Frictions in Shadow Banking: Evidence from the Lending Behavior of Money Market Funds*

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Abstract

We document frictions in money market fund lending that can lead to the transmission of distress across borrowers. Using a novel data set of security-level holdings of prime money market funds, we show that funds with large exposures to Eurozone banks suffered large outflows between June and August 2011. Due to credit market frictions these outflows have significant spillover effects on other firms: non-European issuers that typically rely on these funds raise less total financing from money funds in this period. The results are not driven by issuers' riskiness or exposure to Europe: for the same issuer, money market funds with high exposure to Eurozone banks cut their lending more than other funds. We show that relationships are important in short-term credit markets so that these spillovers cannot be seamlessly offset, even though issuers are large, highly rated firms. In particular, funds with low Eurozone exposure attempt to provide substitute financing but only to issuers with which they have pre-existing relationships.

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1 Introduction

In the aftermath of the financial crisis, risk taking by non-bank financial intermediaries has been heavily scrutinized. Writing before the crisis, Rajan (2006) warned that delegated investment management can create strong incentives for excessive risk taking by non-bank financial intermediaries "searching for yield". Since the crisis, the idea that risk taking at "shadow banks" may be distorted by a variety of regulatory frictions and incentive problems has gained prominence among both policymakers and academics.[1] A critical unanswered question is whether this risk taking can have adverse consequences, disrupting the ability of creditworthy firms to raise financing and invest. In this paper, we provide evidence that such disruptions do occur because there are significant frictions in shadow bank lending.

Frictions in lending are central to the our understanding of how traditional banks affect the broader economy. As the long literature on the bank lending channel suggests, traditional banks maintain relationships with bank-dependent firms, which tend to be small and opaque, to mitigate frictions due to asymmetric information. These frictions can impede the ability of bank-dependent firms to substitute to other sources of financing when their bank experiences difficulties. As a result, distress may be transmitted across firms—problems at one group of firms can impair lender balance sheets, restricting the supply of credit to other creditworthy firms.[2] Thus, when a bank makes a risky loan to a firm with a high probability of distress, it increases the probability that the other firms it lends to suffer a credit supply shock.

The literature has long drawn a sharp distinction between the relationship-based financing provided by traditional banks, where these types of frictions have been extensively studied,[3] and the arm's length financing provided by capital markets. However, if frictions exist in

[1] See, e.g., Volcker (2010), Yellen (2011), Financial Crisis Inquiry Commission (2011), Acharya and Richardson (2009), Becker and Ivashina (2012), Duffie (2010a), Kacperczyk and Schnabl (2012).

[2] Theoretical work includes Bernanke and Blinder (1988), Bernanke and Gertler (1989), and Holmstrom and Tirole (1997). Recent empirical work includes Gan (2007), Khwaja and Mian (2008), Paravisini (2008), Chava and Purnanandam (2011), Iyer and Peydro (2011), and Schnabl (2012).

[3] See, e.g., Bernanke (1983), Rajan (1992), Petersen and Rajan (1994).

shadow bank lending, which is largely market-based, risk taking by shadow banks can have consequences for the broader economy. We study this issue in the context of US prime money market funds, intermediaries in short-term credit markets that are a critical part of the shadow banking system. Using a novel data set of the security-level holdings of prime money market funds,[4] we document that there are important frictions in money market funds lending, creating a channel through which MMFs can transmit distress across firms. In the context of the European sovereign debt crisis, we show that risk taking by MMFs, in the form of investments in risky Eurozone banks, drove large investor redemptions in the summer of 2011, reducing the ability of non-European firms to raise short-term financing. This is particularly surprising given that MMFs are only permitted to purchase securities from the highest credit-quality firms, which are usually large and highly rated.

With over $1.5 trillion in assets, prime MMFs are an important source of short-term financing for both financial and nonfinancial firms. According to the Flow of Funds Accounts, in 2010 MMFs held 37% of all open market paper, making them the single largest holder. Instabilities associated with money market funds played a central role in the financial crisis of 2008. At a smaller scale, similar instabilities surfaced in the summer of 2011 as fears about European sovereign debt problems mounted. According to the Investment Company Institute (ICI), assets managed by prime MMFs fell more than $170 billion (10%) between June and August 2011 due to concerns that these funds were heavily exposed to European sovereign debt through their lending to European banks. This "slow-motion run" (Economist, 2011) represents the largest three-month decline in MMFs assets outside of the chaos surrounding the Lehman default.

Our main contribution is documenting how institutional and market frictions in short-term credit markets blur the sharp distinction between relationship-based and arm's length financing that is traditionally drawn in the literature. In particular, our evidence demonstrates that issuers maintain relationships with specific MMFs and cannot always seamlessly

[4] We will refer to prime money market funds simply as "MMFs".

substitute between different funds as suppliers of financing. This creates a channel through which MMFs can transmit distress across firms, and means that risk taking by MMFs can have negative spillovers effects. Specifically, suppose a fund decides to add a risky firm to its portfolio and concerns arise about the creditworthiness of that firm. These concerns can cause the fund's investors to pull their money, resulting in a sudden and indiscriminate loss of funding for the other creditworthy firms financed by the same fund.

Our analysis proceeds in two steps, tracing the complete chain of events from the incentives for funds to take risks, to the ultimate consequences of that risk taking for issuers. First, we set the stage by examining the incentives for MMFs to take risk and the consequences of their risk taking in terms of runs. Consistent with the existing literature (Christoffersen and Musto, 2002; Kacperczyk and Schnabl, 2012), we document a strong performance-flow relationship prior to June 2011, which created strong incentives for MMFs to take on risk. Facing regulatory constraints on portfolio maturity, funds took on risk by holding large positions in risky Eurozone banks—in May 2011, Eurozone bank investments accounted for more than a quarter of all prime money market fund assets.

Relative to the existing literature, the main contribution of this analysis is that we provide evidence suggesting that incentives, rather than incorrect beliefs about the default probabilities of large financial institutions, drive risk taking behavior. Strikingly, funds that took on risk prior to Lehman's default in September 2008, and suffered large, rapid outflows in September 2008 due to that risk taking, also took on risk by investing in Eurozone banks in the first half of 2011. This shows that even after the financial crisis and recent changes to the regulations governing MMFs, risk taking incentives and behavior remain widespread and strong.[5]

[5] Our results on persistence in risk taking are consistent with Fahlenbrach, Prilmeier, and Stulz (2011) who show that a commercial bank's performance during the 1998 crisis predicts its performance during the recent crisis. In contrast, Strahan and Tanyeri (2012) find that money funds that took on more risk leading up to Lehman's default did not invest in riskier assets in the fall of 2008 after they were guaranteed by the government. This may be because funds feared the negative stigma associated with actually using government guarantee.

This risk taking made funds vulnerable to rapid investor withdrawals. Between June and August 2011, as fears about Eurozone banks grew, MMFs with significant exposures to those banks suffered large investor redemptions. The magnitude of the effect is large: for institutional funds, a 10% higher exposure to Eurozone banks is associated with an annualized outflow of 22% of assets. Moreover, the effect is not driven by a general investor pullback from all risky funds. Investors treat exposure to Eurozone banks as particularly toxic: the effect of exposure to Eurozone banks is unchanged when we control for fund yield as a measure of the overall riskiness of the fund's portfolio.

After examining incentives for risk taking as a first step, we then turn to the main focus of our analysis—the spillover effects of this risk taking on non-European issuers. While in the first step we simply documented endogenous relationships between risk taking and fund flows, here identification is a critical concern, as it is in the literature on the bank lending channel. It could simply be the case that non-European firms funded by MMFs with large exposures to Eurozone banks are riskier firms, and that the June–August 2011 period was associated with a broad withdrawal of funding from all risky issuers.

We address such concerns using our unique security-level data to estimate specifications with issuer fixed effects in a single cross section of issuer-fund (i.e. borrower-lender) pairs, similar to Khwaja and Mian (2008) and Schnabl (2012). In particular, our empirical specifications effectively compare the change in lending to the same issuer over June–August 2011 of two MMFs, one with high exposure to Eurozone banks and one with low exposure to Eurozone banks. These specifications show that for the same issuer, MMFs with larger exposures to Eurozone banks are more likely to withdraw financing. Thus, our results cannot be explained by unobservable issuer characteristics, including riskiness or direct exposure to Europe. Issuer characteristics, or changes in characteristics over June–August 2011, should cause MMFs with high or low exposures to Eurozone banks to react the same way.

We provide direct evidence demonstrating that the key friction driving these spillovers is that relationships are important in the commercial paper (CP) market. Funds with strong

relationships with a particular issuer are less likely to cut their lending to the issuer. Indeed, funds not suffering outflows increase their portfolio allocations to issuers whose other lenders are suffering outflows, but only if they have a pre-existing relationship. Thus, our results suggest that relationships matter in market-based financing: even for large, highly rated firms, arm's length finance is never fully arm's length. This separates our paper from recent work on the bank lending channel, and illustrates how frictions in short-term debt markets can make them a source of systemic risk.

Our paper is related to both the literature on risk taking by financial institutions, including Rajan (2006), Becker and Ivashina (2012), Kacperczyk and Schnabl (2012), and the literature on bank runs and credit supply, including Bernanke (1983), Calomiris and Gorton (1991), Calomiris and Mason (2003), as well as the bank lending channel literature discussed above. Our key contribution is to study the consequences of money market fund risk taking for issuers, showing that because of credit market frictions, fragility in short-term funding markets can be disruptive to large, highly rated firms. Even when based on information about fund exposures to particular risky issuers, investor redemptions can still create collateral damage, reducing the ability of other creditworthy issuers to raise short-term financing.

In addition to contributing to the broader literature on risk taking by financial intermediaries and its effects on the broader economy, our paper is also related to the growing literature on money market funds and contributes to the ongoing policy debate on the regulation of MMFs.[6] This literature has largely focused on fund risk taking before the financial crisis and the effects of government interventions during the crisis itself. Our results document frictions creating a channel by which money market fund risk taking can have spillover effects to the broader economy, and show that the instabilities associated with money market funds persist despite recent changes to the regulations governing them.

[6] Recent papers on MMFs include Christoffersen (2001), Christoffersen and Musto (2002), Baba, McCauley, and Ramaswamy (2009), Duygan-Bump, Parkinson, Rosengren, Suarez, and Willen (2012), McCabe (2010), Adrian, Kimbrough, and Marchioni (2011), Kacperczyk and Schnabl (2012), Strahan and Tanyeri (2012), and Wermers (2012).

The remainder of this paper is organized as follows. Section 2 briefly describes the market turmoil associated with the European sovereign debt crisis. After describing the data in Section 3, we present our results on fund risk taking and investor withdrawals in Section 4. Section 5 presents our results on the spillover effects of investor withdrawals on non-European issuers. Section 6 discusses the results and their implications, and Section 7 concludes.

2 Background

We focus on events in the money markets in the summer of 2011 driven by fears of European sovereign debt defaults.[7] These fears began to surface in late 2009, when Greece revealed that its debt had been substantially understated due to accounting problems. Concerns quickly arose that Greece and other peripheral countries in the Eurozone, including Portugal and Ireland, might default.

Concerns about sovereign debt, in turn, created anxiety about Eurozone banks because of their direct holdings of potentially risky sovereign debt as well as their indirect exposures to peripheral Eurozone economies. In May 2010, faced with growing turmoil in financial markets and funding difficulties for several Eurozone sovereigns, the European Union announced a stabilization package for Greece and created the €440 billion European Financial Stability Facility (EFSF) for future interventions.

Although these measures alleviated Greece's immediate funding needs, they did not address the underlying unsustainability of its debt burden. Furthermore, subsequent events suggested that sovereign debt problems would not be limited to Greece. Ireland accepted an EFSF-funded bailout package in November 2010. Portugal accepted a similar package in May 2011.

As large haircuts or outright default on Greek debt became increasingly likely, concerns

[7] See Bloomberg's European Crisis Timeline for more information: http://www.bloomberg.com/news/2011-11-07/europe-timeline-maastricht-to-papandreou.html

about the solvency of Eurozone banks with large holdings of sovereign debt resurfaced in June 2011. On June 15, Moody's placed the large French banks BNP Paribas, Credit Agricole, and Societe Generale on review for possible downgrade citing their exposures to Greece.

Figure 1
Total Net Assets of Prime MMFs
Weekly data from the Investment Company Institute.

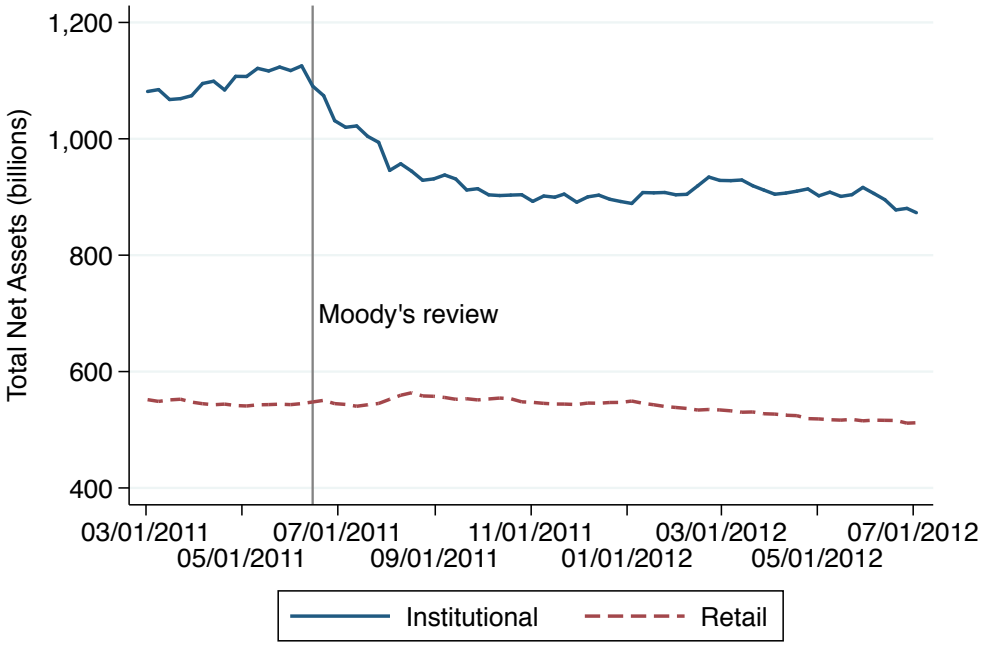

Figure 1 shows that Moody's review set off large investor redemptions from prime MMFs. Assets managed by these funds peaked at $1.67 trillion on June 8 and declined by over $180 billion (11%) to $1.49 trillion on August 31, 2011.[8]

This was a large shock—the fall in aggregate assets is the largest three-month decline except for the depths of the financial crisis in the fall of 2008.[9] Moreover, not all funds were

[8] Figure 1 shows that assets of institutional prime MMFs fell during the week ending on June 15. Unfortunately, our ICI data do not allow us to pinpoint the exact timing of these outflows. Peter Crane kindly provided us daily data from Crane Data for the period of April–June 2011. According to Crane Data, half of the outflows between June 8 and June 15 occur on June 15, the day of Moody's review announcement.

[9] Based on ICI data covering the 1984–2011 period.

equally affected—those with large exposures to Eurozone banks suffered very large outflows. For example, Fidelity Prime Money Market Portfolio, which in May 2011 invested 28% of its assets in Eurozone banks, had outflows of $20 billion (30%), leading Fidelity to issue multiple statements arguing that its exposures to European banks represented "minimal credit risk." Similarly, Dreyfus Institutional Cash Advantage Fund, with 39% of its assets invested in Eurozone banks, suffered outflows of $22.4 billion, almost 50% of its assets.

3 Data

We construct a novel data set of the security-level holdings of all US MMFs. Since November 2010, MMFs have been required to use SEC form N-MFP to report their portfolio holdings as of the last business day of each month. Funds are required to file within 5 business days after the end of the month, but the forms become publicly available only 60 days later. Our data set covers the November 2010–August 2011 period, but most of our analyses focus on the March–August 2011 period.

We focus on prime funds, which are permitted to invest in non-government securities. We exclude feeder funds that invest in other funds, internal funds that manage cash for their fund families and variable annuities.[10] We exclude eight small funds that either start reporting after March 2011 or stop reporting before August 2011. Our results are robust to the inclusion of all of these funds.

The resulting data set covers 177 unique funds, with about $1.7 trillion in assets.[11] The

[10] Funds report their category (e.g., prime, government, municipal) in item 10 of form N-MFP. We manually examine all funds that ever report their category as prime to check for reporting errors. We manually identify internal funds by looking up their profiles as well as by searching for them in the CRSP Mutual Fund database, which does not cover internal funds. Variable annuities are identified in item 9 of form N-MFP. We also exclude two funds that hold only cash during the whole sample period and seven prime muni funds, which we define as prime funds that consistently invest more than 75% of their assets in municipal securities. Some of these funds explicitly state that their investment objectives include "sustainability and social responsibility factors."

[11] After applying our screens, aggregate assets of prime MMFs are very close to the ICI numbers: $1,655 versus $1,660 billion as of May 31, 2011. Before applying our screens, aggregate assets of prime MMFs are larger in N-MFP data than in ICI data. As of May 31, 2011, aggregate assets of prime MMFs reporting on form N-MFP are $1,875 billion, while they are $1,660 billion according to the ICI. Most of the difference is

average fund manages about $9.4 billion, but the distribution of fund size is quite skewed, with the top 10 funds managing around $700 billion in assets during this period.

Our first step is to collapse the raw portfolio holdings data to the fund-issuer-month level. Form N-MFP provides us with issuer name, security CUSIP, if available, and issuer CIK if security CUSIP is not available. Because a given issuer can have multiple issuer CUSIPs and because some instruments, such as repurchase agreements and certificates of deposit, do not have CUSIPs, we have to use a number of other data sets—the CUSIP master file, FISD, S&P Ratings iQuery, the SEC's list of all CIKs matched with entity names, and data sets of Fitch, Moody's and S&P credit ratings publicly available per Rule 17g-2—to link each security to the ultimate parent of the issuer. For example, our algorithm attributes all of the following to BNP Paribas: CDs issued by its Chicago, New York, and San Francisco branches (which have their own issuer CUSIPs), commercial paper issued by BNP Paribas Finance, and repurchase agreements entered into by BNP Paribas Securities.

Next, we classify issuers into different types: ABCP, financials, government and agencies, municipal, nonfinancial, and other. The last category includes holdings of other mutual funds and supranational issuers such as the World Bank and the European Investment Bank. We restrict the sample of issuers in several ways. First, since our focus is the availability of credit for private corporate issuers, we exclude government, agency, and supranational issuers. Second, to alleviate concerns that our results are driven by issuers' direct exposure to European economic conditions, we exclude European issuers. Finally, we exclude municipal issuers because they frequently use bond insurance and letters of credit, making it difficult to determine the MMF's ultimate credit exposure for these issuers.[12] Our results are robust to the inclusion of European and municipal issuers.

It is important to note that most of our analysis is done within the N-MFP data set and

due to the inclusion of internal funds in N-MFP data.

[12] Furthermore, municipal issuers are generally small (the median municipal issuer borrows just $35 million from prime MMFs), are missing from the CUSIP master file most of the time, and have the most variation across funds in the spelling of a given issuer's name.

thus does not cover other sources of short-term financing available to these firms, including revolving credit lines and non-money market fund holders of commercial paper. However, according to the Flow of Funds Accounts, with a 37% share, MMFs are the single largest holder of commercial paper. Therefore, it is unlikely that significant disruptions in the sector are completely offset by other investors. We discuss the potential for firms to substitute to other sources of short-term financing in Section 6.

We use our fund-issuer-month level data to construct a measure of the exposure of fund f to Eurozone banks at time t, which we call *Fund Euro share*,

$$Fund\ Euro\ share_{f,t} = \frac{\sum_{i \in Eurobanks} Outstanding_{i,f,t}}{\sum_i Outstanding_{i,f,t}}$$

where $Outstanding_{i,f,t}$ is the exposure of fund f to issuer i at time t. *Fund Euro share* is simply the fraction of the fund's assets invested in Eurozone banks. In our data, this measure ranges from 0 to 45.8%, with an average of 19.0% and a standard deviation of 11.2%.

In addition we construct a measure of issuer i's indirect exposure to Eurozone banks, which we call *Issuer Euro share*,

$$Issuer\ Euro\ share_{i,t} = \frac{\sum_f Outstanding_{i,f,t} \times Fund\ Euro\ share_{f,t}}{\sum_f Outstanding_{i,f,t}}$$

This is the value-weighted average of *Fund Euro share* across MMFs that provide financing to issuer i. It measures how exposed the funds that provide financing to issuer i are to Eurozone banks. In our data, this measure ranges from 0 to 44.4%, with an average of 17.3% and a standard deviation of 8.4%.

Table 1 reports fund-level summary statistics. We split funds by their *Fund Euro share*. Funds with high *Fund Euro share* tend to be larger, serve more institutional investors, and make up a larger fraction of their fund family's assets.[13] High *Fund Euro share* funds exhibit

[13] We measure *Adviser's MMF share* as follows. First, using our N-MFP data, we calculate the total TNA of all prime MMFs managed by an adviser. Second, using the CRSP mutual fund database, we calculate the total TNA of all mutual funds managed by the adviser. Finally, we calculate the ratio of the two numbers

Table 1
Summary Statistics: Funds

This table reports summary statistics for prime money market funds in our data. The sample of funds consists of prime money market funds filing form N-MFP during the March–August 2011 period, excluding a) funds that exclusively serve the internal cash management needs of their mutual fund family and b) variable annuities.The sample period is March–August 2011. Flows are scaled by lagged assets. Portfolio maturity is the weighted average portfolio maturity. Fund-level gross yield is the value reported on form N-MFP. Fund-level net yield is the weighted average of share class-level net yields. Institutional share is the share of fund's assets in institutional shares classes. Fund Euro share is the share of fund's assets invested in Eurozone banks that were part of July 2011 stress tests. Non-EU financial share is the share of fund's assets invested in financial firms outside the European Union.

	Low Euro Share ($N = 534$)			High Euro Share ($N = 528$)		
	Mean	Median	SD	Mean	Median	SD
Fund characteristics						
Total Net Assets	4615	1214	12774	13335	4974	22159
Institutional share	46.43	47.08	43.70	63.25	97.96	44.75
Adviser's MMF share	20.35	12.82	21.31	33.98	33.93	20.27
Fee waivers (bps)	30.41	29.91	24.87	27.95	13.58	45.27
Fund flows	−0.06	−0.12	7.02	−0.81	−0.74	7.92
Gross yield (bps)	22.11	22.00	7.17	25.43	26.00	7.44
Net yield (bps)	3.13	1.00	6.02	4.39	1.18	5.12
Portfolio maturity (days)	39.08	40.00	8.79	38.29	42.00	13.11
Euro share	8.86	8.16	6.42	25.30	24.31	8.82
Unsecured Euro share	6.58	5.81	5.58	18.63	18.72	8.56
Instrument shares						
ABCP	13.49	11.92	13.31	8.78	5.81	9.69
CD	13.68	12.19	12.15	29.56	32.14	16.02
Financial CP	16.05	14.87	9.50	16.14	14.50	9.32
Government/Agency	14.73	10.59	14.38	10.30	9.83	9.32
Government/Agency repo	9.21	6.01	10.75	14.63	10.04	14.49
Municipal debt	8.82	3.97	11.03	2.91	0.00	4.98
Nonfinancial CP	13.30	8.02	15.20	3.09	0.83	8.59
Other repo	1.31	0.00	4.68	4.35	0.00	6.47
Other	9.42	5.94	13.76	10.25	8.35	7.63
Issuer shares						
ABCP	12.39	11.19	13.08	8.62	5.71	9.57
Eurozone financial	9.41	8.76	6.80	26.43	25.06	9.35
Rest of EU financial	8.69	7.73	6.91	14.18	12.89	7.32
Non-EU financial	24.73	25.14	13.11	31.80	33.22	11.81
Government/Agency	15.30	11.45	14.68	10.30	9.83	9.31
Municipal	9.86	4.30	12.49	2.71	0.18	5.01
Nonfinancial	14.65	8.68	16.87	4.31	1.79	9.80
Other	4.98	2.24	11.74	1.65	1.05	2.12

both slightly higher gross yields, the yield earned by the fund's portfolio assets, and slightly

as of March 2011.

higher net yields, the yield paid to investors. This makes sense since these funds hold securities issued by Eurozone banks, which offer higher yields. The difference in median gross yield of 4 basis points is small in absolute value, but is economically meaningful when compared to the median gross yield of 25 basis points. We also report the breakdown of fund portfolios by instrument and issuer type. The two types of funds have similar portfolio compositions, though of course funds with high *Fund Euro share* have a greater exposure to Eurozone financials, primarily in the form of CDs.

Table 2
Summary Statistics: Issuers and Exposures

This table reports summary statistics for issuers and fund-issuer exposures in our data. The sample of issuers consists of non-European issuers, excluding sovereign, agency, municipal, and supranational issuers. The sample of funds consists of prime money market funds filing form N-MFP during the March–August 2011 period, excluding a) funds that exclusively serve the internal cash management needs of their mutual fund family and b) variable annuities. The sample period is March–August 2011. In Panel A, issuers are split by average issuer Euro share during the pre period. In Panel B, fund-issuer exposures are split by fund Euro share.

Panel A: Issuers						
	Low Euro Share ($N = 738$)			High Euro Share ($N = 732$)		
	Mean	Median	SD	Mean	Median	SD
Outstanding (millions)	846.50	79.75	2248.02	4795.22	710.14	10027.99
Number of funds	14.06	6.00	18.45	27.96	11.00	33.52
Issuer Euro share (%)	9.79	9.71	5.54	21.55	21.08	5.49
Weighted average maturity (days)	54.86	26.64	77.87	47.49	25.73	71.53
Yield (bps)	21.76	19.52	12.67	28.91	28.17	9.78
Panel B: Fund-Issuer Exposures						
	Low Euro Share ($N = 20,725$)			High Euro Share ($N = 20,684$)		
	Mean	Median	SD	Mean	Median	SD
Exposure (millions)	58.20	5.00	224.64	122.72	7.58	385.94
Portfolio share (%)	1.22	0.54	1.77	1.01	0.30	1.69
Weighted average maturity (days)	63.55	34.32	76.88	69.30	37.00	84.29
Yield (bps)	22.96	22.01	11.87	26.18	26.00	11.15

Table 2 reports issuer- and fund-issuer level summary statistics for the issuers in our sample. We focus on these issuers when we analyze the spillover effects of the outflows suffered by MMFs. Panel A reports statistics for the 72 ABCP, 75 financial, and 88 nonfinancial issuers in our sample. Panel B reports fund-issuer level statistics for the same issuers. The median issuer has $279 million outstanding, but the distribution is skewed, with mean and

maximum outstandings of $2.9 billion and $55.1 billion respectively. There are some differences between issuers with high and low *Issuer Euro share*. In our analysis of spillovers, we will use issuer fixed effects to ensure that these differences are not driving our results. The median issuer is held by 9 MMFs. A number of issuers are very widely held. Out of the issuers in our sample, the most widely held is the Bank of Nova Scotia, which is held by 138 or three-quarters of funds. When studying the importance of relationships in money markets we will exclude the most widely held issuers, for which relationships with MMFs are likely to be less important.

Throughout the paper, we separate our analysis into two symmetric periods: June–August 2011 (the post period), the period of large-scale investor redemptions from prime MMFs, and March–May 2011 (the pre period), the three months leading up to these investor redemptions. We do this to make the results as transparent as possible and to avoid econometric issues surrounding standard errors in panel data sets with short time dimensions (Bertrand, Duflo, and Mullainathan, 2004; Donald and Lang, 2007; Angrist and Pischke, 2009; Cameron, Gelbach, and Miller, 2008).

4 Risk Taking and Runs

4.1 MMFs Face Strong Incentives to Take Risk in the Pre Period

We begin our analysis by studying money fund risk taking. Given that there are other papers on the subject (Christoffersen and Musto, 2002; McCabe, 2010; Kacperczyk and Schnabl, 2012; Strahan and Tanyeri, 2012), our analysis in this section has two goals. First, our security-level holdings data allow us to construct more granular, bottom-up measures of risk taking. Here we explore the properties of these measures in normal market conditions before relating them to runs and spillover effects on issuers.

Second, by studying risk taking following the financial crisis, our analysis helps rule out alternative explanations for money fund risk taking. In particular, some have argued that

fund risk taking before the crisis was a one-time mistaken belief about default probabilities.[14] They argue that learning about the risks of investments in financial firms from the crisis, coupled with recent regulatory changes, have reduced MMF risk taking after the crisis. Indeed, studying the period immediately after Lehman's default, Kacperczyk and Schnabl (2012) and Strahan and Tanyeri (2012) find that funds significantly reduced their risk taking. In contrast, our results indicate that once conditions normalized after the crisis, incentives to take risk remained: the funds that took larger risks before Lehman also took on exposure to Eurozone banks during the spring of 2011.

We first analyze the incentives MMFs faced to take on risk in the pre period. In Table 3, we show that there is a strong performance-flow relationship in the pre period. We take a transparent approach, collapsing our monthly panel into a single fund-level cross section. We scale cumulative fund flows over March–May 2011 by total net assets as of February 2011. To ensure that our results are not driven by outliers, fund flows are winsorized at the 5th and 95th percentiles.[15]

In column 1 we regress fund flows on *Fund Euro share* and size. The coefficient on *Fund Euro share* during the pre period is positive and statistically significant at 10%, showing that investors reward funds with higher *Fund Euro share* because their Eurozone bank exposures allow them to offer higher yields. The economic magnitudes are meaningful. A one standard deviation increase in *Fund Euro share* is associated with additional flows of 5.2% of assets on an annualized basis. For comparison, annualized mean fund flows in the pre period were -2.8%.

Column 2 uses our unique security-level data to examine finer grain measures of risk taking. We divide the effect of *Fund Euro share* according to whether the exposure is secured

[14] See, for example, Stevens (2012).

[15] For example, three Morgan Stanley funds experience the largest inflows in our sample, with each fund more than doubling in size. These apparent inflows are due to a one-time sweep of the cash balances of Morgan Stanley Smith Barney clients into Morgan Stanley MMFs in April 2011. Rather than make subjective judgements about such outliers, we winsorize fund flows at the 5th and 95th percentiles. We get similar results when we winsorize at the 1st and 99th percentiles.

Table 3
Fund Flows during the Pre Period (March–May 2011)

The dependent variable is cumulative net flows during the March–May 2011 period scaled by February 2011 net assets. Fund flows are annualized and winsorized at the 5th and 95th percentiles. The sample consists of prime money market funds filing form N-MFP during the March–August 2011 period, excluding a) funds that exclusively serve the internal cash management needs of their mutual fund family and b) variable annuities. Explanatory variables are measured as of February 2011. Fund Euro share is the share of the fund's portfolio invested in Eurozone banks. Unsecured Euro share is the fraction of the fund's portfolio invested in unsecured Eurozone bank claims. Repo Euro share is the fraction of repurchase agreements with Eurozone banks in the fund's portfolio. Fund size is the log of fund TNA. Institutional funds are funds with more than 99% of fund assets in institutional share classes. Robust standard errors are reported. *, **, and *** indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)	(4)	(5)	(6)
Size	3.091*	3.003*	2.878*	2.020	2.557	2.523
	(1.577)	(1.606)	(1.667)	(1.712)	(1.738)	(1.618)
Fund Euro share	0.517*			0.423	0.407	0.360
	(0.273)			(0.277)	(0.280)	(0.280)
Unsecured Euro share		0.556*				
		(0.296)				
Repo Euro share		0.463				
		(0.504)				
Net yield (bps)			1.380***	1.265**		−0.757
			(0.519)	(0.526)		(0.686)
Net yield is [1, 10) bps					6.148	
					(6.857)	
Net yield is [10, 15) bps					−0.841	
					(13.532)	
Net yield is [15, 20) bps					26.795*	
					(15.808)	
Net yield is [20, 26] bps					39.224***	
					(12.537)	
Institutional fund						0.222
						(8.632)
Euro share × Institutional fund						2.429***
						(0.866)
Constant	−36.555***	−36.150***	−32.047***	−33.172***	−37.289***	−33.267***
	(11.130)	(11.526)	(11.396)	(11.492)	(11.836)	(11.108)
N	177	177	177	177	177	177
Adjusted R^2	0.057	0.052	0.082	0.094	0.101	0.134

(i.e. repurchase agreements) or unsecured (i.e. CP or CDs). Though the coefficients are similar, only unsecured exposure to Eurozone banks has a statistically significant association with fund flows. This is consistent with the idea that funds are rewarded for taking on unsecured exposures, which are riskier and increase fund yields more.

Column 3 adds net yield as a regressor. Net yield comes in strongly positively, and column 4 shows that it reduces the coefficient on *Fund Euro share*, suggesting that the positive effect of *Fund Euro share* in the pre period is due to the higher yields offered by Eurozone banks. The magnitude of the coefficient on net yield is large. An increase in net yield of 10 basis points is associated with additional flows equal to 13.8% of assets on an annualized basis. This performance-flow relationship is consistent with the findings of Christoffersen and Musto (2002) and Kacperczyk and Schnabl (2012), who study the precrisis period, but larger in magnitude. For reference, Kacperczyk and Schnabl (2012) estimate that in the precrisis period a 10 basis point increase in yield is associated with a 7% increase in fund assets on an annualized basis. Thus, the performance-flow relationship was nearly twice as strong per basis point from March–May 2011 as it was from August 2007–August 2008. This is consistent with the conjecture of Rajan (2006), who suggested that risk taking incentives in financial intermediaries may increase as nominal yields fall. Column 5 shows that the performance-flow relationship is convex. The reward in terms of fund flows for offering a higher net yield is increasing in the net yield of the fund. Finally, column 6 shows that institutional investors drive the performance-flow relationship. We interact net yield with a dummy indicating whether the fund is an institutional fund. The results show that the performance-flow relationship is strongly positive only for funds that primarily serve institutional investors.

Table 3 shows that funds face strong incentives to take on risk by investing in Eurozone banks. Which funds respond most strongly to these incentives? In Table 4, we examine the characteristics of funds with high *Fund Euro share*. We run cross-sectional regressions of fund f's average *Fund Euro share* in the pre period on other fund characteristics.

We first examine basic fund characteristics. Higher *Fund Euro share* is associated with larger funds that have higher gross yields.[16] Going from a *Fund Euro share* of 0 to 100%

[16] A few funds report their gross yield as zero, which cannot be the case. We exclude these funds from the regressions that include gross yield.

Table 4
Variation in Fund Exposure to Eurozone Banks

The dependent variable is *Fund Euro share*$_{f,pre}$, the share of the fund's portfolio invested in Eurozone banks, averaged over the pre period, March–May 2011. The sample consists of prime money market funds filing form N-MFP during the March–August 2011 period, excluding a) funds that exclusively serve the internal cash management needs of their mutual fund family and b) variable annuities. Except for fund flows in September 2008, all explanatory variables are averages during the March–May 2011 period. September 2008 fund flows are from the CRSP mutual fund database. Fund size is the log of fund TNA. Adviser's MMF share is the fraction of prime money market funds in the fund adviser's total assets under management. Fee waivers is the ratio of waived fees to fund TNA. Institutional funds are funds with more than 99% of fund assets in institutional share classes. Gross yield is the 7-day gross yield reported by the fund. In columns 4, 6, and 8, standard errors are adjusted for clustering by adviser. In all other columns, robust standard errors are reported. *, **, and *** indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Size	1.249***	2.098***	1.778***	1.537***	2.336***	1.657***	1.460***	0.704
	(0.479)	(0.439)	(0.406)	(0.464)	(0.457)	(0.496)	(0.498)	(0.536)
Gross yield	0.387***							0.349**
	(0.136)							(0.155)
Portfolio maturity		−0.140						−0.155
		(0.095)						(0.151)
Institutional fund			4.741***					2.687
			(1.548)					(1.768)
Adviser's MMF share				0.157***		0.066		0.059
				(0.047)		(0.053)		(0.062)
Fee waivers					3.801	−7.844**		−6.655*
					(2.621)	(3.713)		(3.975)
Adviser's MMF share						0.295***		0.258***
× Fee waivers						(0.089)		(0.091)
Fund flows							−0.150***	−0.140***
in September 2008							(0.050)	(0.048)
Constant	−1.522	8.153*	3.180	2.588	−0.407	4.086	6.238	6.461
	(4.160)	(4.667)	(3.230)	(3.244)	(4.078)	(3.974)	(3.781)	(8.980)
N	166	177	177	177	177	177	164	154
Adjusted R^2	0.136	0.124	0.154	0.207	0.120	0.238	0.183	0.329

increases gross yields by 20 basis points. 20 basis points may seem like a small absolute change in yield, but it is very large in relative terms given that the standard deviation of gross yield in the pre-period was 6.8 basis points.

We next turn to fund characteristics that have a more direct economic link to risk taking. We first ask whether institutional funds invest more in Eurozone banks, since we saw above that institutional investors are more aggressive in seeking out the funds offering high yields. Column 3 shows that institutional funds do have higher *Fund Euro share*.

We next examine the idea that funds with significant franchise or reputational value at stake take less risk. If the failure of a money market fund impairs the franchise value of the other funds managed by the same asset manager, the manager will have an incentive to rein in risk taking by the money market fund. The larger the other funds are relative to the adviser's prime MMFs, the stronger these incentives will be. Consistent with Kacperczyk and Schnabl (2012), column 4 shows that this is the case. *Fund Euro share* is higher when prime MMFs make up a larger fraction of the overall mutual fund assets managed by the fund's adviser.[17]

Next we turn to the effect of operating leverage on risk taking. Given the persistent low interest rate environment, many MMFs were forced to waive some of their fees in order to continue paying non-negative net yields to investors. If funds have some fixed costs, this effectively means that their operating leverage increased, which should encourage additional risk taking. Column 5 shows that funds offering larger fee waivers (as a percentage of fund assets) have higher *Fund Euro share*s, though the effect is not statistically significant. Column 6 shows that the effect is concentrated in fund families where prime money funds make up a large fraction of the fund family's total assets. This makes sense—an asset manager with little franchise value at stake and few other sources of income will be more likely to take on risk to help cover expenses.

Column 7 explores the persistence of fund risk taking. We use the CRSP Mutual Fund database to collect flows experienced in September 2008 at the peak of the financial crisis. We use these fund flows as a simple proxy for fund risk taking at the time. McCabe (2010) and Strahan and Tanyeri (2012) show that funds with riskier portfolios suffered larger outflows following Lehman's default. Consistent with the idea that risk taking is indeed persistent, funds that took more risk before the Lehman default and consequently had larger outflows in September 2008 also have larger exposures to Eurozone banks in the spring of 2011. This

[17] To account for correlation across funds managed by the same adviser, we calculate standard errors clustered by adviser.

suggests that neither the experience of the financial crisis nor recent regulatory changes have discouraged money market fund risk taking.

Finally, column 8 shows a saturated multivariate specification. Our power is somewhat limited by the relatively small number of observations relative to the number of regressors. However, the coefficients on gross yield, operating leverage interacted with franchise value, and flows in September 2008 remain statistically significant. Taken together, these results suggest that incentives are a key driver of risk taking as measured by *Fund Euro share*.

4.2 Investors Run on Funds with Large Eurozone Exposure

We now turn to the consequences in the post period, after Moody's placed the French banks on downgrade review, of the money market fund risk taking documented above. In Table 5 we examine the determinants of fund flows in the post period. In column 1 we regress fund flows on *Fund Euro share*. In contrast to the pre period, where *Fund Euro share* had a positive effect on flows, in the post period the effect of *Fund Euro share* is significantly negative and much larger in magnitude. A one standard deviation increase in lagged *Fund Euro share* is associated with annualized fund flows of -9.9% of assets. Mean annualized fund flows in the post period were -5.7%, so the effect of *Fund Euro share* is large.

Column 2 shows that our results are robust to controlling for net yield. In contrast to our results for the pre period, net yield does not drive out the effect of *Fund Euro share* in the post period. Funds with higher net yields do not experience larger outflows in the post period,[18] and there is a strong independent effect of *Fund Euro share* in the post period. This suggests that money market fund investors were not withdrawing from funds that generally invest in riskier assets, only from those with large exposures to Eurozone banks. Column 3 shows that the effect of *Fund Euro share* is also robust to controlling for gross yield instead of net yield, which is a more direct measure of the riskiness of a fund's portfolio.

[18] By contrast, McCabe (2010) uses gross yield as a measure of portfolio risk and finds that following the collapse of Lehman Brothers, funds with higher gross yields experienced larger outflows and were more likely to be supported by their sponsors.

Table 5
Fund Flows during the Post Period (June–August 2011)

The dependent variable is cumulative net flows during the June–August 2011 period scaled by May 2011 net assets. Fund flows are annualized and winsorized at the 5th and 95th percentiles. The sample consists of prime money market funds filing form N-MFP during the March–August 2011 period, excluding a) funds that exclusively serve the internal cash management needs of their mutual fund family and b) variable annuities. Explanatory variables are measured as of May 2011. Fund Euro share is the share of the fund's portfolio invested in Eurozone banks. Unsecured Euro share is the fraction of the fund's portfolio invested in unsecured Eurozone bank claims. Repo Euro share is the fraction of repurchase agreements with Eurozone banks in the fund's portfolio. Fund size is the log of fund TNA. Institutional funds are funds with more than 99% of fund assets in institutional share classes. Robust standard errors are reported. *, **, and *** indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)	(4)	(5)
Size	−6.648***	−6.496***	−6.642***	−5.877***	−6.738***
	(2.064)	(2.137)	(2.314)	(2.044)	(2.022)
Euro share	−0.880***	−0.871***	−0.861***		−0.251
	(0.306)	(0.316)	(0.310)		(0.364)
Net yield		−0.194			
		(0.959)			
Gross yield			0.154		
			(0.594)		
Unsecured Euro share				−1.289***	
				(0.385)	
Repo Euro share				−0.031	
				(0.538)	
Institutional fund					43.733**
					(17.048)
Euro share					−1.923***
× Institutional fund					(0.640)
Constant	61.792***	61.222***	57.919***	57.493***	50.572***
	(15.155)	(15.401)	(16.505)	(15.000)	(15.132)
N	177	177	166	177	177
Adjusted R^2	0.124	0.120	0.110	0.135	0.154

In column 4, we decompose the effect of *Fund Euro share* based on whether the fund's exposure to Eurozone banks is through secured lending or unsecured lending. The results show that only unsecured exposures are associated with outflows.

It may seem somewhat surprising that money market fund investors evaluate the exposures of their funds to Eurozone banks. After all, the relative safety of these funds should weaken investor incentives to monitor risk taking (Kacperczyk and Schnabl, 2012). However, as column 5 shows, our results are largely driven by institutional funds. Institutional

investors are more likely to have the incentives and capabilities necessary to closely monitor fund risk taking. For instance, they likely subscribe to reports by brokerage houses, money market data providers such as iMoneyNet and Crane Data, and the credit rating agencies, which were reporting on money market fund exposures to European banks at the time (e.g., "US Money Fund Exposure to European Banks Remains Significant,"Fitch Ratings 2011).

5 Collateral Damage

We now show that due to credit market frictions the risk taking behaviour documented above, though it may be individually rational, can have significant spillover effects on other issuers. Specifically, we find that MMFs create a channel through which distress at Eurozone banks temporarily disrupts the ability of non-European firms to raise financing in the money markets.

Before we turn to the results, it is worth discussing why we might expect to observe such spillovers. An important institutional friction is that individual MMFs are typically constrained to purchase securities from a fixed list of issuers that their boards have pre-approved. In particular, SEC Rule 2a-7, which governs MMFs, states: "The money market fund shall limit its portfolio investments to those United States Dollar-Denominated securities that the fund's board of directors determines present minimal credit risks." Thus, if a MMF that typically provides financing to a particular issuer becomes constrained due to outflows, there may not be many other funds that can immediately step in to provide financing to that issuer.[19]

[19] Despite the fact that there are only a relatively small number of issuers that raise financing from MMFs, there is anecdotal evidence that the approved issuer lists are both restrictive and slow to change. For instance, Reich and Tang publishes their list on their website. On their November 15, 2011 list, the oldest list that we have access to, there are over 150 issuers that are in our N-MFP data but are not pre-approved by Reich and Tang. Of these, 48 are nonfinancials, including such highly rated (P-1) issuers as Honda, Cargill, Automatic Data Processing, Merck, Google, Texas Instruments, Cisco, Philip Morris International, eBay, Medtronic, Honeywell International, Target, and Campbell Soup. Reich and Tang's list is also quite stable over time. On November 15, 2011, it had 164 approved issuers. By December 27, 2012, over a year later, only 34 issuers were removed and 22 were added. Out of the removed issuers, 16 were downgraded by Moody's to second tier, and 9 are subsidiaries whose parents remain on the list.

As we saw above, MMFs with large exposures to Eurozone banks suffered significant outflows in the post period. Thus, we might expect the non-European issuers financed by those funds to experience temporary difficulties raising financing. Moreover, MMFs are subject to concentration limits: no more than 5% of a fund's assets may be invested in a particular issuer. Thus, in the presence of slow-moving capital (Duffie, 2010b), funds not suffering outflows may not be able to increase the amount of financing they provide to a pre-approved issuer.

In addition, relationships between issuers and specific MMFs—either direct or intermediated by dealers—may be important for mitigating short-run adverse selection problems, even in the absence of formal regulatory constraints. If a money market fund that typically provides financing to a particular issuer becomes constrained due to outflows, that issuer will have to seek financing from other funds, possibly offering higher yields as an enticement. However, as in Rajan (1992), other funds may fear that the issuer's inability to raise financing from its typical funders reflects inside information on the part of those funders. Thus, they may be unwilling to provide financing in the short run until they have done their own research. The fact that MMFs are set up to buy informationally insensitive securities, and therefore have limited credit research capabilities (Gorton, 2009; Hanson and Sunderam, 2012), may exacerbate these asymmetric information problems, even though funds invest in large, highly rated issuers.

5.1 Spillovers: Fund-Issuer Level Evidence

We show that the investor redemptions documented above, generated by distress at Eurozone banks, hampered the ability of other non-European firms to raise financing. While the previous sections documented endogenous relationships between risk taking and fund flows, here identification is a critical concern. It could simply be the case that non-European firms funded by MMFs with large exposures to Eurozone banks are risky firms, and that the June–August 2011 period was associated with a broad withdrawal of funding from all risky

issuers.

We address such concerns using our unique security-level data to estimate specifications with issuer fixed effects, similar to Khwaja and Mian (2008) and Schnabl (2012). This ensures that our results cannot be explained by unobservable issuer characteristics, including riskiness or direct exposure to Europe. We again take a transparent approach, collapsing our monthly panel into a single cross section where the unit of observation is a fund-issuer pair. That is, each fund-issuer pair appears only once in the dataset.

For each money market fund f and each issuer i, we calculate the fund's average holdings of the issuer's securities in the pre (March–May 2010) and post (June–August 2010) periods. We then calculate the percentage change in this fund-issuer exposure measure between the pre and post periods, winsorizing at the 5th and 95th percentiles.

Recall that we exclude European firms. All our results would be stronger if we included these issuers. It is important to note that this means that our estimates are likely to be a lower bound on the cross-firm spillover effects transmitted by MMFs. European firms, particularly financials, are the issuers for whom spillovers are likely to be most important. We omit them for the sake of cleaner identification, but this comes at the cost of underestimating the magnitude of the spillovers. Our final sample consists of non-European financials, nonfinancials, and asset-backed commercial paper (ABCP) issuers.

Finally, recall that the friction we have in mind is that asymmetric information makes fund-issuer relationships important. Thus we would not expect to find significant spillovers for issuers borrowing from a large number of funds. Yet these widely held issuers constitute a significant fraction of our fund-issuer level data set. Therefore, to focus on issuers that are more likely to be affected, we exclude the ten most widely held issuers during the pre period.[20]

We regress the percentage change in fund-issuer exposure on the *Fund Euro share* while

[20] Appendix Table AII reports the results for the ten most widely held issuers.

controlling for issuer fixed effects:

$$\Delta\overline{Outstanding}_{i,f} = \alpha_i + \beta \times \textit{Fund Euro share}_f + \varepsilon_{i,f}$$

We also control for the issuer's share in the fund's portfolio to account for portfolio concentration limits. Specifically, if an issuer already makes up a large fraction of a fund's portfolio, the fund will not be able to increase its lending to that issuer, no matter how attractive the opportunity is.

In these regressions all our identification is coming within issuer. The specification effectively compares the change in lending from the pre period to the post period to the same issuer of two MMFs, one with a high *Fund Euro share* and one with a low *Fund Euro share*. The regressions ask whether funds with higher exposure to Eurozone banks behave differently than those with lower exposure, holding fixed the issuer. Thus, the results cannot be explained by unobservable issuer characteristics, including riskiness, or changes in those characteristics between the pre period and the post period. Any issuer characteristics (or changes in characteristics over the post period) should cause MMFs with high or low exposures to Eurozone banks to react the same way. We cluster our standard errors by fund because the independent variable is constant within fund (see Kloek, 1981; Moulton, 1990).

Table 6 shows the results. In the first column, the coefficient on *Fund Euro share* is negative and statistically significant. The magnitudes here are economically significant. A money market fund with a 10% larger exposure to Eurozone banks reduces its exposure to a given issuer 8.7% more.

One concern with these specifications might be that even within a particular issuer, some funds make riskier, higher-yielding loans to that issuer. This could be the case if, for instance, these funds lend for longer terms or against poorer collateral. To address this concern, in column 2, we control for the yield that fund f earns on its investment in issuer i. The fact that the coefficient on *Fund Euro share* is essentially unchanged helps ensure that our results

Table 6
Identifying Spillovers to Non-European Issuers

This table reports the results of the regressions of the change in fund f's exposure to issuer i between the pre and post periods. In models 1–3, the dependent variable is $\Delta\overline{Outstanding}_{i,f}$, the relative change in the average exposure of fund f to issuer i between the pre and post periods. The change in exposure is winsorized at the 5th and 95th percentiles. In modells 4–6, the dependent variable, $Exit_{i,f}$, is equal to 1 if $\Delta\overline{Outstanding}_{i,f}$ is equal to -100%, and is equal to 0 otherwise. The sample of issuers consists of non-European issuers, excluding sovereign, agency, municipal, and supranational issuers. The sample of funds consists of prime money market funds filing form N-MFP during the March–August 2011 period, excluding a) funds that exclusively serve the internal cash management needs of their mutual fund family and b) variable annuities. Issuer fixed effects are included in all specifications. The 10 most commonly held issuers during the pre period are excluded. Pre period is March–May 2011. Post period is June–August 2011. Portfolio share is the share of issuer i in the portfolio of fund f. Standard errors are adjusted for clustering by fund. *, **, and *** indicate statistical significance at 10%, 5%, and 1%.

	$\Delta\overline{Outstanding}_{i,f}$			$Exit_{i,f}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Portfolio share$_{i,f}$	-14.424^{***}	-14.397^{***}	-14.557^{***}	-0.034^{***}	-0.036^{***}	-0.033^{***}
	(1.441)	(1.451)	(1.450)	(0.005)	(0.005)	(0.005)
Fund Euro share$_f$	-0.865^{***}	-0.866^{***}		0.004^{***}	0.004^{***}	
	(0.279)	(0.279)		(0.001)	(0.001)	
Yield$_{i,f}$		0.077			-0.005^{***}	
		(0.263)			(0.001)	
Unsecured Euro share$_f$			-1.115^{***}			0.005^{***}
			(0.313)			(0.001)
Repo Euro share$_f$			-0.184			0.001
			(0.494)			(0.002)
Constant	36.169^{***}	34.233^{***}	36.968^{***}	0.168^{***}	0.287^{***}	0.165^{***}
	(5.651)	(9.139)	(5.643)	(0.026)	(0.035)	(0.026)
Issuer FE	+	+	+	+	+	+
N	3,837	3,837	3,837	3,837	3,837	3,837
Adjusted R^2	0.116	0.115	0.117	0.156	0.166	0.156

are not driven by the tendency of funds with high *Fund Euro share* to take riskier positions in the same issuer.

In column 3, we split the effect of *Fund Euro share* based on whether the fund's exposure to Eurozone banks is secured or unsecured. As we saw in Table 5, investors largely withdrew from funds that had unsecured exposure to Eurozone banks. Consistent with outflows being driven by riskier exposures, column 3 shows that only unsecured exposure to Eurozone banks creates spillovers on non-European issuers.

Columns 4–6 use a different dependent variable. We simply look at whether fund-issuer

level exposures that are nonzero in the pre period are completely closed out in the post period. This is equivalent to the change in the exposure variable used in Panel A being equal to −100%. The regression coefficient in column 4 is positive and significant. A fund with a 10% higher *Fund Euro share* is 4% more likely to completely exit its position in a given issuer. Given a baseline exit rate of 19.4%, this represents a 21% increase. Overall, the results are broadly similar to those in columns 1–3.[21]

For brevity, we do not report the results of value-weighted regressions here. However, Appendix Table AIII shows that we get similar results when we value-weight the regression using fund-issuer exposure during the pre period. This is not simply a matter of the smallest issuers getting shut out of the market, though we are excluding the very largest issuers.

5.2 Documenting the Mechanism: Relationships

In this section, we provide evidence that the key friction driving our results is the importance of relationships between funds and issuers. We construct two measures of the strength of the relationship between an issuer and a MMF. The measures are similar in spirit, but come from different data sources. Both measures assess the extent to which a fund has previously lent to a given borrower. Our "in-sample" measure counts how often a fund lends to a given borrower over the period November 2010–May 2011 in our data from SEC form N-MFP. For our "out-of-sample" measure, we go further back in time to the first half of 2010. Because form N-MFP was not available at this time, we use the last quarterly (N-Q), semi-annual (N-CSRS), or annual (N-CSR) report filed by each fund during the first six months of 2010.[22]

Because the in-sample measure is based on panel data, we can define relationship strength

[21] Indeed, most of the effect in columns 1–3 is driven by exit. When we restrict our analysis of $\Delta\overline{Outstanding}_{i,f}$ to fund-issuer pairs that are not exited in the post period, the coefficient on *Fund Euro share* is negative but not significant.

[22] In contrast to form N-MFP, which is filed by each individual fund, multiple funds can file on a single form N-Q, N-CSRS, or N-CSR. Therefore, we make sure to use only that portion of each filing that covers the particular fund in question.

within issuer. Specifically, for each issuer we label a fund as having a strong relationship with the issuer if it lends to the issuer more frequently than the median fund lending to that issuer. By contrast, the out-of-sample measure is based on a single cross section of data. Therefore, we simply label a fund as having a strong relationship with the issuer if it lends to that issuer at all during the first half of 2010. Of course, as before our regression specifications will include issuer fixed effects so that the results are driven by variation within issuer. The in- and out-of-sample measures classify 62% and 48% of fund-issuer pairs as having a strong relationship.

These measures are intuitive and likely to capture the importance of relationships in short-term credit markets. A fund that lends to a given issuer more frequently is likely to have better information on the issuer and perhaps even personal connections to the issuer's management. Indeed, as Panel A in Table 7 shows, our measures of relationship strength are associated with differences in lending terms in the pre period. As one would expect, funds that have a strong relationship with an issuer lend for somewhat longer maturities.[23] This is intuitive. A fund that has a stronger relationship with an issuer and potentially better information about that issuer will be less concerned about shocks to the issuer's creditworthiness in the short-term and will therefore be willing to extend credit for longer maturities. Controlling for deciles of maturity, which we do not report for the sake of brevity, strong relationships are also associated with 1–2 basis point higher yields. This suggests that issuers may be willing to pay higher yields to cultivate stronger relationships with particular funds.

In Panel B of Table 7, we turn to the effect of relationship strength on the spillovers we documented in Table 6. We split the effect of *Fund Euro share* by the strength of the fund's

[23] One might be concerned about the possibility of a mechanical association between maturity and our "in-sample" measure of relationship strength. If a fund lends for say six months then we will observe it lending in multiple months, and our "in-sample" measure will tend to classify the fund-issuer pair as having a strong relationship. However, this is quite unusual in our data: fewer than 11% of fund-issuer observations have remaining maturity more than six months. Moreover, our "out-of-sample" measure is immune to this mechanical bias.

Table 7
Relationships in Money Markets

Panel A reports the results of regressions of maturity and yield during the period on the existence of a strong fund-issuer relationship. $Maturity_{i,f}$ and $Yield_{i,f}$ are the average values during the pre period of the exposure of fund f to issuer i. Yield regressions in models 3–4 control for deciles of maturity. Panel B reports the results of regressions of changes in the exposure of fund f to issuer i on fund Euro share interacted with fund-issuer relationship strength. $\Delta\overline{Outstanding}_{i,f}$ is the relative change in the average exposure of fund f to issuer i between the pre and post periods. $Exit_{i,f}$ is a binary variable equal to 1 if $\Delta\overline{Outstanding}_{i,f}$ is equal to -100%, and equal to 0 otherwise. The sample of issuers consists of non-European issuers, excluding sovereign, agency, municipal, and supranational issuers. The sample of funds consists of prime money market funds filing form N-MFP during the March–August 2011 period, excluding a) funds that exclusively serve the internal cash management needs of their mutual fund family and b) variable annuities. Issuer fixed effects are included in all specifications. The 10 most commonly held issuers during the pre period are excluded. Pre period is March–May 2011. Post period is June–August 2011. Robust standard errors are reported. *, **, and *** indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)	(4)
Panel A: Maturity and Yield during the Pre Period				
	$Maturity_{i,f}$		$Yield_{i,f}$	
	In-Sample	Out-of-Sample	In-Sample	Out-of-Sample
Strong relationship$_{i,f}$	8.569***	4.839***	1.635***	1.040***
	(1.372)	(1.506)	(0.309)	(0.304)
Constant	39.204***	42.307***	12.942***	13.178***
	(1.112)	(0.945)	(0.556)	(0.559)
Issuer FE	+	+	+	+
N	3,837	3,837	3,837	3,837
Adjusted R^2	0.550	0.546	0.621	0.618
Panel B: Changes in Exposure during the Post Period				
	$\Delta\overline{Outstanding}_{i,f}$		$Exit_{i,f}$	
	In-Sample	Out-of-Sample	In-Sample	Out-of-Sample
Portfolio share$_{i,f}$	−14.760***	−15.285***	−0.021***	−0.035***
	(1.292)	(1.285)	(0.004)	(0.004)
Strong relationship$_{i,f}$	−7.558	−4.046	−0.159***	−0.055**
	(7.886)	(6.952)	(0.029)	(0.026)
Fund Euro share$_f$	−0.895*	−0.704	0.002	0.003*
× Strong relationship	(0.474)	(0.492)	(0.002)	(0.002)
Fund Euro share$_f$	−0.994**	−0.992**	0.004**	0.005***
× Weak relationship	(0.472)	(0.453)	(0.002)	(0.002)
Fund Euro share$_f$	0.003	0.001	−0.000	−0.000
× Yield$_{i,pre}$	(0.016)	(0.016)	(0.000)	(0.000)
Yield$_{i,pre}$	0.074	0.029	−0.002**	−0.003***
	(0.375)	(0.377)	(0.001)	(0.001)
Constant	40.276***	38.681***	0.321***	0.286***
	(10.740)	(10.389)	(0.035)	(0.033)
Issuer FE	+	+	+	+
N	3,837	3,837	3,837	3,837
Adjusted R^2	0.115	0.115	0.213	0.177

relationship with the issuer. The table shows that high *Fund Euro share* funds cut funding more sharply from issuers with whom they have a weak relationship, though the difference is not statistically significant. This is true using both measures of relationship strength, and we find stronger results when we value weight the regressions in Appendix Table AIV.

Note that our controls help ensure that we are picking up the direct effect of relationships, rather than the effect of an omitted variable. In particular, we control for the interaction of *Fund Euro share* and the yield that fund f earns on its investment in issuer i. This control helps ensure that we are picking up the effect of stronger relationships, not a preference by funds to continue funding on their higher-yielding investments, which simply happen to be ones we label as strong relationships. This is a concern since stronger relationships are associated with slightly higher yields as we saw in Panel A. However, controlling for the interaction of *Fund Euro share* and position-level yield has no effect on the results. In addition, it is important to note that these results are not mechanically driven by the fact that strong relationships are associated with longer maturity loans. We measure post period lending over three months, which ensures that virtually all loans must be rolled over.

5.3 Documenting the Mechanism: Substitution Across Funds

Finally, we examine a critical implication of the idea that there are frictions in money market fund lending: these frictions limit the extent to which substitute financing from funds not facing significant redemptions in the post period is available to issuers. To do so, we now focus on fund-level variation, rather than focusing on the issuer-level variation we analyzed in the last two subsections. Specifically, we examine the share of each issuer in a fund's portfolio. We regress the change in portfolio share on *Issuer Euro share*, the average exposure to Eurozone banks of the MMFs that finance the issuer in the pre period, while controlling for fund fixed effects.[24] Now all identification is coming within fund. The

[24] Note that the change in portfolio share is defined for all fund-issuer pairs, while $\Delta\overline{Outstanding}_{i,f}$ is only defined for fund-issuer pairs where there was positive lending in the pre period. Thus, these specifications allow us to examine fund decisions to start lending in the post period. The number of observations also goes

specifications essentially compare the change in lending from the pre period to the post period of a single fund to two issuers, one with high *Issuer Euro share* and one with low *Issuer Euro share*. The regressions ask whether funds treat issuers with higher *Issuer Euro share* differently than they treat other issuers, holding fixed the fund.

The results show that unconstrained funds with low *Fund Euro share* try to fill the gap left when constrained funds with high *Fund Euro share* withdraw financing. Specifically, funds with low *Fund Euro share* increase the share of high *Issuer Euro share* issuers in their portfolios. Critically, because of the importance of relationships in these markets, these funds only fill the gap for issuers with which they have strong relationships.

The first three columns of Table 8 focus on unconstrained funds with low (below median) *Fund Euro share*. These funds did not face heavy investor redemptions in the post period and therefore were able to provide some substitute financing for issuers with high *Issuer Euro share*. Using our in-sample measure of relationship strength, column 1 shows that these funds increased their lending to high *Issuer Euro share* issuers they have strong relationships with. The coefficient on *Issuer Euro share* interacted with strong relationship is significant at 5.4%. There is no effect for high *Issuer Euro share* issuers they have weak relationships with. Recall that these specifications include fund-level fixed effects. Within a given fund, lending in the post period is tilted towards issuers with high *Issuer Euro share* relative to other issuers, but only for issuers that have a strong relationship with the fund.

Column 2 shows that we obtain similar results when we use our out-of-sample measure of relationship strength. Finally, in column 3 we combine the two relationship measures, labelling a fund-issuer pair as a strong relationship if either the in-sample measure or the out-of-sample measure say it is. This is likely our best proxy for the approved issuer list friction discussed above. Since the lists change slowly, if an issuer has ever received financing from a fund, it is likely to remain on that fund's approved issuer list. The results with this measure are similar in magnitude to the others, and statistically significant at 1.7%.

up significantly relative to our previous results.

Note that these results further refute the idea that issuers with high *Issuer Euro share* are riskier borrowers. If they were, all funds should withdraw from these issuers. But here we find that unconstrained funds find them attractive and increase exposure to them.

Table 8
Substitution Across Funds

This table reports the results of the regressions of the change in the share of fund f's portfolio invested in issuer i between the pre and post periods on issuer Euro share interacted with fund-issuer relationship strength, split by fund Euro share. The sample of issuers consists of non-European issuers, excluding sovereign, agency, municipal, and supranational issuers. The sample of funds consists of prime money market funds filing form N-MFP during the March–August 2011 period, excluding a) funds that exclusively serve the internal cash management needs of their mutual fund family and b) variable annuities. Fund fixed effects are included in all specifications. Models 3 and 6 use the maximum of in- and out-of-sample relationship measures. The 10 most commonly held issuers during the pre period are excluded. Pre period is March–May 2011. Post period is June–August 2011. Standard errors are adjusted for clustering by issuer. *, **, and *** indicate statistical significance at 10%, 5%, and 1%.

	Low Euro Share Funds			High Euro Share Funds		
	In-sample	Out-of-sample	Max	In-sample	Out-of-sample	Max
	(1)	(2)	(3)	(4)	(5)	(6)
Portfolio share$_{i,f}$	−0.070*	−0.088**	−0.087**	−0.091***	−0.104***	−0.100***
	(0.042)	(0.034)	(0.038)	(0.022)	(0.022)	(0.023)
Strong relationship$_{i,f}$	−0.176	−0.018	−0.100	0.060	0.040	0.062
	(0.128)	(0.082)	(0.085)	(0.105)	(0.064)	(0.061)
Issuer Euro share$_i$	0.010*	0.007*	0.009**	−0.002	0.002	−0.001
× Strong relationship$_{i,f}$	(0.005)	(0.004)	(0.004)	(0.005)	(0.004)	(0.003)
Issuer Euro share$_i$	−0.000	−0.000	−0.001*	0.000	0.000	0.000
× Weak relationship$_{i,f}$	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.030***	0.023***	0.028***	0.007**	0.007**	0.006**
	(0.007)	(0.007)	(0.006)	(0.004)	(0.003)	(0.003)
Fund FE	+	+	+	+	+	+
N	20,470	20,470	20,470	20,240	20,240	20,240
Adjusted R^2	0.028	0.034	0.032	0.056	0.065	0.059

Columns 4–6 shows that there is no effect for funds with high *Fund Euro share*. These funds were faced heavy redemptions and had to reduce their positions across the board. As we will see when we present issuer-level results in Table 9, the funds with low *Fund Euro share* were not able to completely offset this withdrawal of financing. This makes sense since larger funds tend to have higher *Fund Euro share*.

5.4 Issuer-Level Evidence

Our results show that frictions in lending make MMFs a channel through which distress at Eurozone banks created funding difficulties for other issuers in the summer of 2011. Funds that were heavily exposed to Eurozone banks cut back on their lending to non-European issuers, particularly those with whom they had weak relationships. While up until now we have focused on our fund-issuer level data to address identification concerns, we next turn to the issuer-level data to understand the size of the spillovers experienced at the firm level. We will not be able to use issuer fixed effects, so identification is more of an issue here than in the fund-issuer level results above. However, we will still try to control for issuer riskiness with the issuer's pre-period yield. Moreover, in untabulated results with our fund-issuer level data, we find that our estimated coefficients on *Fund Euro share* are similar whether or not we include issuer fixed effects. This suggests that unobserved issuer characteristics are not an important driver of changes in lending during the post period.

Table 9
Issuer Level Effects

The dependent variable is $\Delta\overline{Outstanding_i}$, the percentage change in the issuer's average outstanding amount between the pre and post periods. The sample consists of non-European ABCP, financial, and nonfinancial issuers. The dependent variables is winsorized at the 5th and 95th percentiles. Robust standard errors are reported.*, **, and *** indicate statistical significance at 10%, 5%, and 1%.

Issuer Euro share$_i$	-1.611^{***}	-1.473^{**}	-1.407^{**}
	(0.585)	(0.619)	(0.642)
Yield$_i$			-0.157
			(0.473)
Constant	0.344^{***}	0.319^{**}	0.348^{**}
	(0.128)	(0.129)	(0.163)
Issuer type FE	−	+	+
N	231	231	231
Adjusted R^2	0.037	0.030	0.027

Table 9 presents the issuer-level results. The dependent variable is the percentage change in average outstanding amount for each issuer in our N-MFP data between the pre (March–May 2011) and post (June–August 2011) periods. The independent variable is *Issuer Euro*

share. Thus, we estimate the following regression

$$\Delta \overline{Outstanding_i} = \alpha + \beta \times Issuer\ Euro\ share_i + \varepsilon_i$$

In some specifications we include fixed effects for each issuer type (e.g., ABCP, financial, and nonfinancial), to ensure that our results are not driven by a general decline in financing for a particular issuer type.

Column 1 shows that being financed by MMFs that have large Eurozone bank exposures has a strong effect on non-European issuers. Issuers with a 10% higher *Issuer Euro share* (i.e., financed by MMFs with 10% higher exposure to Eurozone banks in the pre period) grow their financing 16% less in the post period. The coefficients here are somewhat larger than those we found in the position-level data. The reason for this is that the position-level data only capture changes in lending by funds that were already lending to a particular issuer. By contrast, the issuer-level data also capture decisions by funds that have not previously lent to an issuer to start doing so. The larger coefficients in the issuer-level data reflect the fact that funds are somewhat less likely to start lending to a new issuer in the post period when that issuer had a high *Issuer Euro share* in the pre period.

In column 2 we add issuer type fixed effects and get similar results. In column 3, we control for the average yield offered by the issuer in the pre period as a measure of the issuer's riskiness. This helps to show that our results are not solely driven by a general aversion to risk among money market fund managers.

6 Discussion

6.1 Firm-Level Effects

Our results illustrate how institutional and market frictions can make MMFs a channel of contagion, transmitting distress across firms and countries. As fears about European

sovereign debt mounted during the summer of 2011, institutional investors withdrew from MMFs with large exposures to Eurozone banks. Faced with large redemptions, funds cut back on their lending both to Eurozone banks and to non-European issuers. Other funds that did not have significant exposures to Eurozone banks and that did not suffer large outflows attempted to increase their lending to the affected non-European issuers, but did so only to issuers with whom the funds had prior relationships. Thus, on average issuers with high *Issuer Euro share* in the pre period were able to raise less financing from MMFs in the post period.

What about other sources of financing? If firms are able to seamlessly substitute to other sources of financing, then the mechanism we document, and by extension risk taking by MMFs, might not have any significant adverse effects on the firms' ability to raise financing and invest. For instance, as noted by Gatev and Strahan (2006), nonfinancial firms typically have standby lines of credit with banks to support their CP programs.[25] Firms draw down these lines of credit to pay off maturing CP in the event of a disruption in the CP market. Gatev and Strahan (2006) argue that banks are uniquely positioned to provide such insurance because they typically receive deposit inflows during market disruptions, and thus effectively have hedged funding.

Unfortunately, our evidence cannot definitively speak to substitution to other sources of short-term financing. The issuers in our N-MFP data span a wide range of countries, firm types (e.g., non-financials, finance companies, banks, insurance companies), and regulatory jurisdictions, making it difficult for us to measure monthly changes in total short-term financing at the firm level.[26] However, there are several reasons to think that firms will not be

[25] Similar arguments apply to ABCP programs, which almost always have liquidity backstops from their sponsors (Acharya, Schnabl, and Suarez, 2012).

[26] Using Capital IQ we did manage to collect quarterly data on outstanding CP and cash holdings for about 50 nonfinancial issuers in our data. Unfortunately, these quarterly data do not exactly match the timing of the events we study in this paper. Most of the outflows from prime MMFs are concentrated in June and July, which are part of the second and third quarters. As a result quarterly changes in outstanding CP include other demand and supply shocks in the CP market. In addition, because reporting of outstanding CP is voluntary, not all nonfinancial issuers consistently report the amount of outstanding CP. Nevertheless, in untabulated results we find negative and sometimes statistically significant relationships between changes

able to seamlessly substitute to other sources of short-term financing. First, the frictions we document for MMFs are likely to apply to other major holders of CP as well. According to the Flow of Funds Accounts, the largest holders of CP are US MMFs (33%), the rest of the world category, which consists primarily of foreign MMFs (20%),[27] mutual funds (14%), and state and local governments (7%). These are all highly regulated entities with strict investment guidelines, and together they hold almost three quarters of outstanding CP. Indeed, many mutual funds and local government cash pools are subject to the same approved issuer list friction we document here. Thus, both formal and informal relationships are important for other major CP investors, making it unlikely that they can seamlessly provide substitute financing for firms.

Second, substitute short-term financing from banks is also unlikely to be seamless. Withdrawals from prime MMFs by institutional investors are unlikely to be deposited in banks—a key reason these investors use MMFs is to diversify their credit exposure away from (and across) banks.[28] Indeed, during the episode we study, both US domiciled banks and US branches of foreign banks saw withdrawals of large time deposits, one of the main instruments purchased by MMFs and institutional investors. Large time deposits at the US branches of foreign banks fell $234 billion between June 1 and August 31, 2011. Large time deposits at domestically chartered banks fell $3 billion over the same period.[29]

in outstanding CP and *Issuer Euro Share* and between changes in cash holdings and *Issuer Euro share*. We do not report these results here because they represent a small fraction of our full sample (less than 25% of all issuers in our sample) and are somewhat sensitive to choice of specification.

[27] Peter Crane kindly provided us with the November 2011 portfolio holdings data of 23 offshore US dollar-denominated prime MMFs. These funds held $117 billion in commercial paper, more than 60% of $191 billion in commercial paper held by the rest of the world category as of December 31, 2011.

[28] See for example the unofficial transcript of the SEC roundtable on MMFs and systemic risk http://www.sec.gov/spotlight/mmf-risk/mmf-risk-transcript-051011.htm.

[29] Federal Reserve's H.8 statistical release, Assets and Liabilities of Commercial Banks. Demand deposits did increase by $150 billion over this period, according to the Federal Reserve's H.6 statistical release, Money Stock Measures. Due to the $250,000 limit on FDIC insurance, institutional investors typically do not rely on such deposit accounts. The FDIC's Transaction Account Guarantee Program (TAG) temporarily guaranteed non-interest bearing accounts above the FDIC limits, so institutional investors may have used deposit accounts in this case. However, since the TAG program expired on December 31, 2012, going forward institutional investors are unlikely to increase their demand deposits when pulling money out of MMFs.

Instead, when they withdraw funds from prime MMFs, institutional investors tend to deposit them in government MMFs, which invest in Treasuries and Agencies. Over the 2008–2012 period, the correlation between weekly flows into institutional prime and institutional government MMFs was -0.34.[30] Substitution between prime and government MMFs is particularly strong during crisis times. For example, the correlation between prime and government flows was -0.89 during the second half of 2008. During the financial crisis, the Federal Reserve set up the Commercial Paper Funding Facility and the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility precisely because banks could not backstop the CP market themselves (Duygan-Bump, Parkinson, Rosengren, Suarez, and Willen, 2012). Thus, for episodes like the one we study, the Gatev and Strahan (2006) hedge mechanism may not be effective. Of course, this is not to say that non-financial firms will not draw on their lines of credit when there are disruptions in the CP market. It does suggest, however, that such disruptions are unlikely to wash out in the aggregate, contrary to what Gatev and Strahan (2006) suggest. Instead, by drawing on their lines of credit, non-financials are likely to transfer their problems to the banking sector, which may itself be facing financing problems due to the market disruption.

Moreover, given that about three quarters of all prime money market fund assets are currently invested in large global financial firms, disruptions to the CP market today are likely to originate from the banking sector. This makes it unlikely that institutional investors who pull their money from MMFs would deposit it banks, as the Gatev and Strahan (2006) mechanism requires. Thus, the frictions in MMF lending we document are likely to create an important channel for the transmission of distress across firms, despite the existence of bank lines of credit for nonfinancial commercial paper programs.

[30] Calculations based on the Investment Company Institute data on weekly assets of MMFs.

6.2 Implications for Financial Stability

The scope for issuers to substitute to other sources of financing also depends on the magnitude of the initial shock. It is important to keep in mind that the initial shock here, while significant, was relatively slow-moving. Redemptions from prime MMFs totalled $170 billion, but took 3 months to accumulate. In contrast, prime MMFs suffered $300 billion in outflows in the *week* following the Lehman Brothers bankruptcy in September 2008. The spillovers we document here would likely be much more severe if the initial shock was of that magnitude. Yet, even in the case of the significant, but by no means catastrophic, shock that we study here, there are significant spillovers across issuers.

The spillovers we document here likely operate in a similar manner but at a much larger scale in periods of significant financial stress. Therefore, it is worth emphasizing that our results trace the full chain of events, from the incentives for risk taking to the ultimate consequences that risk taking has for issuers. This is key to understanding the financial stability implications of risk taking by shadow banks. We show that in the pre period, MMFs had strong incentives to take on risk. In particular, column 3 of Table 3 shows that a fund offering a 10 basis point higher yield attracted annualized inflows amounting to 13.8% of assets. It is important to consider the interest rate environment. The median net yield in the pre period is 1 basis point, the average is 4 basis points, and the standard deviation is 7 basis points, so 10 basis points is a large change in yield. Nonetheless, the strength of the relationship shows how intensely MMF investors desire yield. Since Eurozone banks were offering yields 10–20 basis points higher than other financial firms, MMFs interested in maximizing assets under management would be enticed to take on exposures to those banks. This does not appear to be moral hazard on the part of fund managers. Our results suggest that investors monitor the holdings of their MMFs, and are therefore aware of their risk taking.

Of course, our results do not speak to the ex ante efficiency of this risk taking. The extension of credit to Eurozone banks may have been optimal ex ante. Our results simply

demonstrate that this risk taking stimulated by investors' desire to pick up a few basis points eventually led to investor redemptions that adversely affected other firms. In particular, they suggest that runs are not an effective disciplining device in the context of MMFs, in contrast to the logic of Diamond and Rajan (2001). In their model, the threat of a run prevents the lender from holding up depositors. Our results document investors incentivizing lenders to take on risks and running when those risks turn out poorly, thereby creating financing problems for other issuers.

The transmission mechanism documented here is created by two key features of MMFs. First, the funds issue short-term liabilities with fixed values (i.e., the funds offer stable NAV shares). This gives fund investors incentives to run, redeeming their liabilities when they perceive a risk that the fund may suffer losses. Second, MMFs invest in assets that are relatively short-term (but of longer maturity than their liabilities). This means that issuers can have difficulty rolling their financing or raising new financing when MMFs are constrained.[31]

Both of these features have recently come under scrutiny as academics and policymakers have tried to understand the role of MMFs in financial crises. The SEC recently enacted changes to rule 2a-7, which governs MMFs, requiring funds to invest in higher-quality assets of shorter maturities and maintain larger buffers of liquid assets. However, the events documented in this paper took place after these changes were enacted. There are three reasons these changes may not have fully eliminated the type of spillovers we document. First, incentives for investors to run remain. Second, the required liquidity buffers are fixed over time so funds may not be able to simply draw them down to meet redemptions in periods of turmoil. Third, the tighter restrictions on asset maturity mean that issuers must return to the money markets more often, increasing their vulnerability to short-term disruptions.

There have been calls for stronger reforms to address these issues, including Squam Lake

[31] These two features also distinguish our results from the empirical literature on financial contagion, including Bae, Karolyi, and Stulz (2003) and Cella, Ellul, and Giannetti (2010). This literature typically studies equity prices, which impact issuers less directly since equity is permanent capital.

Group (2011), Ricks (2011a,b), Gorton and Metrick (2010), McCabe, Cipriani, Holscher, and Martin (2012), and Financial Stability Oversight Council (2012). These proposals typically involve either eliminating the stable NAV feature of MMFs, requiring them to hold capital as banks do, or providing them with insurance.

7 Conclusion

We use the market turmoil involving Eurozone banks in the summer of 2011 to explore the instabilities associated with MMFs, a critical part of the shadow banking system. We document that MMFs create a channel through which distress at Eurozone banks hinders the ability of non-European issuers to raise financing due to credit market frictions. MMFs with large exposures to Eurozone banks suffered significant outflows between June and August 2011. Due to institutional and market frictions, non-European issuers that historically raised financing from these funds were unable to immediately and completely substitute to other MMFs. As a result, in the short run these issuers raised less overall financing from MMFs.

We make several contributions. First, we empirically identify a channel through which non-bank financial intermediaries can transmit distress. Our results demonstrate that problems at some firms raising financing from an intermediary can be detrimental to other firms raising financing from the same intermediary. Second, we show that fund-issuer relationships are important in the commercial paper market. Since these issuers are large, highly rated firms, this suggests that relationships always play a central role in finance—arm's length financing is never completely arm's length. Third, we demonstrate that money market fund risk taking has consequences for issuers and therefore could affect the broader economy. We show that creditworthy issuers may encounter financing difficulties because of risk taking by the funds from which they raise financing. Our results document a channel through which risk taking at shadow banks may have spillover effects to the broader economy because of frictions in short-term credit markets.

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Appendix

Table AI
Variable Definitions

Adviser's MMF share$_f$	The fraction of prime money market funds in the fund adviser's total assets under management. *Adviser's prime money market fund assets* are the sum of TNA of all prime money market funds managed by the adviser. *Adviser's total assets under management* are the sum of TNA of all mutual funds in CRSP that are managed by the adviser. We manually match adviser names in N-MFP filings and CRSP. *Adviser's MMF share* is calculated as of March 2011.
Δ*Cash Holdings*$_{i,s\to t}$	Percentage change in cash and short-term investments between quarters s and t. Defined for nonfinancial issuers using Capital IQ data, and winsorized at the 5th and 95th percentiles.
$\Delta CP_{i,s\to t}$	Percentage change in outstanding Commercial Paper (CP) between quarters s and t. Defined for nonfinancial issuers using Capital IQ data, and winsorized at the 5th and 95th percentiles.
Fee waivers$_f$	The ratio of expense reimbursements to fund's TNA. Expense reimbursements are from item 72Y on the fund's N-SAR filing for 2010 fiscal year.
Fund Euro share$_{f,t}$	The share of fund f's portfolio invested in Eurozone banks in month t. In cross-sectional regressions, we calculate the average value during the pre period, *Fund Euro share*$_{f,pre} = T_{pre}^{-1} \sum_{t\in pre}$ *Fund Euro share*$_{f,t}$.
Fund flows$_{f,t}$	Net subscriptions scaled by lagged assets, $\frac{Flows_{f,t}}{TNA_{f,t-1}}$. In cross-sectional regressions, we calculate cumulative fund flows during the pre(post) period, scaled by February(May) 2011 assets. Fund flows are annualized and winsorized at the 5th and 95th percentiles.
Gross yield$_{f,t}$	The fund's 7-day gross yield reported on form N-MFP. Some funds incorrectly report their gross yield as zero, which cannot be the case. We exclude these observations from the regressions that include gross yield.
Institutional fund$_f$	Binary variable equal to 1 for funds with *Institutional share* greater than 99%.

Table AI—*Continued*

Institutional share$_{f,t}$	The share of fund's assets in institutional share classes. A share class is considered to be institutional if a) its minimum initial investment is equal to or is greater than $1 million or is equal to $1, or b) the name of the share class includes "institutional."
Issuer Euro share$_{i,t}$	The value-weighted average of *Fund Euro shares*, calculated over all funds holding issuer i at time t, with the fraction of issuer i held by fund f as the weight. *Issuer Euro share*$_{i,f,t} = \sum_f \frac{Outstanding_{i,f,t}}{\sum_f Outstanding_{i,f,t}} \times$ *Fund Euro share*$_{f,t}$. In cross-sectional regressions, we calculate the average value during the pre period, *Issuer Euro share*$_{i,pre} = T_{pre}^{-1} \sum_{t \in pre}$ *Issuer Euro share*$_{i,t}$.
Net yield$_{f,t}$	The value-weighted average of the 7-day net yields on the fund's share classes.
$\Delta\overline{Outstanding_i}$	Percentage change in the average outstanding of issuer i between the pre and post periods. $\Delta\overline{Outstanding_i} = \frac{T_{post}^{-1} \sum_{t \in post} Outstanding_{i,t}}{T_{pre}^{-1} \sum_{t \in pre} Outstanding_{i,t}} - 1$. Winsorized at the 5th and 95th percentiles.
$\Delta\overline{Outstanding_{i,f}}$	Percentage change in the average exposure of fund f to issuer i between the pre and post periods. $\Delta\overline{Outstanding_{i,f}} = \frac{T_{post}^{-1} \sum_{t \in post} Outstanding_{i,f,t}}{T_{pre}^{-1} \sum_{t \in pre} Outstanding_{i,f,t}} -$ 1. Winsorized at the 5th and 95th percentiles.
Portfolio maturity$_{f,t}$	The fund's dollar-weighted average portfolio maturity.
Relationship strength (in-sample)$_{i,f}$	The number of months between November 2010 and May 2011 in which fund f has a position in issuer i, divided by the number of months in which issuer i is held by any prime money market fund.
Repo Euro share$_{f,t}$	The fraction of repurchase agreements with Eurozone banks in the fund's portfolio.
Size$_{f,t}$	The log of fund's TNA.
Strong relationship (in-sample)$_{i,f}$	Binary variable equal to 1 whenever *Relationship strength (in sample)*$_{i,f}$ is greater than its median value for issuer i.
Strong relationship (out-of-sample)$_{i,f}$	Binary variable equal to 1 whenever fund f holds issuer i during the first sixth months of 2010. Fund holdings are from the N-Q and N-CSR filings made during this period.

Table AI—*Continued*

Unsecured Euro share$_{f,t}$	The difference between *Fund Euro share*$_{f,t}$ and *Repo Euro share*$_{f,t}$. Measures the fraction of unsecured claims on Eurozone banks in the fund's portfolio.
Yield$_{i,t}$	The weighted-average yield paid by issuer i at time t. We extract the yield on each security from the title of the issue, reported in item 27 of form N-MFP. When the issue title does not include its yield, we calculate it based on the principal (item 40), amortized cost (item 41), and time to maturity (item 35).

Table AII
Identifying Spillovers to Non-European Issuers: Top 10 Issuers

This table reports the results of the regressions of the change in fund f's exposure to issuer i between the pre and post periods. In models 1–3, the dependent variable is $\Delta\overline{Outstanding}_{i,f}$, the relative change in the average exposure of fund f to issuer i between the pre and post periods. The change in exposure is winsorized at the 5th and 95th percentiles. In modells 4–6, the dependent variable, $Exit_{i,f}$, is equal to 1 if $\Delta\overline{Outstanding}_{i,f}$ is equal to -100%, and is equal to 0 otherwise. The sample of issuers consists of non-European issuers, excluding sovereign, agency, municipal, and supranational issuers. The sample of funds consists of prime money market funds filing form N-MFP during the March–August 2011 period, excluding a) funds that exclusively serve the internal cash management needs of their mutual fund family and b) variable annuities. The sample is limited to the 10 most commonly held issuers during the pre period. Issuer fixed effects are included in all specifications. Pre period is March–May 2011. Post period is June–August 2011. Portfolio share is the share of issuer i in the portfolio of fund f. Standard errors are adjusted for clustering by fund. *, **, and *** indicate statistical significance at 10%, 5%, and 1%.

	$\Delta\overline{Outstanding}_{i,f}$			$Exit_{i,f}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Portfolio share$_{i,f}$	-13.588^{***}	-13.580^{***}	-13.588^{***}	-0.021^{***}	-0.021^{***}	-0.021^{***}
	(1.833)	(1.839)	(1.832)	(0.004)	(0.004)	(0.004)
Fund Euro share$_f$	-0.093	-0.095		0.002	0.002^{*}	
	(0.256)	(0.254)		(0.001)	(0.001)	
Yield$_{i,f}$		0.070			-0.003^{***}	
		(0.229)			(0.001)	
Unsecured Euro share$_f$			-0.118			0.000
			(0.317)			(0.001)
Repo Euro share$_f$			-0.015			0.007^{***}
			(0.561)			(0.003)
Constant	50.976^{***}	49.154^{***}	51.018^{***}	0.069^{**}	0.136^{***}	0.072^{***}
	(6.863)	(9.363)	(6.865)	(0.027)	(0.033)	(0.027)
Issuer FE	+	+	+	+	+	+
N	1,133	1,133	1,133	1,133	1,133	1,133
Adjusted R^2	0.103	0.102	0.102	0.040	0.052	0.053

Table AIII
Identifying Spillovers to Non-European Issuers: Value-Weighted Results

This table reports the results of the regressions of the change in fund f's exposure to issuer i between the pre and post periods. In models 1–3, the dependent variable is $\Delta\overline{Outstanding}_{i,f}$, the relative change in the average exposure of fund f to issuer i between the pre and post periods. The change in exposure is winsorized at the 5th and 95th percentiles. In modells 4–6, the dependent variable, $Exit_{i,f}$, is equal to 1 if $\Delta\overline{Outstanding}_{i,f}$ is equal to -100%, and is equal to 0 otherwise. The sample of issuers consists of non-European issuers, excluding sovereign, agency, municipal, and supranational issuers. The sample of funds consists of prime money market funds filing form N-MFP during the March–August 2011 period, excluding a) funds that exclusively serve the internal cash management needs of their mutual fund family and b) variable annuities. Issuer fixed effects are included in all specifications. Value-weighted regressions use average fund-issuer exposures during the pre period as weights. The 10 most commonly held issuers during the pre period are excluded. Pre period is March–May 2011. Post period is June–August 2011. Portfolio share is the share of issuer i in the portfolio of fund f. Standard errors are adjusted for clustering by fund. *, **, and *** indicate statistical significance at 10%, 5%, and 1%.

	$\Delta\overline{Outstanding}_{i,f}$			$Exit_{i,f}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Portfolio share$_{i,f}$	-6.153^{***}	-5.896^{***}	-6.386^{***}	-0.022^{***}	-0.024^{***}	-0.023^{***}
	(1.288)	(1.293)	(1.125)	(0.005)	(0.005)	(0.005)
Fund Euro share$_f$	-0.668^{***}	-0.662^{***}		0.003^{***}	0.003^{***}	
	(0.251)	(0.244)		(0.001)	(0.001)	
Yield$_{i,f}$		0.582^{**}			-0.005^{***}	
		(0.251)			(0.001)	
Unsecured Euro share$_f$			-0.734^{**}			0.003^{***}
			(0.285)			(0.001)
Repo Euro share$_f$			-0.184			0.005^{**}
			(0.676)			(0.002)
Constant	15.940^{***}	-1.081	15.950^{***}	0.042^{**}	0.175^{***}	0.042^{**}
	(4.969)	(8.785)	(4.849)	(0.019)	(0.046)	(0.019)
Issuer FE	+	+	+	+	+	+
N	3,837	3,837	3,837	3,837	3,837	3,837
Adjusted R^2	0.096	0.101	0.097	0.125	0.142	0.125

Table AIV
Relationships in Money Markets: Value-Weighted Results

Panel A reports the results of regressions of maturity and yield during the period on the existence of a strong fund-issuer relationship. $Maturity_{i,f}$ and $Yield_{i,f}$ are the average values during the pre period of the exposure of fund f to issuer i. Yield regressions in models 3–4 control for deciles of maturity. Panel B reports the results of regressions of changes in the exposure of fund f to issuer i on fund Euro share interacted with fund-issuer relationship strength. $\Delta\overline{Outstanding}_{i,f}$ is the relative change in the average exposure of fund f to issuer i between the pre and post periods. $Exit_{i,f}$ is a binary variable equal to 1 if $\Delta\overline{Outstanding}_{i,f}$ is equal to -100%, and equal to 0 otherwise. The sample of issuers consists of non-European issuers, excluding sovereign, agency, municipal, and supranational issuers. The sample of funds consists of prime money market funds filing form N-MFP during the March–August 2011 period, excluding a) funds that exclusively serve the internal cash management needs of their mutual fund family and b) variable annuities. Models 1–2 and 5–6 use the in-sample measure of relationship strength; models 3–4 and 7–8 use the out-of-sample measure of relationship strength. Issuer fixed effects are included in all specifications. Value-weighted regressions use average fund-issuer exposures during the pre period as weights. The 10 most commonly held issuers during the pre period are excluded. Pre period is March–May 2011. Post period is June–August 2011. Robust standard errors are reported. *, **, and *** indicate statistical significance at 10%, 5%, and 1%.

	(1)	(2)	(3)	(4)
Panel A: Maturity and Yield during the Pre Period				
	$Maturity_{i,f}$		$Yield_{i,f}$	
	In-Sample	Out-of-Sample	In-Sample	Out-of-Sample
Strong relationship$_{i,f}$	14.086***	13.594***	1.871***	0.288
	(3.704)	(3.490)	(0.552)	(0.463)
Constant	40.705***	43.459***	35.011***	36.566***
	(3.115)	(2.448)	(1.249)	(1.092)
Issuer FE	+	+	+	+
N	3,837	3,837	3,837	3,837
Adjusted R^2	0.555	0.557	0.707	0.703
Panel B: Changes in Exposure during the Post Period				
	$\Delta\overline{Outstanding}_{i,f}$		$Exit_{i,f}$	
	In-Sample	Out-of-Sample	In-Sample	Out-of-Sample
Portfolio share$_{i,f}$	−5.955***	−6.379***	−0.018***	−0.021***
	(1.118)	(1.031)	(0.005)	(0.005)
Strong relationship$_{i,f}$	−16.958	−10.669	−0.108**	−0.021
	(13.068)	(8.432)	(0.048)	(0.033)
Fund Euro share$_f$	−0.536***	−0.250	0.002***	0.002**
× Strong relationship$_{i,f}$	(0.207)	(0.219)	(0.001)	(0.001)
Fund Euro share$_f$	−1.282**	−1.209***	0.005**	0.005***
× Weak relationship$_{i,f}$	(0.498)	(0.317)	(0.002)	(0.001)
Constant	29.637**	21.499***	0.139***	0.066**
	(12.634)	(7.555)	(0.045)	(0.030)
Issuer FE	+	+	+	+
N	3,837	3,837	3,837	3,837
Adjusted R^2	0.097	0.107	0.195	0.146