for funds without redemption restrictions (23 days versus 10 days). In the following sections, I assess the impact of redemption restrictions investigating the March 2020 market turmoil, while controlling for the investor composition and the liquidity of the assets as well as matching funds with redemption restrictions to funds without redemption restrictions based on pre-crisis covariates.

[7]The mean differences of size and age are statistically significant, whereas the difference in leverage is not statistically significantly between the two groups.

4 Redemption restrictions and investor outflows

4.1 The March 2020 market turmoil

To assess the first hypothesis (that redemption restrictions discourage investor redemptions during stress periods), I estimate the following specification:

$$\begin{aligned} \text{Outflows}_{i,t} = \alpha &+ \beta_1 \text{March2020}_t + \beta_2 \text{March2020}_t * \text{Duration}_{i,t-1} + \beta_3 \text{Duration}_{i,t-1} \\ &+ \beta_4 \text{PostMarch2020}_t * \text{Duration}_{i,t-1} + \beta_5 \text{PostMarch2020}_t \\ &+ \beta_6 \text{Controls}_{i,t-1} + \epsilon_{i,t}, \end{aligned} \tag{2}$$

where $\text{Outflows}_{i,t}$ is the normalised outflows from period t-1 to period t in fund i. Duration is first measured as the duration of combined redemption restrictions, as defined in (1), and then as the duration of the individual components of redemption restrictions, namely the notice period, redemption frequency, and the lockup period.[8] March2020 is an indicator variable which equals one in the first quarter of 2020 and zero otherwise. Controls include log(NAV), log(age), log(leverage), cash holdings, portfolio liquidity, lagged and contemporaneous fund returns and lagged outflows. I also control for the fund's investor composition (as percent of total assets), broken down by individual investor sector. The model and explanatory variables follow and are consistent with the literature on fund fragility.[9] β_2 is the main coefficient of interest which shows the effect of higher redemption restrictions on outflows during the COVID-19 crisis period. I exclude funds with a duration of 5 weeks or higher to alleviate

[8] Throughout the regressions, the daily variables are transformed at weekly level to ensure readability of the coefficients.

[9] See for instance Goldstein et al. (2017) or Jin et al. (2022).

the possibility that investor withdrawal decisions during March 2020 are only observable in the next quarter. In this context, I also include four additional interaction terms interacting *Duration* with the four quarters following the March 2020 market turmoil ($PostMarch2020$) to test whether funds with higher redemption restrictions had higher outflows in the year following the crisis period. Given that the explanatory variables are measured before the March 2020 turmoil and due to the exogenous nature of this shock, which was unlikely anticipated by investors and fund managers, endogeneity concerns should be limited.

Table 2 reports the results. According to Column 1, during the first quarter of 2020, funds without redemption restrictions experienced, on average, around 1.6 percentage points higher outflows (in terms of lagged total assets) than in other time periods, highlighting the crisis nature of this period. However, the outflows for funds with redemption restrictions were significantly lower in this period: according to the coefficient on the interaction term $\text{March2020}_t * \text{Duration}_{i,t-1}$, an additional week in the duration of redemption restrictions, on average, reduced outflows by around one percentage point (in terms of total assets). This effect is economically meaningful, as it suggests that a one-week duration in combined redemption restrictions would have, on average, absorbed nearly two thirds of the additional outflows in this period.

In Columns 2 and 3, I control for the possibility that funds with higher redemption restrictions had higher outflows in the periods following the March 2020 market turmoil. First, I find that the coefficient on the interaction term $\text{March2020}_t * \text{Duration}_{i,t-1}$ remains robust in terms of economic magnitude and statistical significance. In addition, all four coefficients on the post-March 2020 interaction terms are statistically insignificant suggesting that redemption restrictions did not result in higher outflows in the year after March 2020. This adds strong evidence that redemption restrictions did not only postpone the timing of

Table 2: Redemption Restrictions and Outflows during the March 2020 Market Turmoil

This table shows the relationship between investor outflows and redemption restrictions with a focus on the March 2020 market turmoil. The dependent variable is normalised outflows. The unit of observation is fund-quarter and standard errors are clustered at the fund level. All variables are defined in the Appendix. Standard errors are in parentheses. The ***, ** and * stand for significant coefficients at the 1%, 5%, and 10% levels, respectively.

	(1) Outflows	(2) Outflows	(3) Outflows	(4) Outflows	(5) Outflows	(6) Outflows
March2020	0.016***	0.015***	0.013***	0.013***		
	(0.004)	(0.004)	(0.004)	(0.004)		
March2020 × Duration	-0.010**	-0.010**	-0.011**			
	(0.004)	(0.004)	(0.004)			
March2020 × Notice				-0.013**	-0.025***	-0.023***
				(0.006)	(0.008)	(0.008)
March2020 × RedFreq				-0.005	-0.004	-0.005
				(0.003)	(0.003)	(0.003)
March2020 × Lockup				0.043	0.029	0.019
				(0.037)	(0.063)	(0.091)
March2020 × PortIlliq	0.001*	0.001*	0.001*	0.001*	0.001*	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
March2020 × Cash	0.071	0.071	0.062	0.063	0.058	0.057
	(0.070)	(0.070)	(0.047)	(0.047)	(0.065)	(0.065)
Jun2020 × Duration		0.002	0.002	0.002	0.003	-0.001
		(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
Sep2020 × Duration		-0.003	-0.003	-0.003	-0.002	0.001
		(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Dec2020 × Duration		0.004	0.004	0.004	0.004	0.007
		(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
Mar2021 × Duration		-0.002	0.000	0.000	-0.002	-0.001
		(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
PortIlliq	-0.000	-0.000	-0.000**	-0.000**	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash	0.079***	0.079***	0.132***	0.132***	0.080***	0.081***
	(0.016)	(0.016)	(0.020)	(0.020)	(0.016)	(0.016)
LnNAV	0.001*	0.001*	0.011***	0.011***	0.002**	0.002**
	(0.001)	(0.001)	(0.004)	(0.004)	(0.001)	(0.001)
LnAge	-0.004***	-0.004***	0.020***	0.020***	-0.003***	-0.003***
	(0.001)	(0.001)	(0.003)	(0.003)	(0.001)	(0.001)
LnLeverage	0.007***	0.007***	-0.001	-0.002	0.008***	0.009***
	(0.003)	(0.003)	(0.006)	(0.006)	(0.003)	(0.002)
Duration	0.001	0.001	-0.002	-0.027	0.061	0.861*
	(0.001)	(0.001)	(0.002)	(0.108)	(0.069)	(0.516)
Notice				0.022	-0.055	-0.855*
				(0.109)	(0.069)	(0.516)
RedFreq				0.013	-0.031	-0.432*
				(0.054)	(0.034)	(0.258)
Lockup				0.002	-0.005	-0.004
				(0.001)	(0.004)	(0.005)
Investor Controls	Yes	Yes	Yes	Yes	Yes	Yes
Lagged Flow	Yes	Yes	Yes	Yes	Yes	Yes
Lagged & cont. Return	Yes	Yes	Yes	Yes	Yes	Yes
Fund FE			Yes	Yes		
Investor x Quarter FE					Yes	Yes
Adj. R-squared	0.14	0.14	0.35	0.35	0.16	0.16
Observations	33,128	33,128	33,128	33,128	33,128	32,861

investor withdrawals, but overall reduced outflows during this stress period.

In Column 4, I break down the effect of redemption restrictions into its individual components. The coefficients on the interaction terms capturing the redemption frequency and lockup period are not statistically significant at the 10% level. However, the coefficient on the interaction term March2020$_t$*Notice$_{i,t-1}$ is larger than when considering the effect of the duration of the combined redemption restrictions. The coefficient on the interaction term suggests that a one-week notice period would have, on average, largely absorbed the additional outflows during this stress episode.

In Column 5, I include Investor $*$ Quarter fixed effects to study outflows within the same investor group and quarter to control for differences in run dynamics during the COVID19 crisis across investor groups (Fricke and Wilke, 2023; Allaire et al., 2023). The effect remains robust. The notice period is still the most relevant restriction in terms of statistical significant and economic magnitude, with a larger coefficient than in the previous specifications. Finally, in Column 6, I restrict the sample to funds where the duration of redemption restrictions is less than 3 weeks, corresponding to the duration of the crisis peak period which lasted between 12 and 31 March (see Dekker et al. (2024)). The effect remains robust. Together with the insignificant coefficients on the interaction terms with the post-March 2020 variables, this finding suggests that the notice period disincentivised investors from redeeming during this crisis period.

4.2 Matching funds with redemption restrictions to funds without redemption restrictions

One concern is the possibility of structural differences between funds with redemption restrictions and those without. As discussed in Section 3.2, funds with redemption restrictions

tend to have more illiquid portfolios and a different investor composition. While I control for those variables throughout the regressions, I address this issue more directly by conducting a matching algorithm that matches funds with redemption restrictions to similar funds that do not have redemption restrictions. The goal is to match funds based on key characteristics that determine the probability to have redemption restrictions, based on pre-crisis data.

To do so, I apply propensity score matching using the nearest neighbour method on a one-to-one basis. I first estimate a logit model estimating the probability for a fund to have redemption restrictions, based on the fund's portfolio liquidity, its level of cash holdings, size, age, leverage as well as the fund's investor composition, broken down by the individual investor sectors (see Column 2 of Table 3). I then apply the nearest neighbour matching procedure, with replacement, selecting the funds closest in terms of their propensity scores, based on the control variables included in the model. The bandwidth is determined by cross-validation with respect to the means of the explanatory variables from the logit model and common support is required.

To ensure that the matched samples of funds with redemption restrictions and funds without redemption restrictions are comparable, I report the covariate balance across the two groups after matching in Table 4. Columns 1 and 3 show the means of the matched samples while Columns 2 and 4 show the variances, for the different covariates. Column 5 shows the standardised bias, which is the difference of the sample means in the matched samples scaled by the square root of the average of the sample variances in the treated and non-treated groups. As a rule of thumb, groups are regarded as sufficiently equal and adequate for linear regression methods if standardised differences are in the range of $\mp$ 0.25 (Imbens and Wooldridge (2009)). For all covariates the standardized bias is well below this threshold. Overall, both the mean and the median standardised bias in covariates across treated and untreated funds in the matched sample is 0.02. In this sense, the two groups resemble very

similar characteristics, providing evidence that the identification is appropriate and that the results are unlikely to be driven by structural differences, such as portfolio liquidity or investor composition.

Table 5 shows the results using the matched sample. In Column 1, I use the Duration measure, while Columns 2 to 5 are based on the individual components of the redemption restrictions. Overall, the effect of redemption restrictions remains robust when using the matched sample. Similar to the main specification, the coefficient on $\text{March2020}_t * \text{Duration}_{i,t-1}$ suggests that a one-week higher redemption restriction, on average, reduced outflows by around one percentage point (in terms of total assets). Furthermore, the effect tends to be mostly driven by the notice period where the coefficients are statistically significant at the 1% level throughout the specifications and the magnitude of the coefficients is similar to the main specification. These findings thus provide additional evidence that the notice period disincentivised investor redemptions in this period, reducing overall outflows in these funds.

Table 3: Determinants of Redemption Restrictions

This table shows the relationship between redemption restrictions and a set of key characteristics. The dependent variable is a dummy variable which is one if a fund has a redemption restriction of at least 2 days and zero otherwise. In Columns 1 and 2, the sample is restricted to the sample period between 2016-Q1 to 2019-Q4, while Columns 3 and 4 are based on the full sample. Columns 1 and 3 show the coefficients from the linear OLS model, while Columns 2 and 4 show the marginal effects based on a logit model. The unit of observation is fund-quarter and standard errors are clustered at the fund level. All variables are defined in the Appendix. Standard errors are in parentheses. The ***, ** and * stand for significant coefficients at the 1%, 5%, and 10% levels, respectively.

	(1) RedRestr	(2) RedRestr	(3) RedRestr	(4) RedRestr
PortIlliq	0.009***	0.008***	0.010***	0.009***
	(0.001)	(0.001)	(0.000)	(0.000)
Cash	0.085***	0.076***	0.078***	0.064***
	(0.026)	(0.025)	(0.018)	(0.018)
LnNAV	-0.026***	-0.025***	-0.031***	-0.031***
	(0.002)	(0.002)	(0.001)	(0.001)
LnAge	-0.078***	-0.076***	-0.108***	-0.104***
	(0.004)	(0.004)	(0.003)	(0.003)
LnLeverage	0.037***	0.032***	0.031***	0.028***
	(0.008)	(0.008)	(0.006)	(0.006)
InvBanks	0.002***	0.002***	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
InvHouseholds	0.000	0.000*	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
InvInsurance	0.002***	0.002***	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
InvNFC	0.000	0.000	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
InvFunds	0.001*	0.001**	-0.003***	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)
InvOtherFinInst	0.001**	0.001**	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
InvPension	0.002***	0.002***	0.001**	0.001*
	(0.000)	(0.000)	(0.000)	(0.000)
InvOther	-0.001***	-0.001***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Regression model	Linear	Logit	Linear	Logit
Sample	Pre-March2020	Pre-March2020	Full	Full
AROC		0.69		0.71
Adj. R-squared	0.10	0.08	0.12	0.10
Observations	18051	18051	35106	35106

Table 4: Covariate Balance across Funds with Redemption Restrictions and Funds without Redemption Restrictions, after Matching

This table shows the means and variance for funds with redemption restrictions (Columns 1 and 2) and funds without redemption restrictions (Columns 3 and 4), in percent, as well as the standardised bias after matching (Column 5). The results are based on propensity score matching using the nearest neighbour procedure, with replacement. The bandwidth is determined by cross-validation with respect to the means of the explanatory variables from the logit model (see Table 3, Column 2). Common support is required. All variables are defined in the Appendix.

	Treated		Control		
	Mean	Variance	Mean	Variance	ND
PortIlliq	3.24	73.14	3.63	79.82	−0.06
Cash	0.05	0.02	0.05	0.02	0.03
LnNAV	17.95	4.41	18.04	4.17	−0.05
LnAge	3.22	0.68	3.23	0.75	0.01
LnLeverage	0.29	0.26	0.28	0.26	0.04
InvBank	21.65	1592.35	22.14	1654.82	−0.01
InvHouseholds	16.56	1268.15	16.01	1186.84	0.02
InvInsurance	20.59	1549.08	21.48	1639.69	−0.02
InvNFC	6.95	546.72	6.80	511.81	0.01
InvFunds	3.33	245.32	3.14	273.63	0.01
InvOthFinInst	5.41	441.53	5.02	426.44	0.02
InvPenFund	14.89	1148.95	14.48	1204.41	0.01
InvOther	7.46	605.91	7.93	696.47	−0.01

4.3 The flow-performance relationship

The March 2020 market turmoil following the onset of the COVID-19 pandemic prompted a global dash for cash by investors. The impact of redemption restrictions on investors may have been particularly strong in this period, as many investors needed to get liquidity on a short notice making funds with redemption restrictions less attractive for those investors. Including Investor $*$ Quarter fixed effects controls for differences in liquidity needs and associated run dynamics across investor groups in March 2020. However, the effect of redemption restrictions may be different in other periods. In this section, I assess whether higher redemption restrictions reduce the sensitivity of investor flows to negative returns more generally. To do so, I introduce redemption restrictions into a flow-performance regression model interacting lagged redemption restrictions with lagged returns. I estimate the following specification:

Table 5: Redemption Restrictions and Outflows during the March 2020 Market Turmoil - Matched Sample

This table shows the relationship between investor outflows and redemption restrictions with a focus on the March 2020 market turmoil, for the sample of matched funds. The dependent variable is normalised outflows. The unit of observation is fund-quarter and standard errors are clustered at the fund level. All variables are defined in the Appendix. Standard errors are in parentheses. The ***, ** and * stand for significant coefficients at the 1%, 5%, and 10% levels, respectively.

	(1) Outflows	(2) Outflows	(3) Outflows	(4) Outflows	(5) Outflows
March2020	0.021***	0.022***	0.016***		
	(0.005)	(0.005)	(0.005)		
March2020 × Duration	-0.010**				
	(0.005)				
March2020 × Notice		-0.015***	-0.015***	-0.027***	-0.023***
		(0.006)	(0.006)	(0.008)	(0.008)
March2020 × Lockup		0.049	0.066	0.028	0.067
		(0.053)	(0.044)	(0.057)	(0.104)
March2020 × RedFreq		-0.004	-0.005	-0.004	-0.005
		(0.004)	(0.003)	(0.004)	(0.004)
March2020 × PortIlliq	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
March2020 × Cash	-0.034	-0.033	-0.014	-0.015	-0.012
	(0.056)	(0.056)	(0.045)	(0.054)	(0.054)
Jun2020 × Duration	-0.000	0.000	0.000	0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
Sep2020 × Duration	-0.004	-0.004	-0.003	-0.000	0.004
	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)
Dec2020 × Duration	0.003	0.003	0.003	0.003	0.009
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)
Mar2021 × Duration	-0.004	-0.004	-0.000	-0.003	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
PortIlliq	0.000	0.000	-0.001**	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash	0.040*	0.043**	0.105***	0.041**	0.041*
	(0.021)	(0.021)	(0.028)	(0.021)	(0.021)
LnNAV	0.000	0.000	0.010**	0.000	0.001
	(0.001)	(0.001)	(0.005)	(0.001)	(0.001)
LnAge	-0.003**	-0.003**	0.020***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)
LnLeverage	0.009***	0.010***	-0.004	0.010***	0.010***
	(0.003)	(0.003)	(0.007)	(0.003)	(0.003)
Duration	0.000	1.145*	0.075	1.136*	1.140*
	(0.001)	(0.650)	(0.317)	(0.640)	(0.645)
Notice		-1.141*	-0.071	-1.133*	-1.138*
		(0.650)	(0.317)	(0.640)	(0.645)
RedFreq		-0.573*	-0.038	-0.569*	-0.571*
		(0.325)	(0.159)	(0.320)	(0.323)
Lockup		-0.013	-0.009	-0.014	-0.009
		(0.021)	(0.008)	(0.020)	(0.020)
Investor Controls	Yes	Yes	Yes	Yes	Yes
Lagged Flow	Yes	Yes	Yes	Yes	Yes
Lagged & cont. Return	Yes	Yes	Yes	Yes	Yes
Fund FE			Yes		
Investor x Quarter FE				Yes	Yes
Adj. R-squared	0.10	0.11	0.28	0.13	0.13
Observations	27334	27334	27334	27334	27103

$$\text{Outflows}_{i,t} = \alpha + \beta_1 \text{Return}_{i,t-1} + \beta_2 \text{Return}_{i,t-1} * \text{Duration}_{i,t-1} + \beta_3 \text{Duration}_{i,t-1} + \beta_4 \text{Controls}_{i,t-1} + \epsilon_{i,t}, \quad (3)$$

where $\text{Outflows}_{i,t}$ is the normalised outflows from period t-1 to period t in fund i. $Duration_{i,t-1}$ is first defined as the combined duration of redemption restrictions, as defined in (1), and then as the duration of the individual components of redemption restrictions, namely notice period, redemption frequency, and lockup period. $Return_{i,t-1}$ shows the lagged return of fund i in period t-1 relative to the sample mean in period t-1. As robustness, and given that the analysis is based on quarterly data, I also run the model using the contemporaneous relationship between return and flow. Controls include lagged log(NAV), log(age), log(leverage), cash holdings, portfolio liquidity, lagged net flows, as well as the fund's investor composition (broken down by the individual investor sectors). β_2 is the main coefficient of interest which shows to what extent higher redemption restrictions mitigate the flow sensitivity to negative past returns.

Table 6 shows the results. In Columns 1 to 6 the dependent variable is Outflows, while in Column 7 the dependent variable is Inflows. Consistent with the literature on bond fund fragility, I find that funds with lower past returns have higher outflows. However, I find that investors in funds with higher redemption restrictions react less strongly to negative returns. While for an average fund without redemption restrictions a negative relative fund return of one percentage point is associated with outflows of 0.26 percent of total net assets, a fund with a weekly redemption restriction would have outflows of only 0.21 percent of total net assets. This effect is statistically significant at the 1% level and robust to including

Investor $*$ Quarter fixed effects (Column 2).

In Columns 3 to 7, I break down the effect into notice period, lockup and redemption frequency, respectively. Similar to the previous analyses the impact comes mainly from the notice period, while the impact of the redemption frequency and the lockup period are not statistically significant at the 10% level throughout the specifications. In Column 4, I restrict the sample period to quarters outside of the March 2020 market turmoil as there may have been other exceptional factors at play during this period that may confound the results. In Column 5, I use contemporaneous returns, given that the lag with quarterly data is relatively long. In Column 6, I use a matched sample to address potential selection bias, following the same methodology as in Section 4.1 (the marginal effects of the logit model are reported in Column 4 of Table 3). The results remain robust throughout the specifications and suggest an economically meaningful impact. According to Column 6, for instance, funds with a notice period of one week would have, on average, around 31 % (0.09/0.29) lower outflows than similar funds that do not have a notice period.

In Column 7, I assess the asymmetry of the impact of redemption restrictions on the flow-performance relationship when focusing on the inflows as dependent variable in response to positive returns. In line with the literature, I find that higher returns are associated with higher inflows (Row 1). As shown by the interaction term $\text{Return}_{i,t-1} * \text{Duration}_{i,t-1}$, this effect is not statistically different for funds with higher redemption restrictions. These findings provide evidence that redemption restrictions predominantly affect the sensitivity of outflows to poor performance, supporting the interpretation that redemption restrictions mitigate the first-mover advantage in investors' redemption decisions thereby reducing fragility in these funds.

Table 6: Redemption Restrictions and the Flow-Performance Relationship

This table shows the relationship between redemption restrictions and the flow-performance relationship. In Columns 1 to 6 the dependent variable is normalised outflows, while in Column 7 the dependent variable is normalised inflows. Column 6 is based on the matched sample, while the other Columns use the full sample. The unit of observation is fund-quarter and standard errors are clustered at the fund level. All variables are defined in the Appendix. Standard errors are in parentheses. The ***, ** and * stand for significant coefficients at the 1%, 5%, and 10% levels, respectively.

	(1) Outflows	(2) Outflows	(3) Outflows	(4) Outflows	(5) Outflows	(6) Outflows	(7) Inflows
Return	-0.26***	-0.25***	-0.25***	-0.37***	-0.39***	-0.29***	0.29***
	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)	(0.07)	(0.07)
Return × Duration	0.05***	0.05***					
	(0.01)	(0.01)					
Return × Notice			0.06***	0.06***	0.05***	0.09**	-0.04
			(0.02)	(0.02)	(0.02)	(0.04)	(0.07)
Return × RedFreq			0.03*	0.03*	0.03*	0.01	0.02
			(0.02)	(0.02)	(0.02)	(0.02)	(0.04)
Return × Lockup			0.01	0.01***	0.01***	-0.37	0.00
			(0.00)	(0.00)	(0.00)	(0.25)	(0.00)
PortIlliq	0.00	0.00	0.00	-0.00	-0.00	-0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Cash	0.13***	0.13***	0.13***	0.12***	0.12***	0.08**	0.12**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)
NetFlows	-0.06***	-0.05***	-0.05***	-0.05***	-0.06***	-0.04*	0.15***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
LnNAV	0.00	0.00	0.00	0.00	0.00	0.00	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
LnAge	-0.00**	-0.00**	-0.00**	-0.00**	-0.00**	-0.00*	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
LnLeverage	0.01***	0.01***	0.01***	0.01*	0.01	0.01**	0.02**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Duration	-0.00	-0.00					
	(0.00)	(0.00)					
Notice			-0.00	0.00	0.00	0.00	-0.00*
			(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Lockup			-0.00	-0.00	-0.00	-0.00	-0.00
			(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
RedFreq			-0.00	-0.00	-0.00	-0.00	-0.00
			(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Quarter FE	Yes						
Investor x Quarter FE		Yes	Yes	Yes	Yes	Yes	Yes
Matched Sample						Yes	
Sample	Ret < 0	Ret < 0	Ret < 0	Ret < 0	Ret < 0	Ret < 0	Ret > 0
March 2020 included	Yes	Yes	Yes		Yes	Yes	Yes
Adj. R-squared	0.05	0.07	0.07	0.07	0.07	0.09	0.09
Observations	21394	21394	21394	21095	20385	17358	13387

5 Redemption restrictions and fund managers' cash hoarding

In this section, I assess my second hypothesis whether redemption restrictions mitigate cash hoarding behaviour among fund managers, with a focus on the March 2020 market turmoil. Following Morris et al. (2017), I define cash hoarding as cases where redemptions result in net outflows but cash holdings increase, suggesting that fund managers sell more bonds than is strictly necessary to meet redemptions. This behaviour can be destabilising from a financial stability perspective, as it may reinforce the impact of redemptions by amplifying the sales of the underlying asset. Alternatively, fund managers may draw on cash first to meet redemptions, and only start selling the underlying assets if the cash runs out, which would be consistent with a "pecking-order" choice of actions. Conversely, fund managers may respond to investor redemptions by buying additional bonds, suggesting a stabilising role in the market.

Figure 2 shows the frequency of each of the three cases, broken down by funds with redemption restrictions and funds without redemption restrictions. Panel (a) focuses on time periods between 2016-Q1 and 2023-Q2 but excludes 2020-Q1, whereas Panel (b) restricts the sample to the March 2020 market turmoil. In line with Morris et al. (2017), I find that cash hoarding behaviour seems to be a common strategy among fund managers to meet net outflows. During periods other than the March 2020 market turmoil, funds without redemption restrictions engaged in around 46% of cases in cash hoarding behaviour when faced with net outflows (Panel (a), Case 3). While this figure is only slightly lower for funds with redemption restrictions, those funds engaged substantially more often in stabilising behaviour (meaning that they more often buy bonds despite net outflows), relative to funds without redemption restrictions (see Case 1). Focusing on the COVID-19 crisis (Panel (b)), cash hoarding

Figure 2: Fund managers' liquidity management strategies

This figure shows the frequency of (i) stabilising, (ii) intermediate and (iii) destabilising behaviour. In Case 1, cash holdings fall by more than investor outflows. The fund manager buys additional bonds, despite investor redemptions, thus playing a stabilising role in the market. Case 2 has investor outflows, and outflows are met partly by reducing cash and partly by selling bonds. In this case, bond sales are entirely driven by investor redemptions. Case 3 represents cash hoarding by fund managers. Redemptions result in net outflows, but cash holdings increase. The fund manager sells more bonds than is necessary to meet redemptions. The methodology follows Morris et al. (2017). Panel (a) focuses on time periods between 2016-Q1 and 2023-Q2 but excludes 2020-Q1, whereas Panel (b) restricts the sample to the March 2020 market turmoil.

(a) Time periods excluding March 2020

(b) March 2020 market turmoil

behaviour among funds without redemption restrictions was substantially higher than during other periods, with around 61% of funds engaging in cash hoarding behaviour (Case 3). However, funds with redemption restrictions engaged substantially less in cash hoarding behaviour during this period relative to funds without redemption restrictions, suggesting lower fire-sale externalities from those funds.

To test more formally whether funds with redemption restrictions had a lower likelihood of engaging in cash hoarding behaviour during the March 2020 market turmoil than funds without redemption restrictions, I estimate the following specification:

$$\begin{aligned}\text{CashHoarding}_{i,t} = \alpha + \beta_1 \text{March2020}_t + \beta_2 \text{March2020}_t * \text{Duration}_{i,t-1} + \beta_3 \text{Duration}_{i,t-1} \\ + \beta_4 \text{March2020}_t * \text{NetFlows}_{i,t} + \beta_5 \text{NetFlows}_{i,t} + \beta_6 \text{Controls}_{i,t-1} + \epsilon_{i,t},\end{aligned} \quad (4)$$

where $\text{CashHoarding}_{i,t}$ equals 1 if fund i hoarded cash during March 2020 and 0 otherwise. A fund is considered as cash hoarding when it faced net outflows in March 2020 and increased the amount of cash during this period. I focus on changes in the cash amount instead of using the portfolio weights, since portfolio weights can be distorted by fluctuations in the valuation of other assets. $\text{Duration}_{i,t-1}$ equals 1 if fund i has redemption restrictions of at least 2 days and 0 otherwise. Controls include the lagged level of cash holdings, log(NAV), log(age), log(leverage), portfolio liquidity, lagged and contemporaneous fund returns and lagged outflows. I also control for the fund's investor composition (as percent of total assets), broken down by the individual investor sectors. I restrict the sample to those funds that faced net outflows, because I am interested in the way funds responded to outflows rather than inflows. Importantly, I control for contemporaneous net flows to isolate the effect of redemption restrictions on cash hoarding, as stricter restrictions may also reduce outflows, as discussed in Section 4. I first estimate the model using a linear probability model (OLS) and then re-estimate it using a logit regression to explicitly model the probability that a fund hoards cash during March 2020, given the binary nature of the dependent variable.

Columns 1 and 2 of Table 7 show the results for the OLS and the logit models respectively. Consistent with Figure 2, bond funds engaged significantly more in cash hoarding behaviour during the March 2020 turmoil than during other periods. According to Row 1, funds without redemption restrictions were around 24 percent more likely to engage in cash hoarding behaviour during the March 2020 turmoil compared to other periods with net out-

flows. However, I find that funds with redemption restrictions were around 13 percentage points less likely to hoard cash than those without restrictions, suggesting reduced fire-sale externalities among such funds during this stress episode.

To quantify the continuous effects on the use of cash holdings and potential differences based on the duration of redemption restrictions, I estimate several variations of the following specification:

$$\begin{aligned}\Delta\text{Cash}_{i,t} = \alpha + \beta_1\text{March2020}_t + \beta_2\text{March2020}_t{*}\text{Duration}_{i,t-1} + \beta_3\text{Duration}_{i,t-1} \\ + \beta_4\text{March2020}_t{*}\text{NetFlows}_{i,t} + \beta_5\text{NetFlows}_{i,t} + \beta_6\text{Controls}_{i,t-1} + \epsilon_{i,t},\end{aligned} \tag{5}$$

where $\Delta\text{Cash}_{i,t}$ is defined as the euro change in cash holdings for fund i between Q4-2019 and Q1-2020, scaled by the fund's total net assets in Q4-2019. $Duration_{i,t-1}$ is first defined as the combined duration of redemption restrictions, as defined in (1), and then as the duration of the individual components of redemption restrictions, namely notice period, redemption frequency, and lockup period. The remaining variables are the same as in specification (4). β_2 shows the impact of an additional week of redemption restrictions on the change in cash holdings during the March 2020 crisis, following net outflows.

Columns 3 to 9 of Table 7 show the results. Columns 3 and 4 show the results for the combined duration measure, while I break down the redemption restrictions into its individual components in Columns 5 to 9. First, I find that funds increased their cash holdings more during March 2020 compared to other periods with net outflows, but this effect is smaller for funds with higher redemption restrictions (see Columns 3 and 4). Second, when breaking redemption restrictions into individual components, the effects of lockup period and redemption frequency are not statistically significant across specifications, while the impact

of the notice period appears the most robust. According to Column 5, I find that, an additional week of notice is associated with an average reduction in the increase of cash buffers by around 2 percentage points during the March 2020 market turmoil. This suggests that, during the crisis, a fund with a one-week notice period would have used around 22% more of its cash buffers to accommodate outflows, relative to a fund without redemption restrictions ((0.09 - 0.07) / 0.09), indicating an economically meaningful impact. This effect is robust to including InvestorxQuarter fixed effects (Column 6) and using the matched sample under different model specifications (Columns 7 to 9). Importantly, since I control for the size of outflows throughout all specifications, these findings provide strong evidence that redemption restrictions, in the form of the notice period, directly impact fund managers' liquidity management strategies, reducing pressures to engage in procyclical cash hoarding behaviour.

Table 7: Redemption Restrictions and Cash Hoarding during the March 2020 Market Turmoil

This table shows the relationship between changes in cash holdings and redemption restrictions, with a focus on the March 2020 market turmoil. In Columns 1 and 2, the dependent variable equals one if fund i engages in cash hoarding behaviour and Duration equals one if fund i has redemption restrictions. In the remaining Columns, the dependent variable is the euro change in cash holdings scaled by the fund's total net assets in Q4-2019. In Columns 3 and 4, Duration uses the continuous measure of combined redemption restrictions, whereas in Columns 5 to 9, the effect is broken down into notice period, redemption frequency and lockup period. The unit of observation is fund-quarter and standard errors are clustered at the fund level. The analysis is restricted to funds with net outflows. In Columns 1 to 6 the results are based on the full sample, while Columns 7 to 9 are based on the matched sample. All variables are defined in the Appendix. Standard errors are in parentheses. The ***, ** and * stand for significant coefficients at the 1%, 5%, and 10% levels, respectively.

	(1) CashHD	(2) CashHD	(3) ΔCash	(4) ΔCash	(5) ΔCash	(6) ΔCash	(7) ΔCash	(8) ΔCash	(9) ΔCash
March2020	0.24***	0.24***	0.08***	0.08***	0.09***		0.11***	0.11***	
	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)		(0.03)	(0.03)	
March2020 × Duration	-0.13***	-0.13***	-0.01**	-0.01**					
	(0.04)	(0.04)	(0.00)	(0.00)					
March2020 × Notice					-0.02***	-0.02***	-0.02***	-0.02***	-0.02***
					(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
March2020 × Lockup					-0.02**	0.00	-0.02*	-0.02**	-0.01
					(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
March2020 × RedFreq					0.00	-0.00	0.00	0.00	0.00
					(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
March2020 × PortIlliq	-0.00	-0.00	0.01*	0.01**	0.01**	0.00*	0.01*	0.01**	0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
March2020 × Cash	-0.39	-0.25	-0.28	-0.40	-0.42	-0.22	-0.84**	-0.91**	-0.85**
	(0.57)	(0.71)	(0.32)	(0.36)	(0.36)	(0.32)	(0.40)	(0.44)	(0.38)
March2020 × NetFlows	0.98***	1.02***	0.55**	0.59**	0.59**	0.51*	0.61***	0.73***	0.49**
	(0.21)	(0.28)	(0.27)	(0.30)	(0.30)	(0.29)	(0.20)	(0.23)	(0.21)
NetFlows	-0.07	-0.07	-0.22***	-0.30***	-0.30***	-0.22***	-0.11***	-0.15***	-0.11**
	(0.05)	(0.05)	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)	(0.05)	(0.04)
Cash	-1.62***	-1.88***	-0.72***	-1.22***	-1.22***	-0.73***	-0.85***	-1.52***	-0.87***
	(0.10)	(0.14)	(0.07)	(0.11)	(0.11)	(0.07)	(0.11)	(0.19)	(0.10)
PortIlliq	-0.00**	-0.00**	-0.00*	0.00**	0.00**	-0.00*	-0.00	0.00*	-0.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
LnNAV	-0.01***	-0.01***	-0.01***	-0.05***	-0.05***	-0.01***	-0.01***	-0.05***	-0.01***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
LnAge	0.02***	0.02***	0.01*	0.02*	0.02*	0.01**	0.01*	0.01	0.01*
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
LnLeverage	-0.02	-0.02	-0.02***	-0.06***	-0.06***	-0.03***	-0.02**	-0.07***	-0.02***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)
Duration	-0.01	-0.01	0.00	-0.00					
	(0.01)	(0.01)	(0.00)	(0.00)					
Notice					-0.00	0.00***	0.00**	-0.01	0.00**
					(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Lockup					-0.00	0.00	0.01	-0.00	0.01
					(0.00)	(0.00)	(0.01)	(0.01)	(0.01)
RedFreq					-0.00	-0.00	-0.00	-0.00	-0.00
					(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Investor Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged Flow	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lagged & cont. Return	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund FE				Yes	Yes			Yes	
Investor x Quarter FE						Yes			Yes
Matched Sample							Yes	Yes	Yes
Adj. R-squared	0.04	0.03	0.03	0.22	0.22	0.07	0.03	0.22	0.09
Observations	12359	12359	12359	12359	12359	12359	9998	9998	9998

6 Conclusion

This paper analyses the effectiveness of redemption restrictions in open-ended bond funds with a focus on the March 2020 market turmoil. Using granular information on contractual impediments to withdrawals based on supervisory reporting data of alternative investment funds investing in bonds, I find that redemption restrictions, in particular the notice period, significantly reduced investor outflows during the March 2020 stress period. Importantly, this reduction was not associated with higher outflows after the crisis, suggesting that redemption restrictions disincentivised withdrawals rather than merely postponing them. I also find that funds with redemption restrictions were less likely to hoard cash to meet redemption requests than funds without redemption restrictions. Instead, they drew more on their liquidity buffers, reducing the need for procyclical asset sales. Finally, over the entire sample period, I find that redemption restrictions reduce the sensitivity of outflows to poor performance without significantly affecting inflows during periods of good performance, suggesting that the restrictions address the fragility arising from investor withdrawals. These findings highlight the potential of redemption restrictions to enhance the resilience of open-ended bond funds. By mitigating investor outflows and fund managers' procyclical liquidity management, redemption restrictions can play a crucial role in reducing fund fragility and supporting financial stability during episodes of market stress.

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Annex

A.1 Variable names

In this appendix, I define the variables used in the analysis:

- *Duration* is the minimum time an investor must wait in order to withdraw the average euro invested in a fund (in days). It combines information on the note period, lockup period and redemption frequency.
- *Notice period* is the time investors need to wait to receive their redemptions (in days).
- *Lockup period* is the time investors need to wait to redeem their shares following their initial investment in the fund (in days).
- *Redemption frequency* is the frequency the fund allows investors to redeem their shares (in days).
- *Inflow* is the fund's inflows as a share of its lagged total net assets.
- *Outflow* is the fund's outflows as a share of its lagged total net assets.
- *Return* is the fund's return, in percent.
- *Cash* is the fund's cash holdings in percent of lagged total assets.
- *LnNAV* is the log of the net asset value of the fund.
- *LnAge* is the log of the fund's age, measured in years since its launch date.
- *PortIlliq* is the average time it takes a fund to liquidate its portfolio (in days).
- *LnLeverage* is the log of the fund's leverage ratio, calculated as assets under mangement over net asset value.
- *InvBanks* is the percent of assets under management that is held by banks.
- *InvGovernment* is the percent of assets under management that is held by government investors.
- *InvHouseholds* is the percent of assets under management that is held by households.

- *InvInsurance* is the percent of assets under management that is held by insurance companies.
- *InvNFC* is the percent of assets under management that is held by non-financial corporations.
- *InvFunds* is the percent of assets under management that is held by other investment funds.
- *InvOther* is the percent of assets under management that is held by other investors.

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For specific terminology please refer to the **ESRB glossary** (available in English only).

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