Safe Assets and Financial Fragility: Theory and Evidence*

Toni Ahnert† Marco Macchiavelli‡

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Abstract

How does the access to safe assets affect the fragility and lending behavior of financial intermediaries? We develop a global-game model of investor redemptions from money market funds that hold safe assets and fund risky corporate borrowers. Using the 2013 U.S. debt limit episode and the Federal Reserve's Overnight Reverse Repurchase (ONRRP) facility as our empirical laboratory, we provide evidence consistent with the model's implications. In particular, access to a safe asset—the ONRRP—attenuates investor redemption incentives and allows money market mutual funds to maintain their lending to corporate borrowers. Overall, our results suggest that the public provision of a safe asset reduces intermediary fragility and increases lending to the real economy.

JEL classification: G01, G23, E58.

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†Bank of Canada and CEPR, email: toni.ahnert@gmail.com

‡Federal Reserve Board, email: marco.macchiavelli@frb.gov

1 Introduction

Safe assets perform a critical role in the economy as medium of exchange and store of value. A recent literature—see Caballero et al. (2017) and Gorton (2017) for reviews—looks at several features and implications of safe assets, including the safety properties of government debt and how their scarce supply induces the private provision of safe assets. However, little is known about how the public provision of safe assets affects the fragility of intermediaries and their lending behavior in times of stress.

We seek to address these issues in this paper, focusing on an important type of intermediary: money market mutual funds (henceforth, money funds) that provide vital short-term funding to financial and non-financial corporations. On the one hand, the provision of safe assets can reduce the fragility of money funds, which in turn can lead to a more stable intermediation of funds to corporations. On the other hand, money funds may seek to boost their liquidity during a stress event by increasing their holdings of safe assets and lending less to corporations.

To study how the access to safe assets affects money funds, we first develop a global-games model of investor redemptions, building on Chen et al. (2010). Money funds hold safe assets and make risky lending to corporate borrowers. Investors decide whether to redeem their shares based on a noisy private signal about fund performance. A safe asset can be liquidated at no cost. One-sided strategic complementarity arises, whereby an investor's incentive to redeem *decreases* in the share of redeeming investors for low redemptions (i.e. when the available safe assets suffices to meet redemptions). Intuitively, sharing the pie among fewer investors in the future is beneficial to investors, inducing them not to redeem. Conversely for high redemptions, costly liquidation of risky assets makes an investor's incentive to redeem increase in the share of redeeming investors, resulting in the usual complementarity.

To deal with one-sided strategic complementarity, we apply the methods developed in Goldstein and Pauzner (2005) to derive a unique equilibrium and obtain three testable implications. First, investors are less likely to run on money funds with access to safe assets, reducing financial fragility. A safe asset incurs no liquidation cost, so a redeeming investor imposes a lower negative externality on other investors, reducing their redemption incentives as a result.[1] Second, the effect on fragility is larger when more investors are active (i.e. decide whether to redeem) and thus the degree of strategic complementarity is higher. Third, funds with access to a safe asset maintain more of their lending to corporate borrowers in times of stress, due to both the lower fragility of such funds and the lower liquidation costs of safe assets.

We next test the model's three implications and find supportive evidence. Our empirical laboratory is the period surrounding a significant stress event in money markets: the 2013 U.S. debt limit episode that, by chance, occurred right after the introduction of the Federal Reserve's Overnight Reverse Repurchase (ONRRP) facility. The ONRPP facility was introduced in September 2013 when overnight rates were at zero. The purpose of the facility was to offer safe assets (overnight reverse repos) at an administered rate so as to exert better control on short-term rates when the Federal Reserve were to lift rates from zero (FOMC 2014, Frost et al. 2015). To provide better interest rate control, a broad range of market participants, including *qualifying* money funds, were allowed to participate. ONRRPs are the safest available asset because they are secured by the safest collateral, Treasuries, have no counterparty risk (the Federal Reserve is the borrower), and mature the next day.

[1] In the empirical analysis we use a 2013 sample, that is before the 2016 money fund reform that introduced floating NAVs for institutional prime funds. Under these circumstances, a given redemption at fixed NAV imposes a negative externality on other investors when redemptions cause liquidation costs, e.g. due to transaction costs or market illiquidity.

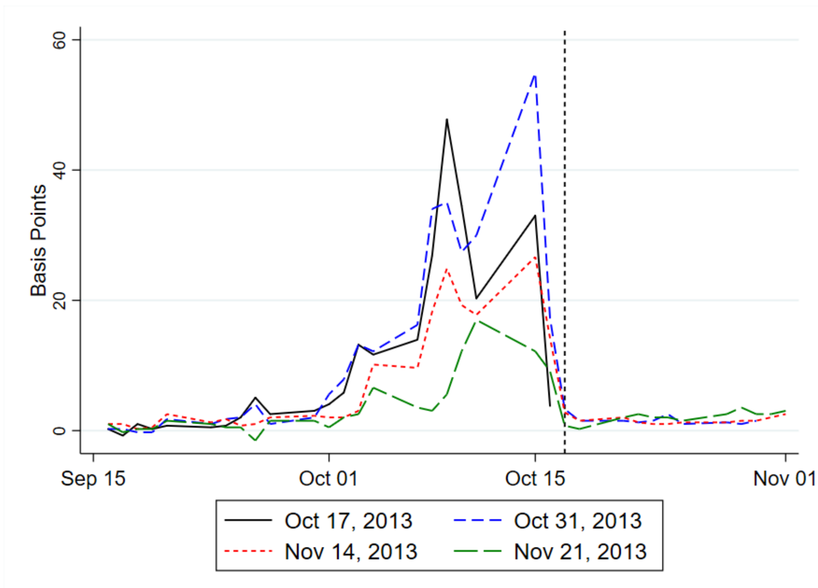
There are two main identification challenges in bringing the model to the data. First, access to safe assets (the ONRRP facility in our case) is not random. However, we exploit the fact that around the launch of the ONRRP in September 2013, there exists a group of money funds that are technically eligible to participate, but since they did not satisfy the eligibility criteria at the last application deadline in September 2012, they do not have access to the facility in 2013. As a result, we can construct a control group that would have participated in the ONRRP if it had been able to apply more recently.[2] We then compare the behavior of this control group to treated funds of similar size. Second, we need an exogenous stress event that occurs after the introduction of the ONRRP but before more money funds are allowed to apply again (November 2014). The event that satisfies these conditions is the U.S. debt limit episode that unfolded in October 2013. The combination of the staggered participation in the ONRRP and the U.S. debt limit episode provide a natural laboratory to study the effect of the provision of safe assets on money markets.

Using the 2013 debt limit as the stress event, we trace money funds' risk exposures to the Treasury securities affected by the debt limit. Yields on Treasury securities with payments scheduled shortly after mid-October increased markedly because of the possibility that Congress would not pass legislation to raise the debt limit in time. The market did not expect an outright default by the U.S. government. Instead, investors priced the possibility of a delay in principal and interest payments scheduled between mid-October and mid-November (see Figure 1). We call these Treasuries at risk of delayed payments "at-risk securities" or "risk exposures". Treasuries are usually considered to be the safest available assets (e.g., Krishnamurthy and Vissing-Jorgensen 2012). Around several debt limit episodes, however, Treasuries ex-

[2] See Section 4 for more details about ONRRP eligibility and the construction of treatment and control groups.

perience a sharp drop in price and become costly to liquidate. Around the October 2013 episode in particular, ONRRP is the safest asset available to *some* money funds.

Figure 1: **Bill yields around the 2013 debt limit episode.** This figure shows the yield (in basis points) of some of the Treasury bills maturing around the 2013 debt limit episode. To reduce clutter, we do not display the at-risk bills maturing on Oct 24, 2013 and Nov 7, 2013, nor at-risk bonds with coupon payments due between October 17 and November 22, 2013. The vertical dashed black line represents Oct 17, 2013, the "breach date". As the maturity date of the bills moves further past the breach date, the spike in yields is reduced, indicating that markets priced the possibility of a delay in payments on Treasury securities.



Using a difference-in-difference-like approach, we find evidence supportive of the model's implications. We first document that money funds with access to the ONRRP (treated funds) are less fragile than control funds. That is, treated funds experience fewer outflows in response to at-risk exposures during the debt limit episode. Consistent with the model's mechanism, access to a safe asset allows treated funds to accommodate redemption by not rolling over ONRRP investments with the Federal Reserve without incurring any fire-sale loss. This, in turn, generates fewer outflows and less of a need for liquidating safe assets in the first place. Second, we find that the effect of access to the ONRRP is more pronounced for the more active institutional investors relative to retail investors (Schmidt et al. 2016). Third, treated funds maintain more of their lending to risky corporate borrowers during the stress episode than control funds.

Identification rests on both the exogeneity of at-risk exposures and the lack of any systematically relevant difference between funds in the treatment and control groups. We address both endogeneity concerns by conducting several checks. Regarding the exogeneity of at-risk exposures, we show that neither being an ONRRP counterparty nor the general risk profile of the fund is correlated with at-risk exposures ex ante (before the stress event). However, it might still be the case that funds with no exposure to at-risk Treasuries possess better managerial skills and thus stay away from those securities. If so, we would expect to observe a positive and significant correlation between at-risk exposures during the 2011 debt limit episode and at-risk exposures for the 2013 episode. However, the two variables are uncorrelated, suggesting that managerial skill is unlikely to drive our results.

Another potential concern is that money funds that are ONRRP counterparties in 2013 are systematically less sensitive to runs than other funds for reasons unrelated to the access to safe assets. To address this concern, we exploit the fact that no ONRRP facility exists during the 2011 debt limit episode. We show that funds that are ONRRP counterparties in 2013 are actually more sensitive to the 2011 debt limit episode than other funds. If anything, this finding strengthens our results.

We refer to the ONRRP offered by the Federal Reserve as safe in order to distinguish them from the other triparty repos offered by private firms, namely broker-dealers. For a combination of collateral and counterparty risks,[3] these private triparty

[3]It is important to remember that repos backed by even the safest collateral are still subject to counterparty risk, and therefore there are various degrees of safety even for repos backed by the same Treasury collateral. Indeed, Lehman lost access even to triparty repos backed by Treasury

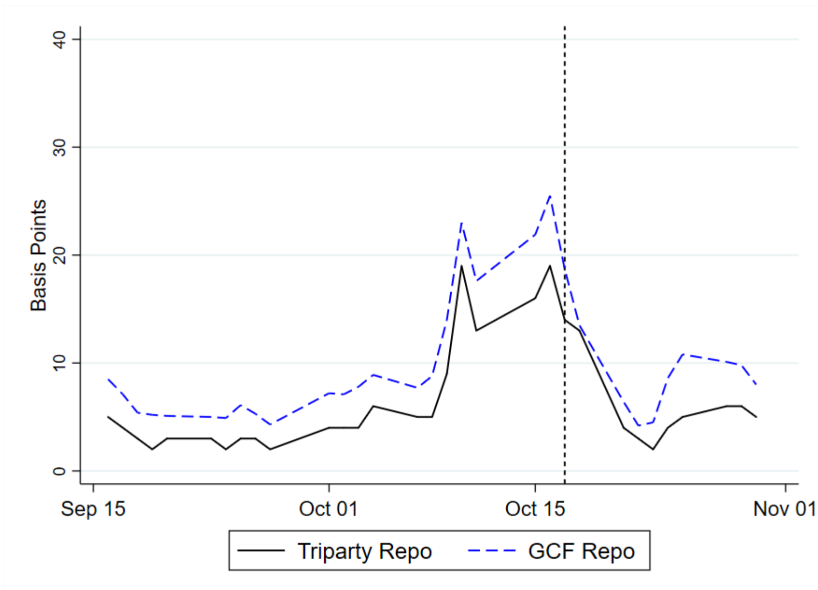
repos become risky during the 2013 debt limit episode: while the ONRRP facility offers an interest rate of one basis point throughout the episode, rates on triparty repos backed by Treasuries go from two basis points on September 27 to 19 basis points on October 16 at the height of the debt limit episode, before retracing to two basis points on October 23 (see Figure 2). Interdealer repos, where typically smaller dealers and hedge funds borrow from larger dealers, follow a similar pattern: the GCF Treasury repo rate went from four basis points on September 27 to 25 basis points on October 16. In sum, ONRRP are completely safe throughout the debt limit episode while private repos are not.

Literature. To the best of our knowledge, ours is the first paper to shed light on the financial intermediation and stability effects of providing safe assets to money funds during financial stress. On the theoretical side, Chen et al. (2010) develop a model of investor redemptions from mutual funds using global-games methods of Morris and Shin (2003). They show that strategic complementarity among investors result in the fragility of mutual funds. We build on this model and allow for asset heterogeneity, whereby mutual funds hold both safe and risky assets, and study the implications for the fragility of the fund, its ability to maintain intermediation to the real economy, and the role of investor sophistication. Since safe assets make the redemption choices of investors one-sided strategic complements, we apply the global games methods of Goldstein and Pauzner (2005) to derive a unique equilibrium.

On the empirical side, McCabe (2010), Kacperczyk and Schnabl (2013), and Strahan and Tanyeri (2015) document the interplay of money funds' outflows and

collateral. Copeland et al. (2014) suggest two explanations for this pattern: first, upon the default of the triparty repo borrower, the money fund that lends money against general Treasury collateral may receive a Treasury security which the money fund is unable to hold because it exceeds the 13-months residual maturity limit imposed by SEC rules. Second, a money fund manager may be afraid of facing investors' redemptions that could be triggered if the fund makes the headlines of a news story that associates it with the failing dealer–headline risk.

Figure 2: **Repo rates around the 2013 debt limit episode.** This figure shows two different repo rates around the 2013 debt limit episode. The solid black line represents the rate on triparty treasury repos with overnight tenor, and similarly the dashed blue line displays the rate on GCF treasury repos with overnight tenor. GCF repo is a blind-brokered, interdealer repo market cleared by FICC that operates on the triparty platform. The GCF repo market mainly consists of smaller dealers borrowing from the larger dealers that have a broader access to repo funding. The vertical dashed black line represents Oct 17, 2013, the "breach date", at which point Treasury was expected to run out of cash. The 2013 debt limit episode was resolved just one day prior, on Oct 16, 2013.



risk-taking around Lehman's collapse. Chernenko and Sunderam (2014) show the importance of relationships in money markets during financial stress. Schmidt et al. (2016) illustrate the interactions of retail and institutional investors in money funds after the bankruptcy of Lehman Brothers. Goldstein et al. (2017) show that redemptions from corporate bond funds are more sensitive to the underperformance of the fund during financial stress. We complement these studies by analyzing the effect of the public provision of a safe asset to money funds on fragility and intermediation.

Our work is also related to the safe assets literature. Most of the literature has focused on the supply of safe assets by the Treasury and by financial firms via short-term debt (Gorton 2017, Krishnamurthy and Vissing-Jorgensen 2012, 2015, Sunderam

2014, Kacperczyk et al. 2017, Greenwood et al. 2010, 2015). Our complementary focus is on the provision of safe repos by the Federal Reserve and its effects on money funds.

There is a nascent literature on the effects of ONRRP. While our focus is on financial intermediation and stability implications, see Martin et al. (2019) for a theory of monetary policy implementation through the ONRRP. Anderson and Kandrac (2017) show that introducing the ONRRP facility has a pricing impact in the triparty repo market by improving the bargaining power of money funds with ONRRP access.

2 Model and hypotheses

In the Appendix, we develop a model in which safe assets held by mutual funds affect investor redemptions, building on Chen et al. (2010). Funds hold safe assets and risky assets (mostly by lending to riskier corporate borrowers). Risky assets have a higher expected return but are costly to liquidate if the fund needs to meet large redemptions. Treated funds hold ONRPP as a safe asset and face no cost of liquidation, while control funds use Treasuries as safe assets that were somewhat costly to liquidate during the debt limit episode, as shown in the introduction. Introducing a safe asset into mutual funds' portfolios leads to one-sided strategic complementarity in redemption decisions. That is, the incentives to redeem increase in the proportion of redeeming investors only when redemptions are high enough such that some risky assets are liquidated. We use the global-games methods developed in Goldstein and Pauzner (2005) to solve for a unique equilibrium and derive three hypotheses.

Hypothesis 1 *Funds with access to a safe asset are less fragile. That is, treated funds experience smaller outflows in response to at-risk exposures during the debt* *limit episode than control funds.*

Intuitively, funds that have access to a safe asset do not incur the cost of liquidation during the debt limit episode. Investors who withdraw are initially served by liquidating (or not renewing) ONRRP, which is costless. Thus, these investors do not impose a negative externality on investors who stay in the (treated) fund. In contrast, investors who withdraw from funds without access to a safe asset cause some liquidation costs and thus impose a negative externality on investors who stay in the (control) fund. As a result, a fund with access to a safe asset can meet more redemptions before having to liquidate the risky asset.

When redemptions impose a negative externality on other investors, an investor's withdrawal incentive increases in the proportion of withdrawing investors. This generates self-fulfilling redemptions. Since treated funds are less exposed to this mechanism, they are less fragile. Hence, fewer investors redeem for a given amount of risk exposure. We next describe how the magnitude of this effect depends on investor sophistication.

Hypothesis 2 *Fund fragility increases in the degree of investor sophistication. Moreover, the access to a safe asset reduces fragility by more when investor sophistication is high.*

Investor sophistication is modeled as the fraction of investors making a redemption decision (while the remainder is passive), following Schmidt et al. (2016). Its empirical counterpart is the share of institutional investors (as opposed to retail investors). For the range of redemptions in which liquidation is costly, a larger proportion of active investors increases a given investor's concern about other investors withdrawing and causing a negative externality. This increases a given investor's incentive to redeem and, as a result, the higher degree of strategic complementarity in redemption decisions raises fund fragility. Since access to a safe asset reduces the degree of these redemption complementarities, the impact of the safe asset is higher for a larger share of sophisticated investors.

Hypothesis 3 *Funds with access to a safe asset liquidate less in expectation. That is, treated funds maintain more of their lending to riskier corporate borrowers during the debt limit episode than control funds.*

Intuitively, treated funds liquidate fewer of their risky assets than control funds in expectation, which is for two reasons. First, if Hypothesis 1 holds, treated funds are less fragile, so large-scale redemptions occur less often for treated funds. Second, for any given amount of redemptions, the amount liquidated is lower because the access to a safe asset reduces the cost of liquidation. Both effects combine and result in lower average liquidations by treated funds. In other words, treated funds maintain more lending to riskier borrowers during the debt limit episode than control funds.

3 Data and Background

In this section we introduce the data set and provide some background on the 2013 debt limit episode in the U.S. and the ONRRP facility offered by the Federal Reserve. Our data set is the result of merging four different data sources: iMoneyNet weekly data, N-MFP month-end filings, MSPD reports, and confidential daily ONRRP data.

First, iMoneyNet contains weekly data on assets under management and yields at the share-class level, and fund-level data on asset holdings, yields, and liquidity measures. Money funds offer rights (shares) on the same pool of assets to different investors (retail and institutional), with differing fee structures. At the fund level, asset holdings are broken down in several categories, including Treasuries, agency debt, repos, domestic and foreign bank obligations, first-tier and second-tier commercial paper, and asset-backed commercial paper. As a measure of fund profitability, we use the annualized gross yield. As a measure of fund liquidity, we use the percentage of assets with residual maturity of seven days or less.

Second, N-MFP month-end filings contain information on the assets held by each fund as of the last business day of the month. We use this information to compute the percentage of assets invested in "at-risk" Treasuries, namely the Treasury securities that are at risk of delayed payments during the 2013 debt limit episode. To identify the specific Treasury securities with principal or interest payments at risk of being delayed (October 17 to November 22), we use information from the third data set, the monthly statement of the public debt (MSPD) available on TreasuryDirect.

Debt limit episode. The debt limit is a limit on the amount of money that the U.S. government can borrow from the public. Once reached, Congress has the option to suspend the debt limit until a later date. However, if Congress does not act in time, the Treasury can invoke a debt issuance suspension period (DISP) which makes certain extraordinary measures to borrow additional funds available (typically, withholding transfers to certain government trust funds). These extraordinary measures, together with the current cash balances are used to meet current payments. Usually, the Treasury Secretary informs Congress about the date at which the extraordinary measures are expected to run out (the "breach date").

In May 2013, after the previous debt limit suspension expires, Treasury Secretary Lew declares a DISP and starts using extraordinary measures to meet federal obligations (Cashin et al. 2017, Austin 2019). Secretary Lew indicates on August 2 that the extraordinary measures can be extended to last until October 11, in light of stronger fiscal revenues. On August 26, he updates Congress that the extraordinary measures would be exhausted in mid-October. Then, in a September 25 communication, Treasury indicates that it expects to exhaust its borrowing capacity on October 17, at which point it would have only $30 billion in cash to meet current obligations. When Congress could not pass a budget deal and on September 30, the government shuts down. This acts as a wake-up call to markets that the standoff in Congress may even delay a timely resolution of the debt limit. As a result, yields on Treasury securities with payments shortly after October 17 increase (see Figure 1). On October 16, in the third week of the shutdown, Congress passes a budget deal that includes the suspension of the debt limit, ultimately putting an end to the debt limit episode.

ONRRP. As the final data source, we use confidential fund-level investments (take-up) at the ONRRP facility operated by the New York Fed. At the July 2013 FOMC meeting, participants discussed the possibility of offering reverse repos to a broad set of cash investors, such as money market funds (Frost et al. 2015). With ONRRP access, a money fund can lend cash overnight to the New York Fed and obtain Treasuries as collateral. Historically, the Federal Reserve has conducted open market operations, including repos and reverse repos with Treasury and agency collateral, with the primary dealers. The purpose of enlarging the set of ONRRP counterparties from the usual set of primary dealers to include money market funds is unrelated to possible developments surrounding the 2013 debt limit. Instead, its purpose was to test the extent of interest rate control in light of a possible future tightening of monetary policy (Frost et al. 2015, Ihrig et al. 2015). Daily ONRRP operations start on September 23, 2013. Initially, the offered interest rate is one basis point and the individual cap is $500 million. The offered rate increases to two basis points on October 21, 2013 as a way of testing both the sensitivity of take-up to rate changes and the extent of interest rate control. The individual cap is raised to $1 billion on September 27, 2013 and stays at that level for the rest of our sample.

During mid-2013 the overall U.S. Money fund industry manages about $3.2 trillion, with $1.9 trillion in prime funds and $1 trillion in government (agency and Treasury) funds. In this paper, we focus solely on prime money funds due to their ability to invest in a wider range of debt instruments, which is crucial to meaningfully measure their extent of risk-taking. Government money funds, on the other hand, can only invest in government debt and repos backed by government debt. Panel A of Table 1 shows some statistics for the sample of all prime funds surrounding the 2013 debt limit episode. As also shown in Figure 3, prime funds' flows turn from mildly positive prior to October 2013 to negative during the debt limit episode. At-risk exposures are mechanically smaller in the pre-stress period because at the beginning of that period some at-risk bills were not issued yet. Other variables tend to be quite stable around the debt limit episode.

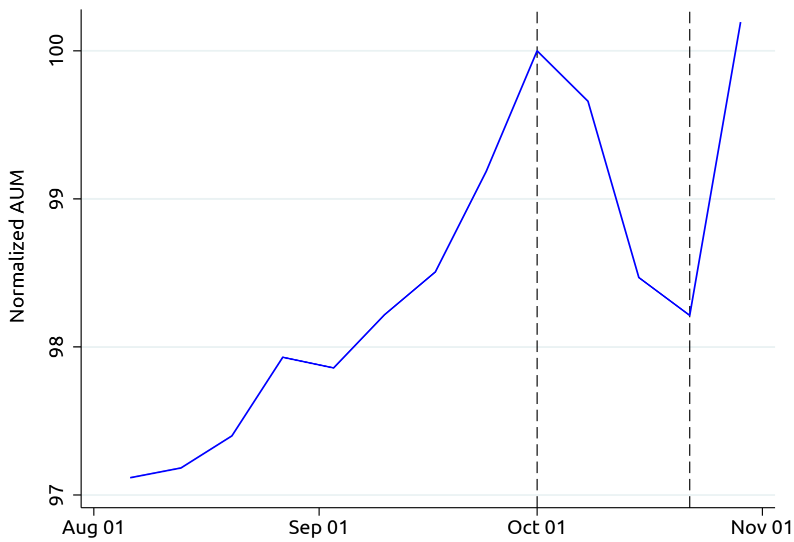
4 Identification and Results

We start by describing the construction of the main variables as well as the control and treatment groups. On October 1, 2013, a week after the ONRRP facility started its daily operations, the U.S. federal government shutdown begins and Treasury reaffirms that extraordinary measures would be exhausted no later than October 17, the breach date. At that point, with no additional borrowing capacity, Treasury would only have about $30 billion to meet current payments. The shutdown serves as a wake-up call to

Table 1: **Summary statistics: pre-crisis vs crisis.** The sample is at the fund-week level. AUM is the assets under management of the fund, in $ billion. Flows is the weekly percentage change in the fund's AUM. Yield is the gross annualized yield in basis points. Mat7d is the percentage of the fund assets maturing in 7 days or less. Repo and Treasuries are the percentage of assets invested in repos and Treasuries, respectively. AtRisk is the percentage invested in at-risk securities, namely those Treasuries with principal or interest payments between October 17 and November 22, 2013. Prime Risk is the percentage invested in ABCP, foreign bank obligations, and second-tier CP. Panel A includes all prime funds while Panels B and C include only the prime funds in Sample 2 (repo-capable prime funds with AUM between $4 and $8 billion); those in the treatment group are ONRRP counterparties while those in the control group are not.

	Pre-crisis (Jul 1 – Sep 30)					Crisis (Oct 1 – Oct 16)				
	Obs.	Mean	St.Dev.	p(25)	p(75)	Obs.	Mean	St.Dev.	p(25)	p(75)
Panel A: All Prime Funds										
AUM	2046	7.93	18.71	0.34	6.52	462	8.19	19.36	0.37	6.92
Flows	2046	0.05	4.40	-0.95	0.89	462	-0.21	3.96	-1.13	0.85
Yield	2045	18.78	5.28	16	23	462	18.60	5.22	15	22
Mat7d	2025	42.09	16.68	33	47	458	41.40	15.62	33	46
Repo	2046	12.93	12.60	4	18	462	13.64	12.92	4	19
Treasuries	2046	4.78	6.75	0	8	462	4.88	7.49	0	7
AtRisk	2037	0.87	1.65	0	1.34	462	1.79	5.08	0	2
PrimeRisk	2046	25.07	15.20	13	36	462	24.62	14.62	15	35
Panel B: Treatment Group, Sample 2 (12 funds)										
AUM	130	5.45	1.67	3.71	6.59	36	5.22	2.22	3.37	6.86
Flows	130	-0.15	2.90	-1.06	0.51	36	-0.53	3.92	-1.75	0.74
Yield	130	19.95	3.95	17	22	36	19.67	3.30	17	22
Mat7d	130	35.2	12.98	30	42	36	36.31	10.32	32	44
Repo	130	13.07	10.63	6	21	36	13.72	9.70	7.5	18
Treasuries	130	5.76	4.43	0	10	36	5.89	4.23	1.5	9.5
AtRisk	130	1.20	1.42	0	2.71	36	1.21	1.31	0	2.43
PrimeRisk	130	29.92	10.65	26	37	36	30.58	9.85	28	36
Panel C: Control Group, Sample 2 (8 funds)										
AUM	112	5.53	1.36	4.17	6.75	24	5.80	1.37	4.83	6.96
Flows	112	1.18	6.05	-1.03	2.85	24	-1.34	3.58	-2.29	0.43
Yield	112	22.23	3.04	20	24	24	22.38	3.44	19	25
Mat7d	112	40.58	9.41	33	44	24	40.42	9.12	32	45.5
Repo	112	7.36	6.01	0	11	24	6.21	5.60	0	11
Treasuries	112	2.05	2.65	0	4	24	3.67	5.39	0	4
AtRisk	112	0.39	0.73	0	0.54	24	0.5	0.77	0	1.04
PrimeRisk	112	33.84	17.31	24	47	24	33.75	16.59	27	46.5

Figure 3: **Prime funds' assets around the 2013 debt limit episode.** This figure shows the evolution of prime funds' assets under management (AUMs) around the 2013 debt limit episode. Prime AUMs in blue are normalized to equal 100 on Oct 01, 2013, the beginning of the debt limit episode period. The first and second vertical dashed lines represent the beginning of the debt limit episode (Oct 01, 2013) and the first day in the post-debt limit episode period (Oct 22, 2013), respectively.



markets that Treasury securities with principal or interest payments due soon after October 17, 2013 could enter a technical default due to a delay in payments until new legislation would suspend the debt limit. The Treasury securities that display spikes in yields following October 1, 2013 are those with either principal or interest payments due between October 17 and November 22, 2013, as shown in Figure 1. We refer to these Treasuries as at-risk securities. While they are fully fungible with other Treasury bills prior to October 1, they become a source of risk for money funds at the onset of the debt limit episode (as they sell at a discount).

We first analyze at the fund level how the sensitivity of outflows to at-risk securities depends on whether or not a fund has access to the ONRRP facility. Since ONRRP counterparties are different from other funds, we restrict our sample to funds that are essentially identical other than for the fact that some are ONRRP counterparties while others are not.

Even though daily ONRRP operations start on September 23, 2013, the New York Fed had previously conducted a few test operations with some eligible money funds. From February 1, 2011 onwards, the most stringent initial eligibility criteria are as follows: a fund needs to have assets under management (AUM) of no less than \$5 billion for the most recent six months (measured at each month-end) and it has to be a consistent investor in the triparty repo market. The last date prior to October 2013 in which money funds could apply to become counterparties is in September 2012.[4] We then restrict our sample of ONRRP counterparties, the treatment group, to prime money funds with AUM between \$5 and \$10 billion as of September 30, 2013. On the other hand, our control group consists of prime money funds that did not satisfy the two above-mentioned requirements in 2012 but do so in September 2013 and, at the same time, report AUM between \$5 and \$10 billion as of September 30, 2013. Funds belonging to the control group would have applied to become ONRRP counterparties in 2013 had they been allowed to do so. Indeed, virtually all of these funds become counterparties later on once applications are allowed again in November 2014.[5]

The sample of funds in the treatment and control groups that satisfy these requirements we call "Sample 1". For robustness, we use two additional samples with different AUM windows: "Sample 2" keeps funds capable of triparty repo transactions and AUM between \$4 and \$8 billion; "Sample 3" keeps funds capable of triparty repo transactions and AUM between \$5 and \$8 billion. Therefore, money funds in both

[4]Information on ONRRP eligibility criteria, application deadlines, and the list of eligible funds is obtained from https://www.newyorkfed.org/markets/rrp_announcements.

[5]There is only one fund in the control group that is not a counterparty in 2014. This is because the fund's AUM declines to just below the minimum AUM requirement sometime between October 2013 and November 2014 and therefore loses its eligibility.

treatment and control groups have similar size as of September 2013 and are both able to operate on the triparty repo platform. This last feature is important because some prime money funds purposefully decide not to invest in triparty repos as they seek exposures to maturity and counterparty risk to boost yields, and repos limit such exposures. As a result, requiring the control group to consist of money funds that additionally invest in triparty repos implies that we are comparing money funds with similar risk profiles. As a precaution, we still control for lagged yield and size.

Panels B and C of Table 1 provide summary statistics for the treatment and control groups in Sample 2. Relative to funds in the control group, those in the treatment group have 2 basis points lower yields in part due to their greater allocations to repos (13% instead of 7%) and slightly lower allocations to riskier assets (30% average PrimeRisk for the treated funds istead of 34% for the control funds). Treated funds have higher average exposures to at-risk securities relative to control funds, which, if any, works against our finding that treated funds are less sensitive to at-risk exposures. Using public N-MFP data, we estimate that the average allocation to ONRRP of all the ONRRP-eligible prime funds is 3.2% of assets, while the average allocation for the treated funds in Sample 2 is 4.7%, out of a total allocation to repo of 13%. Due to the well documented month-end deveraging in Treasury repos by foreign dealers (Anbil and Senyuz 2018, Munyan 2017), the month-end allocations to ONRRP by money funds overestimate the average allocations throughout the month.

We acknowledge that in our setting, as in many other studies, there is a trade-off between identification and sample size. In our case, we prefer to have a cleaner identification that relies on funds in the control group being virtually ONRRP-eligible had there been an application window in 2013. Since this requires picking funds around or just above the $5 billion eligibility threshold, the cleaner identification comes at the cost of a relatively small sample size.

4.1 Fund fragility and run-risk

Under **Hypothesis 1**, funds with access to a safe asset are less sensitive to risk exposures. To assess whether the ONRRP facility reduces the sensitivity of flows to risk exposures, we run the following diff-in-diff-style panel regression at the fund level:

$$
\begin{aligned}
Flow_{i,t} = &\beta_1 AtRisk_{i,t-1} + \beta_2 Treat \cdot AtRisk_{i,t-1} + \beta_3 Crisis \cdot AtRisk_{i,t-1} \\
&+ \beta_4 Treat \cdot Crisis \cdot AtRisk_{i,t-1} + \gamma X_{i,t-1} + \mu_i + \mu_t + \varepsilon_{i,t} \qquad (1)
\end{aligned}
$$

where $Flow_{i,t}$ is the weekly percentage change in AUM at the fund level, $AtRisk_{i,t-1}$ is the percentage of the fund's assets invested in Treasury securities with either principal or interest payments scheduled between October 17 and November 22, 2013.[6] $Treat$ equals one for prime funds in the treatment group, while the omitted group consists of prime funds in the control group (both described above). $Crisis$ equals one during the 2013 debt limit episode (October 1 to October 16, 2013). $X_{i,t-1}$ is a set of lagged controls that include gross simple yields (Yield), the logarithm of the fund's AUM (Size), the fund's weighted average maturity of assets (WAM), and the share of assets invested in Treasuries.

We control for yields to allow for a well-documented flow-performance feedback, whereby past performance influences current flows (Ippolito 1992, Sirri and Tufano 1998, Del Guercio and Tkac 2002, Chen et al. 2010, Goldstein et al. 2017). We also

[6] Data regarding the fund-specific exposure to at-risk securities comes from end-of-month N-MFP reports. For each fund, $AtRisk_{i,t-1}$ is constant within the month. We use its lag so as to incorporate information that pertains to the month that just ended.

Table 2: **Flows sensitivity around the 2013 debt limit.** The sample contains information on prime funds at the fund-week level and goes from July 1 to October 16, 2013. Sample 1 keeps funds capable of repo transactions, with AUM between $ 5 and $ 10 billion as of September 30, 2013; Sample 2 keeps repo-capable funds with AUM between $ 4 and $ 8 billion as of September 30, 2013; finally, Sample 3 keeps repo-capable funds with AUM between $ 5 and $ 8 billion as of September 30, 2013. The dependent variable, Flows, is the weekly percentage change in the AUM of a fund. Crisis equals one from October 1, 2013 to October 16, 2013. Treat equals one if a fund is an ONRRP counterparty. AtRisk is the lagged percentage of assets invested in at-risk Treasuries. Controls is a set of lagged controls, including gross yields, log of AUM, WAM, and the share of assets invested in Treasuries. Fund and week fixed effects are included in all regressions. Standard errors clustered at the family level in parentheses; ***,**,* indicate statistical significance at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Sample 1		Sample 2		Sample 3	
	Dependent variable: Flows					
Crisis · AtRisk	-3.074***	-1.317*	-2.286***	-1.724**	-3.142***	-1.603**
	(0.290)	(0.669)	(0.518)	(0.773)	(0.351)	(0.733)
Crisis · Treat · AtRisk	3.091***	1.620**	2.269***	2.035***	3.043***	1.821**
	(0.321)	(0.627)	(0.469)	(0.689)	(0.356)	(0.650)
N	331	331	302	302	246	246
R^2	0.102	0.136	0.115	0.152	0.139	0.168
Controls	No	Yes	No	Yes	No	Yes

allow for size effects, even if our treatment and control groups are already of similar size by construction. Next, we control for the fund's WAM since it is a proxy for the maturity risk taken by the fund. One may argue that funds with higher at-risk exposures are those that generally hold more Treasury securities. To account for the heterogeneity in Treasury holdings so that our results come from the actual Treasuries at risk of delayed payments and not the overall investments in Treasuries, we control for the share of assets invested in Treasuries. Finally, μ_i and μ_t are a set of fund and week fixed effects that control for unobserved fund characteristics and aggregate shocks, respectively. Errors are clustered at the fund family level. If at-risk exposures drive outflows during the debt limit episode, we expect $\beta_3 < 0$. In addition, if access to the ONRRP facility insulates flows from risk exposures we expect $\beta_4 > 0$.

Consistent with **Hypothesis 1**, the provision of a safe asset reduces the sensitivity of outflows to risk exposures. Indeed, Table 2 shows that during the debt limit episode, funds with access to the ONRRP facility are significantly less sensitive to risk exposures than similar funds without such access. For instance, in column (4) the additional sensitivity of outflows to at-risk exposures during the crisis is -1.7 for the control group, while it equals 0.3 $(2 - 1.7)$ for the treatment group. Both the sensitivity of the control group and the incremental sensitivity of the treatment group are statistically significant at the 5% level.

In terms of economic magnitude, an interquartile range increase in at-risk exposures during the debt limit crisis leads to additional outflows by 1.7 percentage points in the control group $(-1.7 \cdot 1)$, which is equivalent to 60% of the interquartile range of outflows for the control group (2.7). On the other hand, the same increase in at-risk exposures leads to an insignificant and small increase in flows for the treatment group (10% of the interquartile range of flows for the treatment group). The estimated elasticities vary somewhat across samples and specifications, but in all of them the additional elasticity of the treatment group fully offsets the negative sensitivity of the control group. In other words, having access to safe assets isolates fund flows from risk exposures, reducing fund fragility.

Each money fund can manage its assets on behalf of both retail and institutional investors, the latter being more active and risk sensitive (Schmidt et al. 2016) in their decisions to allocate cash to money funds. We account for this heterogeneity in investor behavior in Table 3, by splitting money fund flows between retail and institutional share-classes. Consistent with **Hypothesis 2**, the results of Table 3 show that the sensitivities of outflows to at-risk exposures are two to three times larger for institutional investors relative to retail ones. Moreover, the reduced sensitivity to risk exposures in the treatment group is more pronounced for the more sophisticated institutional investors. These results are consistent with the model's mechanism, whereby

Table 3: **Flows sensitivity: institutional vs retail.** The sample contains information on prime funds at the share-class-week level and goes from July 1 to October 16, 2013. Samples 1, 2 and 3 are defined as in Table 2. The dependent variable, Share-Class Flows, is the weekly percentage change in the AUM of a fund's share class (retail or institutional). Retail and Instit identify retail and institutional share-classes, respectively. Crisis equals one from October 1, 2013 to October 16, 2013. Treat equals one if a fund is an ONRRP counterparty. AtRisk is the lagged percentage of assets invested in at-risk Treasuries. Controls is a set of lagged controls, including gross yields, log of AUM, WAM, the share of assets invested in Treasuries. Fund, institutional, and week fixed effects are included in all regressions. Standard errors clustered at the family level in parentheses; ***,**,* indicate statistical significance at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Sample 1		Sample 2		Sample 3	
	Dependent variable: Share-Class Flows					
Retail · Crisis · AtRisk	-2.464***	-2.563**	-0.754*	-0.529	-2.192***	-1.497
	(0.441)	(1.118)	(0.388)	(0.713)	(0.412)	(0.916)
Retail · Crisis · Treat · AtRisk	2.718***	2.834***	1.070***	0.879	2.588***	1.956**
	(0.290)	(0.944)	(0.299)	(0.630)	(0.366)	(0.865)
Instit · Crisis · AtRisk	-5.395***	-5.846***	-2.204**	-2.766***	-4.914***	-4.975***
	(0.595)	(1.001)	(0.881)	(0.772)	(0.448)	(0.396)
Instit · Crisis · Treat · AtRisk	6.086***	7.186***	2.590**	3.635***	5.537***	6.260***
	(0.560)	(0.930)	(0.934)	(0.991)	(0.384)	(0.610)
N	966	966	834	834	658	658
R^2	0.032	0.038	0.038	0.046	0.044	0.056
Controls	No	Yes	No	Yes	No	Yes

a larger share of active investors increases the degree of strategic complementarity in investor redemption choices, while access to a safe asset reduces it.

4.2 Intermediation to risky borrowers

We next ask how access to a safe asset affects the degree of intermediation to risky corporate borrowers during stress episodes. As before, we focus on prime funds since, differently from government funds, they invest in a wide range of instruments with various risk profiles. Prime funds indeed provide both secured and unsecured funding to banks, dealers, and non-financial corporations.

We build a weekly prime-fund-specific measure of risk-taking, called $PrimeRisk$, by adding up the portfolio shares of asset-backed commercial paper (ABCP), second-tier commercial paper (A2/P2), and foreign bank obligations (FBO). The latter are unsecured certificates of deposit issued by foreign banks. These three investment classes are considered the riskiest and least liquid investments available to prime funds.[7] To estimate the differential effect of exposure to at-risk securities on risk-taking for treated and control funds, we run the following regression:

$$PrimeRisk_{i,t} = \beta_1 AtRisk_{i,t-1} + \beta_2 Treat \cdot AtRisk_{i,t-1} + \beta_3 Crisis \cdot AtRisk_{i,t-1} + \beta_4 Treat \cdot Crisis \cdot AtRisk_{i,t-1} + \gamma X_{i,t-1} + \mu_i + \mu_t + \varepsilon_{i,t} \quad (2)$$

where all variables other than $PrimeRisk$ are defined in Section 4.1. As before, errors are clustered at the fund family level. **Hypothesis 3** predicts that funds exposed to at-risk Treasuries would reduce lending to risky borrowers by less if they have access to the ONRRP facility ($\beta_3 < 0$, $\beta_4 > 0$), i.e. maintaining more lending to the real economy.

Table 4 shows that larger at-risk exposures are associated with significantly more intermediation to risky borrowers for ONRRP counterparties relative to the funds in the control group ($\hat{\beta}_3 < 0$, $\hat{\beta}_4 > 0$). The estimated elasticities in Samples 1 and 3 are of similar magnitudes, while those pertaining to Sample 2 are significantly lower in absolute value. Nevertheless, the relevant finding is that, across all specifications, the additional coefficient for the treatment group during the crisis ($\hat{\beta}_4$) fully offsets the negative effect of at-risk exposures on risk-taking for the control group ($\hat{\beta}_3$).

Economically, the intermediate estimates of Sample 1 (column (2)) suggest that an interquartile range increase in at-risk exposures (1.6 for Sample 1) during the debt

[7] See Covitz et al. (2013), and Kacperczyk and Schnabl (2013) regarding the riskiness of ABCP, and Chernenko and Sunderam (2014) regarding the run on Eurozone banks, a very large part of the foreign banks issuing FBOs. Second-tier commercial paper is the lowest quality of commercial paper that money funds can invest in by SEC rules.

Table 4: **Risk taking around the 2013 debt limit.** The sample contains information on prime funds at the fund-week level and goes from July 1 to October 16, 2013. Samples 1, 2 and 3 are defined as in Table 2. The dependent variable, Prime Risk, is the percentage of assets invested in ABCP, foreign bank obligations, and second-tier CP. Crisis equals one from October 1, 2013 to October 16, 2013. Treat equals one if a fund is an ONRRP counterparty. AtRisk is the lagged percentage of assets invested in at-risk Treasuries. Controls is a set of lagged controls, including gross yields, log of AUM, WAM, and the share of assets invested in Treasuries. Fund and week fixed effects are included in all regressions. Standard errors clustered at the family level in parentheses; ***,**,* indicate statistical significance at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Sample 1		Sample 2		Sample 3	
	Dependent variable: Prime Risk					
Crisis · AtRisk	-4.932***	-5.228***	-1.471	-1.275	-5.158***	-6.266***
	(0.338)	(0.850)	(0.990)	(1.066)	(0.378)	(0.721)
Crisis · Treat · AtRisk	5.170***	5.408***	1.637*	1.519*	5.154***	6.172***
	(0.187)	(0.678)	(0.830)	(0.770)	(0.217)	(0.525)
N	331	331	302	302	246	246
R^2	0.962	0.962	0.963	0.963	0.970	0.971
Controls	No	Yes	No	Yes	No	Yes

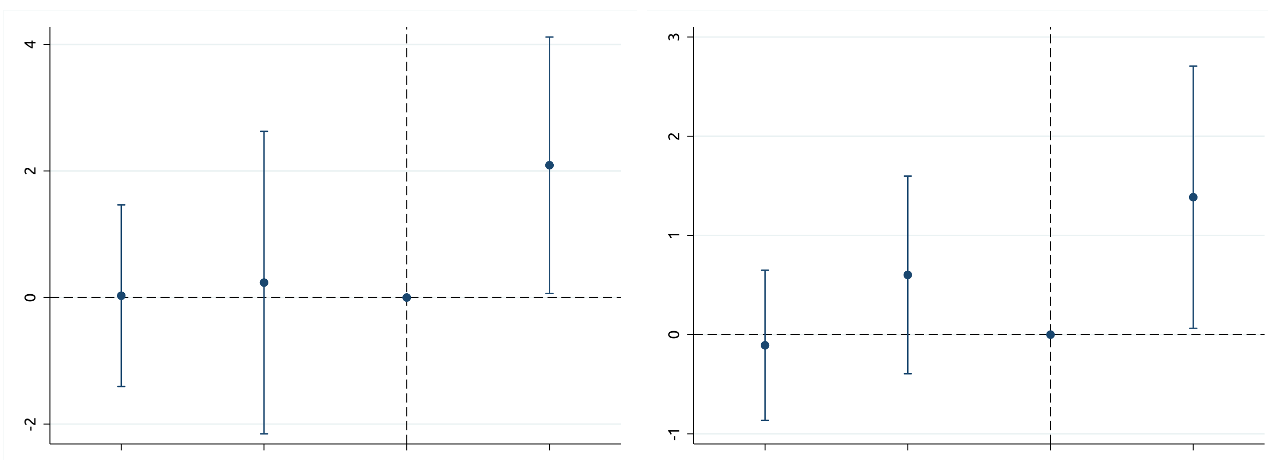
limit episode leads to a decline in $PrimeRisk$ by 8 percentage points $(1.6 \cdot 5.2)$, which is equivalent to 40% of the interquartile range of $PrimeRisk$ for the control group (20 for Sample 1). On the other hand, the same increase in at-risk exposures leads to a negligible and statistically insignificant increase in $PrimeRisk$ for the treatment group (3% of the interquartile range of $PrimeRisk$ for the Sample 1 treatment group). This suggests that the ONRRP facility enables its money funds counterparties to continue intermediating liquidity even to the riskier borrowers during periods of stress, especially when such stress is not due to an impairment in these borrowers' creditworthiness. Recall that the shock is to the safety of Treasuries instead, resulting in liquidation cost in the stress episode. In sum, the ONRRP facility supports lending to risky borrowers during a stress episode, consistent with the model's prediction.

4.3 Robustness checks

In this section we seek to alleviate concerns that our findings may be driven by alternative channels. Specifically, we check for parallel trends; provide more evidence for the lack of a flight to ONRRPs during the 2013 debt limit episode; mitigate concerns regarding the endogeneity of at-risk exposures; and finally conduct some placebo tests exploiting the 2011 debt limit episode which occurred pre-ONRRP.

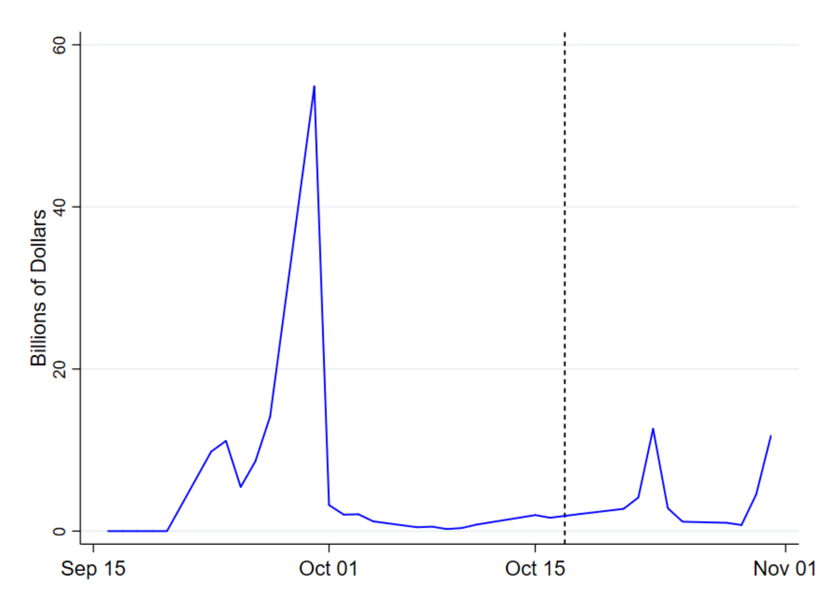
Figure 4: **Flow sensitivity and risk taking, parallel trends.** This figure shows selected coefficients from the estimation of Equation (1), with the additional variables $T(-3) \times AtRisk$, $T(-2) \times AtRisk$, $T(-3) \times Treat \times AtRisk$, and $T(-2) \times Treat \times AtRisk$. By dividing the eight pre-crisis weeks in four subperiods, $T(-2)$ and $T(-3)$ are indicator variables for the two intermediate pre-crisis subperiods (Borusyak and Jaravel 2017). The dependent variables are Flows in panel (a) and Prime Risk in panel (b). In each panel, the first two coefficients represent the additional sensitivity of flows to at-risk exposures for treated funds in the two intermediate subperiods of the pre-crisis period, $T(-3) \times Treat \times AtRisk$ and $T(-2) \times Treat \times AtRisk$. The omitted groups in the pre-crisis period are the first two and the last two weeks pre-crisis. The vertical dashed line represents the start of the crisis. The additional flow sensitivity for the treated funds during the crisis, $Crisis \times Treat \times AtRisk$, is represented by the last coefficient. The insignificance of the first two coefficients suggests a lack of pre-trends in the sensitivity of flows to at-risk exposures.

(a) Flow sensitivity (b) Risk taking



Our results are not driven by pre-existing trends that continued over the debt limit episode. Indeed, following Borusyak and Jaravel (2017), Figure 4 shows that the parallel trends assumption seems to hold in the data. Specifically, in panel (a) the sensitivity of flows to at-risk Treasuries is not significantly different between treated and control funds before the 2013 debt limit episode unfolds (the vertical dashed line). Notice that the at-risk Treasuries are not risky before the start of the debt limit episode, as shown in Figure 1. Similarly, in panel (b) the significantly greater lending to riskier counterparts in response to at-risk exposures for funds in the treated group only materializes at the onset of the debt limit episode.

Figure 5: **ONRRP Take-up around the 2013 debt limit.** This figure shows the total ONRRP take-up by money funds (both government and prime) around the 2013 debt limit episode. The vertical dashed line represents Oct 17, 2013, the "breach date". ONRRP take-up remains low during the debt limit episode. The spike in take-up on September 30 is completely unrelated to the debt limit episode. On the contrary, it is explained by the window dressing behavior of foreign dealers (Anbil and Senyuz 2018, Munyan 2017). Some foreign implementations of the Basel III supplementary leverage ratio are computed using only quarter-end snapshots, and some foreign dealers deleverage on those reporting dates by reducing their triparty treasury repo borrowings. Money funds respond to the lack of demand by foreign dealers at quarter-end by increasing investments at the ONRRP. As foreign dealers return to the repo market the following day, ONRRP take-up declines accordingly.



The fact that treated funds maintained lending to riskier borrowers during the debt limit episode is also evident from the dynamics of aggregate ONRRP take-up shown in Figure 5. Apart from the quarter-end spike in take-up that is solely due to foreign dealers' window dressing behavior (Anbil and Senyuz 2018, Munyan 2017) which forces money funds to place additional cash at the ONRRP, take-up remains low and flat during the debt limit episode.[8]

Moreover, in Table 5 we show the results of regressing the share of assets invested in ONRRPs on at-risk securities and other controls, for the subset of prime money funds with access to the facility. Before the debt limit episode, at-risk Treasuries, which at that point are not risky yet, are not significantly associated with ONRRP take-up. During the episode, funds with more risky exposures display higher ONRRP take-up, even though the additional effect is not statisitically significant. This suggests that indeed there was no clear flight to the ONRRP facility during the debt limit episode.

Table 5: **Determinants of ONRRP take-up.** The daily sample contains information on the prime funds that are Fed counterparties at the fund-day level and goes from September 23 (beginning of ONRRP) to October 16, 2013. Crisis goes from October 1, 2013 to October 16, 2013. The weekly sample uses weekly averages of the variables used in the daily sample. The dependent variable, ONRRP/AUM, is the share of fund's assets invested in ONRRP. Crisis equals one from October 1, 2013 to October 16, 2013. AtRisk is the lagged percentage of assets invested in at-risk Treasuries. Time FE refers to daily dummies for the daily sample and weekly dummies for the weekly sample. Controls is a set of lagged controls, including gross yields, log of AUM, WAM, and the share of assets invested in Treasuries. Fund and time fixed effects are included in all regressions. Standard errors clustered at the family level in parentheses; ***,**,* indicate statistical significance at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)
	Dep. var.: ONRRP/AUM			
Crisis · AtRisk	0.842	0.791	0.522	0.516
	(0.529)	(0.588)	(0.316)	(0.397)
N	646	646	190	190
R^2	0.168	0.190	0.254	0.297
Controls	No	Yes	No	Yes
Sample	Daily		Weekly	

[8]Foreign dealers subject to Supplementary Leverage Ratio (SLR) implementations that require reporting of quarter-end balance sheet snapshots drop their treasury repo borrowings at quarter-ends in order to display less leverage. As they deleverage, they demand less repo funding from money funds, which in turn place the surplus cash at the ONRRP facility (Anbil and Senyuz 2018).

Table 6: **Persistence of at-risk exposures across episodes.** The sample is a cross-section of all prime funds. We regress the share of at-risk securities each fund held prior to the 2013 debt limit episode on the share of at-risk securities it held during the 2011 episode. Specifically, the dependent variables are the share of securities at risk during the 2013 episode held in July 2013 (columns (1) and (2)), August 2013 (columns (3) and (4)), and September 2013 (columns (5) and (6)). Columns (1), (3), and (5) employ OLS estimators while columns (2), (4), and (6) use a Tobit model, with the dependent variable left-censored at zero. The marginal effects of the Tobit models are displayed in the bottom two rows of the table. Standard errors clustered at the family level in parentheses; ***,**,* indicate statistical significance at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	(OLS)	(Tobit)	(OLS)	(Tobit)	(OLS)	(Tobit)
Dep. var.:	$\text{AtRisk}_{jul'13}$		$\text{AtRisk}_{aug'13}$		$\text{AtRisk}_{sep'13}$	
$\text{AtRisk}_{jul'11}$	0.094	0.148	0.103	0.203	0.005	0.186
	(0.081)	(0.170)	(0.090)	(0.210)	(0.104)	(0.359)
N	156	156	156	156	156	156
	Tobit: marginal effects					
$dP(y > 0)/dx$		0.017		0.019		0.008
		(0.018)		(0.020)		(0.016)
$dE(y \mid y > 0)/dx$		0.045		0.062		0.055
		(0.051)		(0.063)		(0.105)

The 2013 debt limit episode unfolded during the early stages of the ONRRP facility and, at that time, funds faced an individual ONRRP cap of $1 billion, significantly smaller than the more recent $30 billion individual cap. However, for the prime funds in our treatment groups (with assets between $4 and $10 billion), the cap is actually a sizable fraction of assets, and none of these funds ever reaches the cap during the debt limit episode.

Next, Tables 6 and 7 mitigate additional concerns regarding the selection of at-risk Treasuries by riskier funds or less sophisticated funds. Table 6 shows that the probability of holding at-risk Treasuries during the 2013 debt limit episode is uncorrelated with how many at-risk securities a fund held during the 2011 debt limit episode.[9] The zero correlation between at-risk exposures in the two debt limit episodes

[9]The main timeline of the 2011 debt limit episode is as follows: the debt limit episode starts on July 14, 2011 when Moody's puts the U.S. government on review for a downgrade, at which point yields on at-risk Treasuries start to increase. The date on which Treasury's borrowing capacity would be exhausted (the breach date) is August 2, 2011. Exactly on that date, the debt limit is resolved with a budget resolution that increases the debt limit. The Treasuries whose pricing is affected by the 2011 debt limit are those with either principal or interest payments between the August 2 breach

Table 7: **Determinants of 2013 at-risk exposures.** The sample is a cross-section of prime funds: in columns (1) and (2) we keep all prime funds while in columns (3) and (4) we keep prime funds with AUM greater than \$5 billion. We regress the share of at-risk securities each fund held at the end of September 2013 on several lagged regressors: Treasuries is the percentage of assets invested in Treasuries; FED CP is a dummy equal to one if a fund is an ONRRP counterparty; Yield is the gross yield in basis points; Flows is the weekly percentage change in the fund's AUM; Prime Risk is the percentage invested in ABCP, foreign bank obligations and second-tier CP; finally, WAM is the fund's weighted average maturity of its assets. Standard errors clustered at the family level in parentheses; ***,**,* indicate statistical significance at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)
	Dependent variable: AtRisk			
Treasuries_{t-1}	0.313***	0.263***	0.208***	0.183***
	(0.102)	(0.079)	(0.021)	(0.024)
FED CP	-0.728	-0.544	0.055	0.131
	(0.476)	(0.468)	(0.293)	(0.303)
Yield_{t-1}		-8.754*		-3.111
		(5.047)		(2.986)
Flows_{t-1}		0.026		0.043
		(0.048)		(0.034)
PrimeRisk_{t-1}		-0.017		-0.015
		(0.026)		(0.012)
WAM_{t-1}		0.050*		0.010
		(0.028)		(0.011)
N	156	156	47	47
R^2	0.198	0.214	0.658	0.691
Sample	All Prime		Prime, AUM> 5 bln	

mitigates the concern that our results could be driven by selection bias, whereby funds with better managerial skills consistently stay away from at-risk securities– which would imply a positive correlation. The zero correlation is also inconsistent with the possibility that funds with higher 2011 exposures subsequently reduce their 2013 exposures, as this learning would lead to a negative correlation.

Finally, Table 7 documents that the only fund-level characteristic that is significantly correlated with at-risk Treasury holdings is the overall amount of Treasuries held: the coefficients show that on average around 20% of Treasury holdings are made up of at-risk Treasuries. This is not surprising and is consistent with the fact that an ex-ante random portion of a money fund's Treasury holdings becomes risky dur-

date and the expected resolution date of September 9. Those are the at-risk Treasuries for the 2011 debt limit episode.

ing the debt limit episode. In addition, liquidating such risky Treasuries would not have been worthwhile as they were trading at fire-sale prices that might have caused significant losses if sold (see Figure 1). Notice that we control for the lagged share of Treasury holdings in our main findings of Tables 2, 3, and 4. Importantly, Table 7 also shows that at-risk exposures are not correlated with the status of being an ONRRP counterparty, nor with our measure of risk-taking by prime money funds, $PrimeRisk$.

The lower flow sensitivity of ONRRP counterparties previously documented in Tables 2 and 3 could be due not just to the provision of safe assets by the ONRRP facility, but also to an "imprimatur" or certification effect. That is, the perception that ONRRP counterparties could be safer than other funds just because the Federal Reserve has approved them as trading counterparties. In order to disentangle the two effects, we exploit the 2011 debt limit episode and compare the flow sensitivity of funds that were ONRRP counterparties in 2011 with that of other funds. Notice that in 2011 the Federal Reserve did not conduct daily ONRRP operations, but only infrequent test operations with some eligible money funds. These 2011 counterparties were therefore approved by the Federal Reserve, but they did not have access to ONRRP investments during the 2011 debt limit episode, making this the ideal laboratory to test for an imprimatur effect. Specifically, the imprimatur hypothesis predicts that the flow sensitivity to at-risk exposures is lower for ONRRP counterparties than for other funds, even if the former cannot take advantage of ONRRP investments. The 2011 debt limit unfolded in a similar fashion as the 2013 episode (see footnote 9). On July 14, 2011 Moody's puts the U.S. government on a downward review and yields on Treasuries with payments between the August 2 breach date and September 9 are affected. These are the at-risk securities for the 2011 episode. The debt limit episode

Table 8: **Imprimatur Effect (?) and Placebo (2011).** The sample includes information on all prime funds at the fund-week level and goes from May 3 to August 2, 2011. The dependent variable, Flows, is the percentage change in a fund's AUM. During the 2011 episode considered in this table, Crisis goes from July 14, 2011 to August 2, 2011. Treat '11 identifies funds that belong to the New York Fed reverse repo counterparty list as of May 2011 (the same prime funds appear in the July 2011 list). Similarly, Treat '13 identifies funds that are ONRRP counterparties around the 2013 debt limit episode. AtRisk is the percentage of assets invested in Treasuries with principal or interest payments at risk of being delayed (between August 2 and September 9, 2011). Controls is a set of lagged controls, including gross yields, log of AUM, WAM, and the share of assets invested in Treasuries. Fund and week fixed effects are included in all regressions. Standard errors clustered at the family level in parentheses; ***,**,* indicate statistical significance at 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)	(4)
	Dependent variable: Flows			
Crisis · AtRisk	0.172*	0.175*	0.0761	0.0566
	(0.093)	(0.097)	(0.199)	(0.212)
Crisis · Treat '11 · AtRisk	-0.381***	-0.304***		
	(0.111)	(0.111)		
Crisis · Treat '13 · AtRisk			-0.642*	-0.442
			(0.331)	(0.315)
N	2548	2545	2548	2545
R^2	0.078	0.083	0.081	0.089
Controls	No	Yes	No	Yes

that started on July 14 is then resolved by Congress exactly on the breach date.

In Table 8, columns (1) and (2) show that the sensitivity of outflows to risk exposures is higher for the 2011 ONRRP counterparties than for other funds. Thus, we find evidence against the imprimatur effect. The main results of Tables 2 and 3 are then likely driven by the availability of a safe asset to ONRRP counterparties. Finally, the placebo regressions in columns (3) and (4) dismiss any additional concern that the results in Table 2 are due to the fact that those funds that in 2013 are ONRRP counterparties intrinsically have flows that are less sensitive to risk exposures. Indeed, columns (3) and (4) show that, if any, the funds that in 2013 are ONRRP counterparties are more sensitive to risk exposures during the 2011 debt limit episode.

Finally, we have a few thoughts on external validity. In this paper we study an instance of stress due to the deterioration in credit quality of U.S. Treasury securities, which is not necessarily comparable to a shock such as the collapse of Lehman Brothers. However, we believe that the differential behaviors (documented in the paper) of ONRRP counterparties relative to non-counterparties should still persist even in the presence of a different shock. Indeed, money fund investors tend to run from funds with larger exposures to risk, whichever the risk is in the specific circumstance. As a result, money funds have an incentive to improve the liquidity of their assets so as to be able to accommodate current and future redemptions. Therefore, we expect that our findings that treated funds are less prone to run-risk and are able to maintain their lending to corporate borrowers carries through to other stress scenarios.

5 Conclusion

We have studied how access to safe assets affects the fragility and lending behavior of financial intermediaries. We have developed a global-game model of investor redemptions from money market mutual funds that hold publicly provided safe assets and lend to risky corporate borrowers. Since the safe asset can be liquidated at no cost, access to it reduces the fragility of the fund and allows it to maintain more lending to the real economy. The model highlights a mechanism whereby safe asset reduce the redemption incentives of investors because of a lower negative externality imposed on other investors and, thus, a lesser concern about the redemptions of other investors.

We find evidence in the data to support the model's implications. We use the staggered introduction of the Federal Reserve's ONRRP facility and the 2013 U.S. debt limit episode as our empirical laboratory. This timing allows us to compare similar money funds that only differ in their access to a safe asset—the ONRRP—

while there was a shock to the liquidation costs of some Treasury securities. In sum, access to the ONRRP reduces the run-risk of money funds in response their exposure to at-risk Treasuries and allows these funds to keep funding more risky corporate borrowers during this stress event.

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Appendix

A Theoretical Model

We develop a model of the effect of safe assets on redemptions from mutual funds. Specifically, we incorporate a safe asset into the mutual fund runs model of Chen et al. (2010), resulting in one-sided strategic complementarity in redemption decisions. We use the global-games methods developed in Goldstein and Pauzner (2005) to solve for the unique equilibrium and derive three hypotheses.

There are two dates $t = 1, 2$, one good, and universal risk neutrality. Investors consume at either date. Prior to $t = 1$, each investor from a continuum $[0, 1]$ holds one share in a mutual fund, where the total amount of investment is normalized to 1. Prior to $t = 1$, funds invested $S \in (0, 1)$ in a safe asset and $1 - S$ in a risky asset that we interpret as lending to riskier borrowers. In the context of money market mutual funds studied, these are commercial paper, certificate of deposits, and bills. Safe assets are heterogeneous across funds: treated funds (T) were eligible for ONRRP from the Federal Reserve prior to $t = 1$ and hold these as a safe asset, so their cost of liquidation is $\eta_T = 0$. Control funds were ineligible for ONRRP and hold Treasuries as safe assets. While Treasuries are normally very safe and liquid assets, they become costly to liquidate during the debt limit episode. Accordingly, we interpret $t = 1$ as the beginning of the debt limit episode, so the cost of liquidation is positive at this particular time, $\eta_C > 0$. The cost of liquidation of risky assets is $\lambda > \eta_C$. Consistent with our timing interpretation, the liquidation costs $(\eta_T, \eta_C, \lambda)$ are commonly known at $t = 1$.

The fund generates returns at $t = 1$ and $t = 2$. The return on the safe asset is normalized to 1 at each date. The gross return on the risky asset is R_1 at $t = 1$, which is commonly known. At $t = 1$ each investor decides whether to withdraw their money (by redeeming their share). We assume that only a fraction $\overline{N} \in \left(0, \frac{1}{1+\lambda}\right)$ of all investors make a withdrawal choice.[10] We interpret $\overline{N}$ as a measure of investor sophistication, as in Schmidt et al. (2016). Since the fund is always solvent, investors withdrawing at $t = 1$ receive the current value per share

$$\pi_1 \equiv S + (1 - S)R_1. \tag{3}$$

The fact that redemptions impose a negative externality on the investors who stay in the fund is captured by funds having to sell assets to meet redemptions. Due to illiquidity, generated by transaction costs or asymmetric information, a fund needs to sell $1 + \lambda$ units of the risky asset to receive one unit of funds. A pecking order is optimal, whereby a fund sells safe assets first in order to meet redemptions, because only $1 + \eta$ units of the safe asset have to be sold to receive one unit of funds. For simplicity, we abstract from fund inflows. We also assume that redeeming investors do not bear a portion of the liquidation cost.[11]

Let $R_2(\theta)$ be the gross return on the risky asset at $t = 2$, where R_2 strictly increases in the fundamental of the fund θ realized at $t = 1$, which captures its ability to generate high future returns. It can be related to the skill of the fund manager or the strength of the investment strategy or both. We assume a uniform distribution: $\theta \sim \mathcal{U}[-B, B]$ for some $B > 0$. The payoffs to investors who stay in the fund at $t = 1$

[10] This simplifying assumption ensures that the fund is always solvent, ruling out the additional complications arising from bankruptcy—see Goldstein and Pauzner (2005) for an analysis of these issues.

[11] Consistent with this assumption, changes to NAV rules occurred after the period of investigation.

depend on whether the safe asset suffices to meet redemptions at $t = 1$. We consider each of these cases in turn.

Case 1: few withdrawals ($N \leq \underline{N}$)**.** In this case, only safe assets are liquidated, which is at cost $1 + \eta$ per unit, with $\eta_T = 0 < \eta_C$. Thus withdrawals worth $\frac{S}{1+\eta}$ can be met. Since withdrawing investors each receive π_1 at $t = 1$ and the fund is always solvent to meet these redemptions, we have $\underline{N} \equiv \frac{S}{(1+\eta)\pi_1}$. Since, $\eta_T < \eta_C$, a treated fund can meet more withdrawals without liquidating the risky asset than a control fund, $\underline{N}_T > \underline{N}_C$. We turn to the payoff of investors staying in the fund at $t = 1$. The cumulative return of the risky asset, of which the funds holds $1 - S$, is $R_1 R_2(\theta)$ at $t = 2$. With few withdrawals, some safe asset remain at $t = 2$, $S - (1 + \eta)N\pi_1$. All proceeds of the fund are shared among the remaining $1 - N$ investors. Thus, the payoff at $t = 2$ to investors staying with the fund at $t = 1$ is

$$\pi_2(\theta, N) \equiv \frac{(1 - S)R_1 R_2(\theta) + S - (1 + \eta)N\pi_1}{1 - N}. \tag{4}$$

The net payoff from not withdrawing is $v(\theta, N) \equiv \pi_2(\theta, N) - \pi_1$. The condition $\eta_C < \frac{(1-S)R_1(R_2(\theta)-1)}{\pi_1}$ suffices for the net payoff from not redeeming to *increase* in the proportion of all investors withdrawing, $\frac{dv}{dN} > 0$, for $N \leq \underline{N}$. In words, more withdrawals are good for non-withdrawing investors as long as withdrawals are small enough (strategic substitutability). Intuitively, more withdrawals have two opposing effects. First, the fund returns at $t = 2$ are shared with fewer investors, which increases the incentives to wait. Second, more withdrawals lead to some liquidation costs (for control funds) borne by non-withdrawing investors, which increases the incentives to withdraw. For a low liquidation cost, the first effect dominates.

Case 2: many withdrawals ($\underline{N} < N$)**.** In this case, all safe assets are exhausted and the residual amount required to meet redemptions, $N\pi_1 - \frac{S}{1+\eta}$, triggers costly liquidation of risky assets, forgoing the return R_2. Thus, the payoff to non-withdrawing investors is

$$\pi_2(\theta, N) \equiv \frac{(1-S)R_1 R_2(\theta) - (1+\lambda)\left(N\pi_1 - \frac{S}{1+\eta}\right) R_2(\theta)}{1-N}. \tag{5}$$

Thus, there is strategic complementarity among investors once the risky asset is liquidated, $\frac{dv}{dN} < 0$, so the incentive to withdraw increases in the proportion of investors withdrawing.

Taken together, there is one-sided strategic complementarity in the withdrawal incentives of investors. If the fundamental θ were commonly known at $t = 1$, we obtain dominance bounds that solve $R_2(\underline{\theta}) = 1$ and $R_2(\overline{\theta}) = \frac{(1-\overline{N})\pi_1}{(1-S)R_1[1-(1+\lambda)\overline{N}]+S(1+\lambda)\left(\frac{1}{1+\eta}-\overline{N}\right)}$.[12] That is, an investor strictly prefers to withdraw for $\theta < \underline{\theta}$ even if no other investor withdraws, $N = 0$. Similarly, an investor prefers to stay for $\theta > \overline{\theta}$ even if all other investors withdraw, $N = \overline{N}$.

We use the global-games methods proposed by Goldstein and Pauzner (2005) to obtain a unique equilibrium. Specifically, the fundamental of the fund θ is not common knowledge at $t = 1$. Instead, each investor i receives a noisy signal

$$\theta_i = \theta + \epsilon_i, \tag{6}$$

where $\epsilon_i \sim \mathcal{U}[-\epsilon, \epsilon]$ is an i.i.d. noise term that is also independent of θ. For example, all investors see some common information about the fund (e.g. some rating) but have slightly different interpretations of it, generating different assessments captured by θ_i.

[12] Note that $\overline{\theta} > \underline{\theta}$ is ensured by $S < \frac{1+\eta}{\lambda-\eta}\lambda\overline{N}\pi_1$, which we assume henceforth.

There is a unique equilibrium characterized by a threshold θ^*, whereby each investor withdraws if and only if $\theta_i < \theta^*$ (threshold strategy). Since we heavily rely on Goldstein and Pauzner (2005), we only sketch the proof here, going through a few key steps. Let $\alpha \in [0,1]$ be the proportion of investors withdrawing (out of $\overline{N}$): $N \equiv \overline{N}\alpha$. First, given the realized θ and the threshold θ^* (to be determined), we have

$$N(\theta, \theta^*) = \overline{N} \begin{cases} 1 & \theta \leq \theta^* - \epsilon \\ \frac{1}{2} + \frac{\theta^* - \theta}{2\epsilon} & \text{if} \quad \theta^* - \epsilon \leq \theta \leq \theta^* + \epsilon \\ 0 & \theta \geq \theta^* + \epsilon \end{cases} \tag{7}$$

by a law of large numbers. Also note that $2\epsilon d\alpha = -d\theta$, which we will use later.

Second, the payoff difference is $v(\theta, N) = \pi_2 - \pi_1$ for each of the two cases, where v is continuous at $\underline{N}$. The posterior is $\theta|\theta_i \sim \mathcal{U}[\theta_i - \epsilon, \theta_i + \epsilon]$, so the expected payoff difference is

$$\Delta(\theta_i, \theta^*) \equiv \int_{\theta_i - \epsilon}^{\theta_i + \epsilon} v(\theta, N(\theta, \theta^*)) \frac{d\theta}{2\epsilon}. \tag{8}$$

The threshold equilibrium implies that $\Delta(\theta^*, \theta^*) = 0$. Changing the variable of integration from θ to α, using $2\epsilon d\alpha = -d\theta$, and taking the limit of $\epsilon \to 0$ (that we impose henceforth) yields the run threshold θ^* implicitly defined by $f(\theta^*) = 0$:

$$\begin{aligned} 0 = f(\theta^*) \quad &= \quad \int_0^{\underline{N}/\overline{N}} \frac{(1-S)R_1(R_2(\theta^*) - 1) - \eta\pi_1\alpha\overline{N}}{1 - \alpha\overline{N}} d\alpha + \cdots \\ &\quad \cdots + \int_{\underline{N}/\overline{N}}^1 \left(\frac{R_2(\theta^*)}{1 - \alpha\overline{N}} \left[(1-S)R_1 + S\frac{1+\lambda}{1+\eta} - (1+\lambda)\alpha\overline{N} \right] - \pi_1 \right) d\alpha \end{aligned} \tag{9}$$

Note that $\frac{df(\theta^*)}{d\theta^*} > 0$ and $\frac{df(\theta^*)}{d\eta} < 0$. Therefore, the implicit function theorem yields $\frac{d\theta^*}{d\eta} > 0$, which is the basis for our first hypothesis. Specifically, $\eta_T < \eta_C$, so we have

$$\theta_T^* < \theta_C^*. \tag{10}$$

In words, treated funds (T) are less fragile than control funds (C).

Moreover, $R_1 < 1 + \lambda$ suffices for $\frac{d\theta^*}{d\overline{N}} > 0$ at $S = 0$. Therefore, under two conditions described below, we obtain

$$\frac{d\theta^*}{d\overline{N}} > 0, \tag{11}$$

which is the basis of our second hypothesis. These conditions are (i) $R_1 < 1 + \lambda$ (to ensure strategic complementarity) and (ii) a small enough S. The latter is consistent with our weekly sample from June 2013 to January 2014: the safe asset share is 16% (median) with a standard deviation of 13%, where this share is Treasuries and repos as a fraction of AUM.

Finally, we calculate the expected liquidation volume at $t = 1$. The probability of a run is $\Pr\{\theta < \theta^*\} = \frac{\theta^*+B}{2B}$ and the proportion of investors withdrawing (for $\epsilon \to 0$) is $N(\theta, \theta^*) = \overline{N}\,\mathbf{1}_{\{\theta<\theta^*\}}$. Thus, the amount liquidated for $\theta < \theta^*$ is $(1 + \lambda)\left(\overline{N}\pi_1 - \frac{S}{1+\eta}\right)$. Taken together, the expected liquidation volume is $ELV \equiv \frac{\theta^*+B}{2B}(1 + \lambda)\left(\overline{N}\pi_1 - \frac{S}{1+\eta}\right)$, which is lower for treated funds and is the basis of our third hypothesis.

$$ELV_T < ELV_C. \tag{12}$$