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Investment funds and euro disaster risk

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Abstract

We document that compared to all other investor groups investment funds exhibit a distinctly procyclical behavior when financial-market beliefs about the probability of a euro-related, institutional rare disaster spike. In response to such euro disaster risk shocks, investment funds shed periphery but do not adjust core sovereign debt holdings. The periphery debt shed by investment funds is picked up by investors domiciled in the issuing country, namely banks in the short term and insurance corporations and households in the medium term.

Keywords: Investment funds, non-bank financial intermediation, euro disaster risk, sovereign debt markets.
JEL-Classification: F34, F45, G23.

Non-technical summary

Investment funds have grown significantly in their influence, holding a substantial portion of global financial assets. For some euro area countries, investment funds hold more than 20% of total outstanding sovereign debt. However, they operate under less stringent regulations compared to other financial entities like banks. This makes investment funds susceptible to runs, which can lead to rapid selling of assets that might destabilize financial markets. This paper examines the role of investment funds in euro area sovereign bond markets, with a particular focus on their behavior during periods of stress.

We focus on the period from 2007 to 2023 and examine how investment funds adjust their holdings of euro area sovereign debt in periods when perceived disaster risk within the euro area rises. Disaster risk refers to low-probability and high-impact economic events, such as financial crises. In this paper, it refers more narrowly to financial market beliefs about the probability of a rare, euro-related disaster, such as a country exiting the euro area. We use detailed data from two unique datasets to track these holdings and analyze their responses to political events that unexpectedly influence these market beliefs.

A key finding is that investment funds tend to sell off sovereign debt from euro area periphery countries during these risk events, rather than accumulating safer core debt. We document that fund responses are driven by both fund-investor and fund-manager decisions. Specifically, we estimate that responses are driven by both the need to meet fund-investor redemptions and the intention to reduce the portfolio weight of periphery sovereign debt in the funds' portfolios. Delving deeper, we document that funds with characteristics that correlate with weaker fund-manager and fund-investor expertise about euro area sovereign debt markets are more sensitive to euro disaster risk shocks. For example, funds exhibit a stronger response of debt holdings and larger outflows if they are not domiciled in and do not have a geographical focus on the euro area, have a low portfolio share of euro area sovereign debt at the outset and are not focused only on bond markets.

The paper also explores how investment funds responses compare to those of other major investors in euro area sovereign debt, including banks, insurance companies, pension funds, and international investors. We find that investment funds are unique in their significant shedding of periphery debt in response to euro disaster risk shocks. Instead, banks pick up the periphery sovereign debt in the short term, and households and insurance corporations in the medium term. Moreover, the absorption is concentrated among investors in periphery countries and the debt of their own sovereign, implying an increase in investor home bias. These findings suggest the the investment-fund sector should be monitored carefully to prevent market fragmentation

and ensure an effective transmission of monetary policy.

Overall, the paper highlights the critical role investment funds play in the financial system, especially during periods of instability, and underscores the need for enhanced oversight and understanding of their market behaviors.

1 Introduction

Investment funds have become increasingly visible players in global financial markets. For example, their share in world financial sector asset holdings reached 15% in 2022 (FSB, 2023). At the same time, they operate under a relatively loose regulatory regime and face strategic complementarities in investor redemptions (Chen et al., 2010). This makes them particularly prone to runs, which can trigger fire sales and negative asset price spirals with spillovers to other funds and market segments (Falato et al., 2021; Vissing-Jorgensen, 2021; Ma et al., 2022). Against this background, a key question is how the presence of investment funds affects the transmission of shocks.

A case in point are sovereign debt markets. Despite investment funds' growing footprint, our understanding of their role for the volatility that has afflicted these markets during several stress episodes remains incomplete. Moreover, we lack evidence on how investment funds and other investor groups interact in these markets during stress episodes. Understanding the drivers of volatility is critical given persistently high debt levels in several major advanced economies.

We shed light on these issues focusing on the effects of euro disaster risk shocks in euro area sovereign debt markets over the time period from 2007 to 2023. In particular, we study how investment funds adjust their holdings of euro area sovereign debt and how they interact with other investors in response to changes in financial-market beliefs about the probability of a euro-related, institutional rare disaster. We make use of information on investor holdings of euro area sovereign debt from two unique, granular security-level datasets. For the identification of euro disaster risk shocks we exploit a series of unexpected political events.

Studying investment funds in euro area sovereign debt markets in the context of disaster risk events is important. They hold up to 25% of outstanding sovereign debt in the euro area (Figure D.1, left). Moreover, anecdotal evidence suggests they exhibit a distinct behavior during stress episodes. A prominent example is the political deadlock between Italy's President and Prime Minister over a cabinet appointment in May 2018 and the following snap election that sparked fears of a strong mandate for euro-sceptic parties. In this episode, investment funds rebalanced from periphery towards core debt (Figure 1, top left). In contrast, other key investors such as banks actually picked up periphery debt (top right). This rebalancing was accompanied by a sharp and persistent rise in yields and volatility in periphery relative to core sovereign debt markets (bottom).

We first document that in response to euro disaster risk shocks investment funds generally shed periphery but do not accumulate core sovereign debt; rebalancing from periphery to core debt as in Figure 1 does occur occasionally, but emerges as a more systematic pattern only more recently. Periphery debt is shed both to meet fund-investor redemptions and to reduce its portfolio weight. Funds with features that correlate with weaker fund-investor or fund-manager expertise about euro area sovereign debt markets are more sensitive.

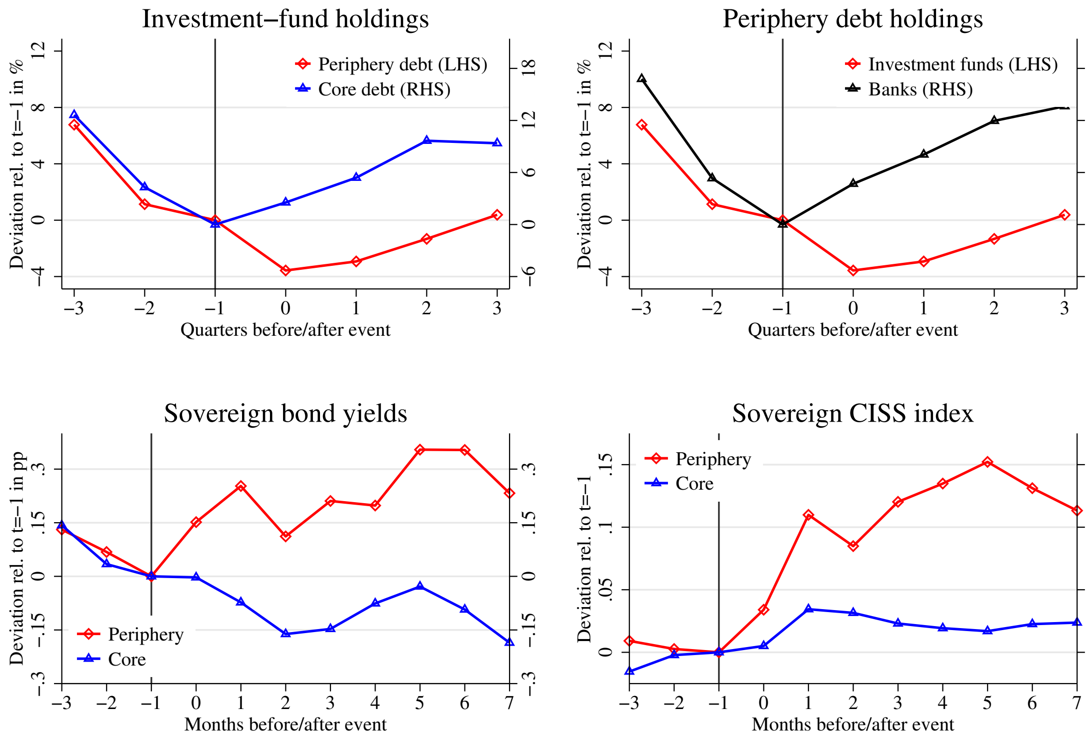
We then broaden the focus and explore how investment-fund responses compare to those of other key holder-sectors of euro sovereign debt. We document that only investment funds shed periphery debt in response to euro disaster risk shocks. Banks pick it up in the short term, and households and insurance corporations in the medium term. Moreover, the absorption is concentrated among investors in periphery countries and the debt of their own sovereign, implying an increase in investor home bias in response to euro disaster risk shocks. Overall, our analysis reveals a distinctly procyclical role of investment funds in euro area sovereign debt markets during disaster risk episodes. This is an important finding, as the related literature focuses on the behavior of banks during such situations (Acharya and Steffen, 2015; Altavilla et al., 2017; Ongena et al., 2019), but does not explore which investors and out of which reasons are driving the sell-off.

In more detail: In the spirit of Barro (2006), Wachter (2013), and Barro and Liao (2021), we conceive of euro disaster risk shocks as exogenous innovations to financial-market beliefs about the probability of a euro-related, institutional rare disaster. Just as financial markets in real time, we remain agnostic about the scenario that would play out if such a disaster were to materialize in terms of euro area dissolution or country exit(s) and sovereign debt redenomination or default.

As shocks to beliefs about the probability of such a rare disaster are not observable, we adopt a proxy-variable approach for identification. In particular, we use the change in the spread between the credit default swap (CDS) premia of euro area periphery and core sovereign debt issuers as a proxy variable. Technically, our identification approach is equivalent to the internal instrumental-variable approach introduced in the context of structural vector-autoregressive models by Plagborg-Møller and Wolf (2021).

We provide three pieces of evidence to demonstrate that euro disaster risk but no other macro-financial shocks are the key driver of the change in the periphery-core CDS spread in our sample period—and hence that it is a valid proxy variable for euro disaster risk shocks. First, we carry out a narrative analysis of intra-day news reports archived by the ECB external communications department on dates with large movements in the CDS spread. The analysis reveals that the largest spikes in the CDS spread coincide with unexpected political events related to elections, resignations, or disagreements between national governments and international institutions. All of these events have a clear intuitive flavor of euro disaster risk shocks. Second, we show that among existing industry-standard measures of other key macro-financial shocks only a broader

Figure 1: Dynamics in holdings of euro area sovereign debt and financial conditions around May 2018



Note: The top row shows the evolution of investor holdings of core and periphery sovereign debt around May 2018. The plots show percentage differences in holdings relative to the level one quarter before the event. The percentage changes are calculated at the security level and are then averaged over holder-countries at a given point in time using as weight the corresponding level of holdings. Before calculating weighted averages, the percentage changes are trimmed at $min(p_{95}, 75\%)$ to account for extreme changes due to holdings at the security level rising from values very close to zero. The left-hand side panel shows fund holdings of periphery (red diamond lines) and core (blue triangle lines) sovereign debt. The right-hand side panel shows periphery debt holdings (red diamond lines; same as in right-hand side panel) and banks (black triangle lines). Core countries include Austria, Belgium, Estonia, Finland, France, Germany, Luxembourg, and the Netherlands, while periphery countries include Cyprus, Greece, Ireland, Italy, Lithuania, Latvia, Malta, Portugal, Slovakia, Slovenia, and Spain. Data are taken from the ECB's Securities Holdings Statistic by Sector (SHSS) described in Section 3.1. The bottom row shows the evolution of 10-year sovereign bond yields in the left-hand side panel and the sovereign Composite Indicator of Systematic Stress (CISS) of Garcia-de Andoain and Kremer (2017) in the right-hand side panel.

class of disaster risk shocks but not monetary policy, geopolitical risk and oil supply shocks correlate with the change in the CDS spread. Third, we argue that the patterns in the impulse responses of macro-financial variables to a change in the CDS spread cannot be rationalized by shocks other than euro disaster risk shocks. Taken together, this suggests that euro disaster risk but no other macro-financial shocks drive the change in the CDS spread—and hence that it is a valid proxy variable for euro disaster risk shocks.

We first study the effects of euro disaster risk shocks at the investment-fund level. We make use of a proprietary dataset on investment-fund holdings of euro area sovereign debt from Refinitiv Lipper (RL). Out of the 750 million observations at the fund $\times$ security $\times$ time level in the full RL dataset available to us over the time period from January 2007 to December

2023, we use the 20 million observations on holdings of euro area central government debt. We focus on actively managed and investable funds for which euro area sovereign debt is not trivial simply by design due to their geographical focus, asset type or universe. We aggregate the security-level data to about 0.8 million fund × issuer × time observations for about 5,000 funds and 19 euro area sovereign issuers. These observations cover more than 60% of the universe of investment-fund holdings of euro area sovereign debt at the end of 2022.

We then run fund × issuer panel local-projection regressions for a fund's holdings of euro area sovereign debt on the change in the CDS spread as proxy variable for euro disaster risk shocks. In some specifications we exploit the granularity of our dataset to control for all unobserved time variation at the fund level by including fund × time fixed effects as in Khwaja and Mian (2008).

Our main finding in this part of our analysis is that in response to euro disaster risk shocks the average investment fund persistently sheds periphery but does not adjust holdings of core debt. The estimated effects on fund holdings of periphery debt are economically significant. For example, our estimates imply that for one of the largest euro disaster risk shocks in the sample—namely May 2018—the average fund reduced its holdings of periphery sovereign debt by up to 10%. Given that investment funds held about 13% of euro area sovereign debt outstanding at the time (Figure D.1, right panel), this implies a shedding of 1.3% of total outstanding amounts. This is close to the actual sales of about 1.7% of total outstanding amounts observed during this event. Rolling-window regressions suggest that the rebalancing from periphery to core depicted in Figure 1 is a pattern that emerges systematically only towards the end of our sample period since about 2018.

The finding that funds typically shed periphery but do not build up core debt holdings is not obvious *a priori*. For example, for given balance-sheet size, fund-managers may speculate on a temporary undervaluation of periphery relative to core debt and therefore rebalance from the core to the periphery. In case there are outflows so that balance-sheet size has to be reduced, fund-managers may satisfy fund-investor redemptions by shedding—in the sense of Gorton (2017)—'safe' core debt at temporary overvalued prices rather than periphery debt at depressed prices. In fact, we document that in response to euro disaster risk shocks funds do experience persistent outflows. Responding to these redemptions by shedding periphery debt rather than safe core debt suggests that fund-managers deem euro disaster risk shocks warrant a persistent portfolio rebalancing.[1] Indeed, we document that the fund responses we estimate are driven by both the need to meet fund-investor redemptions and the fund-manager decision

[1] In contrast, Ma et al. (2022) find that funds first sold their safest assets in the face of outflows at the onset of the COVID-19 pandemic.

to reduce the portfolio weight of periphery sovereign debt.

Delving deeper we document that funds with characteristics that correlate with weaker fund-manager and fund-investor expertise about euro area sovereign debt markets are more sensitive to euro disaster risk shocks. Specifically, funds exhibit a greater response of debt holdings and outflows when they are not domiciled in and do not have a geographical focus on the euro area, have a low portfolio share of euro area sovereign debt at the outset and are not focused only on bond markets. In further extensions, we document that fund responses at the intensive margin are much more important than responses at the extensive margin, that funds shed only periphery debt denominated in euro but not other currencies, and that funds shed only debt with relatively long residual maturity.

In the second part of our analysis we then broaden the focus and study how investment-fund responses compare to those of other holder-sectors, namely euro area-domiciled banks, insurance corporations, pension funds, households, and the rest of the world. This also allows us to address the question which investor groups pick up the periphery debt shed by investment funds. We make use of administrative records on the universe of euro area-domiciled investor holdings of sovereign debt from the Securities Holdings Statistics by Sector (SHSS) available to ECB staff. Of the 245 million observations at the holder-country $\times$ holder-sector $\times$ security $\times$ time level in the full SHSS dataset over the time period from 2013q4 to 2023q4, we focus on the 2 million observations on holdings of euro area central government debt.

We start by running holder-country $\times$ security panel local-projection regressions separately for each holder-sector. We find that compared to other holder-sectors investment funds exhibit the by far strongest—if not the only—shedding of periphery debt. Consistent with our results based on RL data, rest-of-the-world investors reduce their holdings of periphery sovereign debt. While we lack granular information on the composition of this investor group, existing work suggests a significant share consists of non-euro area-domiciled investment funds (Arslanalp and Tsuda, 2014; Kaufmann, 2023). We document that other euro area-domiciled investors pick up the periphery debt shed by investment funds, namely banks in the short term and households and insurance corporations in the medium term.

We then split holder-sectors into those domiciled in the core and those domiciled in the periphery. Moreover, we split periphery debt holdings of periphery holder-sectors into those issued by their own and by other periphery sovereigns. We show that most of the rebalancing in response to euro disaster risk shocks plays out among periphery holder-sectors, and especially in debt of their own sovereign. For example, Italian sovereign debt is picked up by Italian rather than by Spanish or core banks in the short term, and eventually by Italian rather than by Spanish or core households and insurance corporations in the medium term. The only exception are investment funds, as core-domiciled funds shed periphery debt more strongly than periphery-domiciled funds. These findings suggest euro disaster risk shocks accentuate the home bias in periphery sovereign debt markets. In particular, in the data periphery debt is held predominantly by periphery investors, especially by domestic banks, insurance corporations, and households.

Our results inform important policy questions. First, as investment funds have become key investors in euro area debt markets, our findings imply that fiscal policy and governments more generally must internalize that investor appetite may be more sensitive than in the past. As the procyclical behavior of investment funds tends to be destabilizing, they can exert a strong disciplining force on fiscal policy. Second, our findings imply that especially the investment-fund sector needs to be monitored carefully to detect sovereign debt market fragmentation in terms of unwarranted risk premia early on (Lane, 2020). Fragmentation might require the ECB to deploy potentially costly and previously unused non-standard measures such as the Outright Monetary Transactions (OMT) or the Transmission Protection Instrument (TPI) when it impairs the smooth transmission of monetary policy (ECB, 2012, 2022).

Related literature. We contribute to several strands of the literature. First, our paper is related to work on sovereign debt demand by different groups of investors and financial intermediaries. We relate most closely to work in this strand of the literature that focuses on the behavior of banks during the European Sovereign Debt Crisis (Acharya and Steffen, 2015; Altavilla et al., 2017; Ongena et al., 2019) and on investment-fund responses to changes in risk (Converse and Mallucci, 2023). A related line of work studies the investor base of sovereign debt across countries and shows that its composition can be relevant for debt riskiness and financing costs (Arslanalp and Tsuda, 2014; Fang et al., 2022). A second related line of work studies the demand for sovereign debt in advanced economies and specifically the euro area in the context of quantitative easing and tightening (Koijen et al., 2017, 2021; Eren et al., 2023). A third related line of work explores own and cross-demand elasticities in global bond markets over time and especially in stress episodes (Nenova, 2024).

We expand these strands of the literature in several dimensions. While the supporting role of banks during the European sovereign debt crisis has been studied extensively, little evidence exists on the question of which investors shed sovereign debt. Against this background, we analyze the dynamics of investor holdings of sovereign debt during such stress episodes, especially—but not only—for investment funds. We document that investment funds strongly shed sovereign debt, how this varies across fund characteristics such as domicile, geographical focus and investment strategy, and that it is driven both by the need to meet investor redemptions and to rebalance portfolios. Moreover, we are the first to explore the behavior of all investor groups in euro area sovereign debt markets during stress episodes in a unified analysis. We document that essentially only investment funds shed sovereign debt during stress episodes, while the other investor groups absorb.

Second, our paper is related to the broader literature on the behavior and role of non-bank financial intermediaries. Raddatz and Schmukler (2012) assess drivers of investment-fund portfolio choice more generally and find evidence for procyclical trading behavior. Di Maggio and Kacperczyk (2017), Choi and Kronlund (2018) and Kaufmann (2023) show that the investment-fund sector rebalances towards riskier assets when monetary policy loosens. Elliott et al. (2020, 2024) find that non-banks counteract the domestic and cross-border effects of US monetary policy tightening through banks. Converse et al. (2023), Chari (2023) and Chari et al. (2022) find that mutual-fund investors are sensitive to global risk shocks, accentuating the proyclicality of capital flows especially to emerging markets. Relatedly, Giannetti and Laeven (2016) show that US equity funds are more likely to sell geographically remote assets when aggregate market volatility is high. Allaire et al. (2023) document that funds whose investor base is tilted towards other funds were more sensitive to redemption runs during the early stage of the COVID-19 pandemic. Breckenfelder and Hoerova (2023) show that these outflows were dampened for funds which held more securities eligible for the ECB's Pandemic Emergency Purchase Programme. Maggiori et al. (2020) document how currency denomination shapes investment-fund portfolios. Bertaut et al. (2023) study the role of duration and exchange-rate risk for non-bank investors on emerging-market bond markets. Bidder et al. (2024) document that bond prices are particularly sensitive to investment fund sales. Cerutti et al. (2019) show that when emerging markets rely more on mutual funds their gross equity and bond inflows are more sensitive to variation in global push factors.

We expand this strand of the literature literature by analyzing how investment funds react on sovereign debt markets in response to changes in 'local' disaster rather than global risk or changes in monetary policy. We thereby study the role of investment funds for what has been dubbed financial market fragmentation and has been taken as impetus for the design of a variety of prominent non-standard ECB monetary policy measures, including the OMT in 2012 and the TPI in 2022.

Third, our paper contributes to the literature on the broader financial-market effects of euro area sovereign stress (Broner et al., 2014; Becker and Ivashina, 2018; Ioannou et al., 2024). Some work in this literature studies the drivers of euro area sovereign bond yields during stress episodes (Bayer et al., 2018; Krishnamurthy et al., 2018; De Santis, 2019; Corradin and Schwaab, 2023). We expand this strand of the literature by providing evidence on the dynamics of euro area sovereign debt demand across the investor-group universe during such episodes.

Finally, our paper is related to the literature on the financial-market effects of sovereign and political risk (Costantini and Sousa, 2022; Della Corte et al., 2022; Choi et al., 2023). Most of this work explores the relationship between risk and returns or capital flows. In contrast, we study how different investor groups adjust their sovereign debt holdings in response to variation in risk regarding a euro-related, institutional rare disaster.

The rest of this paper is organized as follows. In Section 2 we explain how we think of euro disaster risk shocks and how we use a proxy-variable approach for identification. Section 3 introduces the RL and SHSS datasets. In Section 4 we carry out our analysis at the investment-fund level, while Section 5 presents our analysis across all holder-sectors. Section 6 concludes.

2 Conceptual framework

In this section we first introduce a conceptual framework for individual fund holdings of euro area sovereign debt to guide our empirical analysis. We then explain how we conceive of euro disaster risk shocks and how we identify their effects with a proxy-variable approach. Finally, we present estimates for the effects of euro disaster risk shocks on macro-financial variables.

2.1 General setup

Suppose that demand by fund f in period t for debt issued by euro area sovereign i is given by

$$\begin{aligned} h_{fit} =& \gamma^d_{fi} + \rho_h h_{fi,t-1} + \boldsymbol{\beta}^d \boldsymbol{x}_{ft} + \epsilon^d p_{it} + \boldsymbol{\delta}^d \boldsymbol{k}_{it} + \boldsymbol{\lambda}^d \boldsymbol{\eta}_t + u^d_{fit} \\ =& \gamma^d_{fi} + \rho_h h_{fi,t-1} + \boldsymbol{\beta}^d \boldsymbol{x}_{ft} + \boldsymbol{\theta}^d \boldsymbol{w}_{it} + \boldsymbol{\lambda}^d \boldsymbol{\eta}_t + u^d_{fit}\,, \end{aligned} \tag{1}$$

where p_{it} is the average price of the bonds of issuer i and ϵ^d the price elasticity of demand, the $K_k \times 1$-vector $\boldsymbol{k}_{it}$ includes other issuer-specific demand shifters, $\boldsymbol{w}_{it} \equiv (p_{it}, \boldsymbol{k}'_{it})'$ and $\boldsymbol{\theta}^d \equiv (\epsilon^d, \boldsymbol{\delta}^{d\prime})$, the $K_x \times 1$-vector $\boldsymbol{x}_{ft}$ fund-specific demand shifters, the $K_\eta \times 1$-vector $\boldsymbol{\eta}_t$ demand shifters common to all funds and issuers, and u^d_{fit} unobserved fund-issuer-specific demand shocks. The fund-specific demand shifters $\boldsymbol{x}_{ft}$ may include funding supply in terms of investor inflows, the issuer-specific demand shifters $\boldsymbol{k}_{it}$ net debt issuance, credit risk and macroeconomic fundamentals, and the common demand shifters $\boldsymbol{\eta}_t$ global investor risk appetite and interest-rate levels. The intercept term γ^d_{fi} absorbs time-invariant fund-specific, issuer-specific, and fund-issuer specific demand factors, for example fund mandate, domicile and manager, or investor-base preferences and issuer size. Persistence in fund demand reflected in ρ_h could be due to mechanical roll-over of matured debt and strategic asset allocation.

To close the system, abstracting from intercepts for simplicity of exposition, we assume $\boldsymbol{x}_{ft}$ for funds $f = 1, 2, \ldots, N_f$, $\boldsymbol{w}_{it}$ for issuers $i = 1, 2, \ldots, N_i$, and $\boldsymbol{\eta}_t$ evolve according to linear vector-autoregressive (VAR) processes

$$\begin{aligned}
\boldsymbol{R}_0^x \boldsymbol{x}_{ft} &= \boldsymbol{R}_1^x \boldsymbol{x}_{f,t-1} + \boldsymbol{\Lambda}^x \boldsymbol{\eta}_t + \boldsymbol{u}_{ft}^x, && (2)\\
\boldsymbol{R}_0^w \boldsymbol{w}_{it} &= \boldsymbol{R}_1^w \boldsymbol{w}_{i,t-1} + \left[\boldsymbol{\Lambda}_0^w + \mathbb{1}(i \in \mathcal{C})\boldsymbol{\Lambda}_1^w\right] \boldsymbol{\eta}_t + \boldsymbol{u}_{it}^w, && (3)\\
\boldsymbol{R}_0^\eta \boldsymbol{\eta}_t &= \boldsymbol{R}_1^\eta \boldsymbol{\eta}_{t-1} + \boldsymbol{u}_t^\eta, && (4)
\end{aligned}$$

where $\boldsymbol{u}_{ft}^x$, $\boldsymbol{u}_{it}^w$ and $\boldsymbol{u}_t^\eta$ are fund-specific, issuer-specific and common structural shocks, respectively, and $\mathbb{1}(i \in \mathcal{C})$ is a scalar dummy variable that equals unity if issuer i is a core country. For simplicity of exposition, in Equations (2) and (3) we assume that all correlation between funds and between issuers is due to common variables $\boldsymbol{\eta}_t$; note that these may include cross-issuer averages/aggregates—e.g. euro area variables—and cross-fund averages/aggregates—e.g. fund-sector variables. Specifically, we assume that there are no bilateral cross-fund spillovers in Equation (2) and that individual funds do not affect individual issuers in Equation (3) and common variables in Equation (4). This assumption is consistent with the typically granular size of investment funds in the data (see Section 3 below). Moreover, we assume that there are no bilateral cross-issuer spillovers in Equation (3), and that individual issuers do not affect individual funds in Equation (2) and common variables in Equation (4).[2]

Due to the block-recursive structure of Equations (2) to (4), the reduced form of Equation (1) is

$$h_{fit} = \gamma_{fi} + \rho_h h_{fi,t-1} + \boldsymbol{\beta} \boldsymbol{x}_{f,t-1} + \boldsymbol{\delta} \boldsymbol{w}_{i,t-1} + \boldsymbol{\kappa} \boldsymbol{\eta}_{t-1} + \nu_{fit}, \tag{5}$$

where

$$\boldsymbol{\beta} \equiv \boldsymbol{\beta}^d (\boldsymbol{R}_0^x)^{-1} \boldsymbol{R}_1^x, \ \boldsymbol{\delta} \equiv \boldsymbol{\theta}^d (\boldsymbol{R}_0^w)^{-1} \boldsymbol{R}_1^w,$$
$$\boldsymbol{\kappa} \equiv \left\{\boldsymbol{\beta}^d (\boldsymbol{R}_0^x)^{-1} \boldsymbol{\Lambda}^x + \boldsymbol{\theta}^d (\boldsymbol{R}_0^w)^{-1} \left[\boldsymbol{\Lambda}_0^w + \mathbb{1}(i \in \mathcal{C})\boldsymbol{\Lambda}_1^w\right] + \boldsymbol{\lambda}^d\right\} (\boldsymbol{R}_0^\eta)^{-1} \boldsymbol{R}_1^\eta,$$

and the reduced-form error generally is a linear combination of all structural shocks

$$\begin{aligned}
\nu_{fit} &\equiv u_{fit}^d + \boldsymbol{\beta}^d (\boldsymbol{R}_0^x)^{-1} \boldsymbol{u}_{ft}^x + \boldsymbol{\theta}^d (\boldsymbol{R}_0^w)^{-1} \boldsymbol{u}_{it}^w \\
&\quad + \left\{\boldsymbol{\beta}^d (\boldsymbol{R}_0^x)^{-1} \boldsymbol{\Lambda}^x + \boldsymbol{\theta}^d (\boldsymbol{R}_0^w)^{-1} \left[\boldsymbol{\Lambda}_0^w + \mathbb{1}(i \in \mathcal{C})\boldsymbol{\Lambda}_1^w\right] + \boldsymbol{\lambda}^d\right\} (\boldsymbol{R}_0^\eta)^{-1} \boldsymbol{u}_t^\eta \\
&= u_{fit}^d + \boldsymbol{r}^x \boldsymbol{u}_{ft}^x + \boldsymbol{r}^w \boldsymbol{u}_{it}^w + \boldsymbol{r}^\eta \boldsymbol{u}_t^\eta.
\end{aligned} \tag{6}$$

[2] Relaxing the assumptions on cross-issuer as well as issuer-fund and issuer-aggregate spillovers would imply that the evolution of fund holdings of issuer i debt we aim to derive starting from Equation (1) is additionally determined by variables of all other issuers $j \neq i$. We at least to some extent account for this in our empirical analysis by including euro area variables as controls.

Denoting by ϕ_t the euro disaster risk shock and partitioning $\boldsymbol{u}_t^\eta \equiv (\phi_t, \widetilde{\boldsymbol{u}}_t^{\eta\prime})'$ we have

$$h_{fit} = \gamma_{fi} + \rho_h h_{fi,t-1} + \boldsymbol{\beta}\boldsymbol{x}_{f,t-1} + \boldsymbol{\delta}\boldsymbol{w}_{i,t-1} + \boldsymbol{\kappa}\boldsymbol{\eta}_{t-1} + \left[\psi + \mathbb{1}(i \in \mathcal{C})\chi\right]\phi_t + u_{fit}, \tag{7}$$

where

$$\psi \equiv \left[\boldsymbol{\beta}^d(\boldsymbol{R}_0^x)^{-1}\boldsymbol{\Lambda}^x + \boldsymbol{\theta}^d(\boldsymbol{R}_0^w)^{-1}\boldsymbol{\Lambda}_0^w + \boldsymbol{\lambda}^d\right](\boldsymbol{R}_0^\eta)^{-1}\boldsymbol{e}_{N_\eta,1}, \; \chi \equiv \left[\boldsymbol{\theta}^d(\boldsymbol{R}_0^w)^{-1}\boldsymbol{\Lambda}_1^w\right](\boldsymbol{R}_0^\eta)^{-1}\boldsymbol{e}_{N_\eta,1},$$

and $\boldsymbol{e}_{N_\eta,k}$ is an $N_\eta \times 1$ vector with unity at the k-th position and zeros elsewhere, and

$$\begin{aligned} u_{fit} &\equiv u_{fit}^d + \boldsymbol{r}^x\boldsymbol{u}_{ft}^x + \boldsymbol{r}^w\boldsymbol{u}_{it}^w + \boldsymbol{r}^\eta(\boldsymbol{I}_{N_\eta} - \boldsymbol{e}_{N_\eta,1}\boldsymbol{e}_{N_\eta,1}')\boldsymbol{u}_t^\eta \\ &= u_{fit}^d + \boldsymbol{r}^x\boldsymbol{u}_{ft}^x + \boldsymbol{r}^w\boldsymbol{u}_{it}^w + \widetilde{\boldsymbol{r}}^\eta\widetilde{\boldsymbol{u}}_t^\eta. \end{aligned} \tag{8}$$

As the euro disaster risk shock ϕ_t is not directly observable, it has to be identified from the data.

2.2 Identifying euro disaster risk shocks with a proxy-variable approach

In the spirit of Barro (2006), Wachter (2013), and Barro and Liao (2021), we think of a euro disaster risk shock as an unexpected and exogenous signal that induces financial markets to update their beliefs about the probability of a euro-related, institutional rare disaster.[3] Just as financial markets in real time, we remain agnostic about the precise scenario that would play out if such a disaster were to materialize. In general, it could involve the dissolution of the euro area or the exit of a subset of countries associated with corresponding sovereign debt redenomination and/or default.

Against this background, we adopt a proxy-variable approach for identification. In particular, we assume that euro disaster risk shocks ϕ_t affect some observable variable π_t according to

$$\pi_t = \boldsymbol{\varpi}\boldsymbol{d}_{t-1} + \alpha\phi_t + \boldsymbol{\vartheta}\boldsymbol{\zeta}_t, \tag{9}$$

where $\boldsymbol{\zeta}_t$ are other structural shocks from the system in Equations (2) to (4). The proxy-variable approach consists of using Equation (9) to substitute out the unobserved euro disaster risk shock ϕ_t in Equation (7).

Note that the proxy-variable approach is equivalent to the 'internal IV' approach in structural VAR models. In particular, Plagborg-Møller and Wolf (2021) show that structural impulse

[3] A somewhat different but related conceptualization is as a shock to financial market beliefs about the probability distribution over a set of policies which have different insurance properties against economic shocks and which the government may adopt in the future (Pastor and Veronesi, 2013).

responses can be estimated consistently by ordering an IV first in a recursive VAR model rather than using it along the external IV approach introduced by Stock (2008) and Mertens and Ravn (2013). Because of the recursive structure, the internal IV approach involves substituting out the structural shock of interest in the equations of all other endogenous variables in the VAR model by the IV. This is exactly what we do in the proxy variable approach in this paper.

In order to be a valid proxy variable, π_t must satisfy the standard instrumental variable (IV) (i) relevance condition that it is correlated with the euro disaster risk shock ($\alpha \neq 0$) and (ii) exogeneity condition that it is uncorrelated with all other structural shocks ($\boldsymbol{\vartheta} = 0$), at least conditional on the controls $\boldsymbol{d}_{t-1}$ (Miranda-Agrippino and Ricco, 2023).[4]

2.3 Change in the periphery-core CDS spread as proxy variable

As we want to identify a euro disaster risk shock, a natural idea is to consider a proxy variable that prices such a tail risk and is readily available over a long time period and reasonably high frequency: CDS premia. In particular, we use the monthly change in the spread between the average sovereign CDS premium across euro area periphery and core countries, respectively. For brevity, in the following we refer to this as the 'change in the CDS spread' and denote it by $\Delta(\overline{cds}_t^p - \overline{cds}_t^c)$.

In Appendix A.1 we show that when issuer-specific CDS premia are among the variables $\boldsymbol{w}_{it}$ in Equation (3), then the proxy-variable Equation (9) is given by

$$\Delta(\overline{cds}_t^p - \overline{cds}_t^c) \quad = \quad \boldsymbol{\varpi}^w \left(\overline{\boldsymbol{w}}_{t-1}^p - \overline{\boldsymbol{w}}_{t-1}^c\right) + \boldsymbol{\varpi}^\eta \boldsymbol{\eta}_{t-1} + \alpha\phi_t + \boldsymbol{\vartheta}^\eta \tilde{\boldsymbol{u}}_t^\eta + \boldsymbol{\vartheta}^{\boldsymbol{w}} \left(\overline{\boldsymbol{u}}_t^{w,p} - \overline{\boldsymbol{u}}_t^{w,c}\right), \quad (10)$$

where $\overline{\boldsymbol{w}}_{t-1}^p$ and $\overline{\boldsymbol{w}}_{t-1}^c$ are cross-issuer averages of periphery and core issuer-specific variables (including the lagged level of the CDS spread), respectively, and $\overline{\boldsymbol{u}}_t^{w,p}$ and $\overline{\boldsymbol{u}}_t^{w,c}$ are cross-issuer averages of periphery and core issuer-specific shocks, respectively. These may include a variety of shocks, for example liquidity shocks in country-specific sovereign CDS markets. As $\overline{\boldsymbol{u}}_t^{w,i}$ vanishes by definition when the number of issuers N_i grows, we drop them in the following to simplify the exposition.[5]

Equation (10) allows us to be more specific about the conditions required for the change in the CDS spread to be a valid proxy variable for euro disaster risk shocks. In particular, conditional on $\overline{\boldsymbol{w}}_{t-1}^p - \overline{\boldsymbol{w}}_{t-1}^c$ and $\boldsymbol{\eta}_{t-1}$, the change in the CDS spread has to satisfy the relevance condition $\alpha \neq 0$ and the exogeneity condition $\boldsymbol{\vartheta}^\eta = \boldsymbol{0}$. Intuitively, the validity of the change

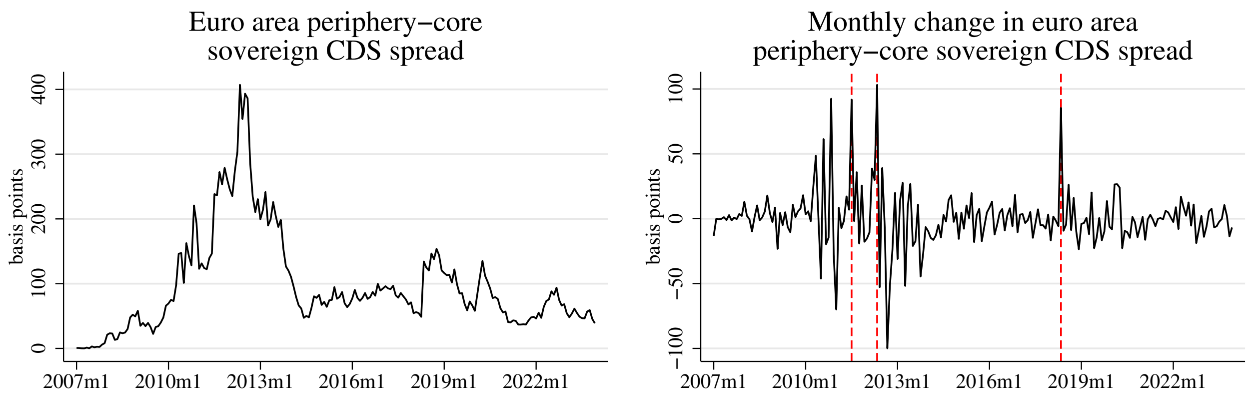
[4]In general, the proxy variable π_t in Equation (9) may also be driven by structural shocks to variables that are not part of the system in Equations (2) to (4) or by measurement error. If the share in the variation of π_t that is due to these other shocks is large, it remains a valid but becomes weak proxy variable.

[5]In Appendix B we show that even in finite samples the bias that arises because of these terms is very small with T and N_i comparable to those in our empirical analysis.

in the CDS spread as a proxy variable requires that conditional on $\overline{\boldsymbol{w}}^p_{t-1} - \overline{\boldsymbol{w}}^c_{t-1}$ and $\boldsymbol{\eta}_{t-1}$ its variation is driven exclusively by the euro disaster risk shock ϕ_t and not by any other common macro-financial shocks $\tilde{\boldsymbol{u}}^\eta_t$.

We use data for Italy and Spain (Austria, Germany, France, Netherlands, Belgium, Finland) to calculate the average periphery (core) sovereign CDS premium. We then calculate the periphery-core CDS spread as the difference between the (unweighted) averages of periphery and core sovereign CDS premia. We use only Italy and Spain for the periphery because many other countries (Greece, Ireland, Portugal, Cyprus) went through a "Troika" program so that their CDS premia might be weak proxy variables due to large measurement error for a significant part of our sample period. The CDS contracts are denominated in US dollar, have a maturity of five years, and pertain to senior debt. Our sample period spans from January 2007 to December 2023. The left-hand side panel in Figure 2 shows the evolution of the level of the periphery-core CDS spread, and the right-hand side panel the associated monthly changes. We explore several robustness checks with alternative choices for our proxy variable, including calculating the periphery-core CDS spread based on data for more countries, using only the largest spikes in the periphery-core CDS spread, excluding the height of the sovereign debt crisis in 2010-12, using the change in the periphery-core sovereign bond yield spread, and using the average CDS premium across euro area countries instead of the periphery-core spread.

Figure 2: Euro area periphery-core sovereign CDS spread dynamics



Note: The left-hand side panel shows the evolution of the periphery-core sovereign CDS spread and the right-hand side panel the corresponding first difference over time. The red dashed vertical lines in the right-hand side panel indicate the three largest positive spikes in the change in the CDS spread in the sample period.

In Appendix A.2 we present in detail two pieces of evidence to argue that the change in the CDS spread satisfies the relevance condition $\alpha \neq 0$ and the exogeneity condition $\boldsymbol{\vartheta}^\eta = \mathbf{0}$ in Equation (10) and hence is a valid proxy variable for euro disaster risk shocks.

First, we show that the CDS spread usually does not move much except for a few occasions when it changes a lot. Importantly, a narrative analysis of intra-daily real-time news reports archived by the ECB communications department reveals that the drivers of these few spikes are events related to euro disaster risk shocks ($\alpha \neq 0$) but not to other common macro-financial shocks ($\boldsymbol{\vartheta}^{\eta} = \mathbf{0}$). For example, these spikes are all related to unexpected and exogenous political events such as elections, resignations, disagreements between national governments and international institutions, the design of new regulatory/supervisory bodies and practices, or rating downgrades triggered by such events.

Second, we show that when evaluated over the full sample period beyond the few large spikes in the change in the CDS spread is correlated strongly with industry-standard measures of disaster risk shocks ($\alpha \neq 0$) that are broader in nature, more sophisticated in their construction and available only for shorter time periods. At the same time, we show that the change in the CDS spread is not correlated with industry-standard measures of other common macro-financial shocks such as US and euro area monetary policy shocks, geopolitical risk shocks as well as oil supply shocks ($\boldsymbol{\vartheta}^{\eta} = \mathbf{0}$).

2.4 Macro-financial effects of euro disaster risk shocks

Before we estimate investment-fund responses to euro disaster risk shocks we discuss estimates of their macro-financial effects using the change in the CDS spread as proxy variable. Following Jorda (2005), we estimate panel local projections

$$y_{i,t+\ell} = \gamma_i^{(\ell)} + \boldsymbol{\rho}^{(\ell)}\boldsymbol{w}_{i,t-1} + \boldsymbol{\beta}^{(\ell)}\boldsymbol{\eta}_{t-1} + \left[\lambda_0^{(\ell)} + \lambda_1^{(\ell)}\mathbb{1}(i \in \mathcal{C})\right]\phi_t + q_{it}^{(\ell)}, \tag{11}$$

where $y_{i,t+\ell}$ is an outcome variable of interest for country i at horizon ℓ, $\boldsymbol{w}_{i,t-1}$ are country-specific variables including $y_{i,t-1}$, and $q_{it}^{(\ell)}$ is a composite residual that includes all other period-t and future structural shocks up to horizon ℓ. Note that Equation (11) emerges from Equation (3) in the same fashion as Equation (1) emerges from Equation (7) when deriving the associated reduced form.

Using Equation (10) to substitute the unobserved euro disaster risk shock in Equation (11) we get

$$y_{i,t+\ell} \quad = \quad \gamma_i^{(\ell)} + \boldsymbol{w}_{i,t-1}\boldsymbol{\beta}^{(\ell)} + \boldsymbol{d}_{t-1}\boldsymbol{\mu}^{(\ell)} + \left[\widetilde{\lambda}_0^{(\ell)} + \widetilde{\lambda}_1^{(\ell)}\mathbb{1}(i \in \mathcal{C})\right]\Delta(\overline{cds}_t^{p} - \overline{cds}_t^{c}) + \nu_{it}^{(\ell)}, \tag{12}$$

where $\boldsymbol{d}_{t-1} \equiv (\boldsymbol{\eta}_{t-1}', \boldsymbol{w}_{t-1}^{p\prime} - \boldsymbol{w}_{t-1}^{c\prime})'$, $\widetilde{\lambda}_0^{(\ell)} \equiv \lambda_0^{(\ell)}/\alpha$, $\widetilde{\lambda}_1^{(\ell)} \equiv \lambda_1^{(\ell)}/\alpha$, and $\nu_{it}^{(\ell)} \equiv q_{it}^{(\ell)} - \left[\widetilde{\lambda}_0^{(\ell)} + \widetilde{\lambda}_1^{(\ell)}\mathbb{1}(i \in \mathcal{C})\right]\boldsymbol{\vartheta}^{\eta}\widetilde{\boldsymbol{u}}_t^{\eta}$. Recall that in Appendix A.2 we present evidence that $\boldsymbol{\vartheta}^{\eta} = \mathbf{0}$.

Note that using a proxy-variable approach does not allow us to identify $\lambda_0^{(\ell)}$ and $\lambda_1^{(\ell)}$ in Equation (11), but only $\widetilde{\lambda}_0^{(\ell)}$ and $\widetilde{\lambda}_1^{(\ell)}$ in Equation (12). However, practically this only means that we cannot scale the impulse responses to represent the effects of a one-standard deviation euro disaster risk shock. Instead, we have to interpret impulse responses relative to that of some reference variable (Stock and Watson, 2018; Plagborg-Møller and Wolf, 2021). For example, we could say that a euro disaster risk shock that raises reference variable R by Δ^R induces a change in variable of interest A by Δ^A.

For the estimation of Equation (12) we include in $\boldsymbol{w}_{i,t-1}$ the lagged dependent variable $y_{i,t-1}$ as well as lags of the logarithms of country i industrial production and the one-year German Bund rate. In $\boldsymbol{d}_{t-1}$ we include the lagged level of the CDS spread as well as lags of the periphery-core spreads between year-on-year industrial production growth rates and the logarithms of the stocks of central government debt outstanding. To avoid that small countries drive results as much as large countries, we weight observations by countries' average nominal GDP over the sample period.

Figure 3 presents the impulse responses to an increase in the CDS spread for macro-financial variables of core (blue) and periphery (red) countries; core countries include Austria, Belgium, Estonia, Finland, France, Germany, Luxembourg, and the Netherlands, and periphery countries include Cyprus, Greece, Ireland, Italy, Latvia, Lithuania, Malta, Portugal, Slovenia, Slovakia, Spain. Equity prices drop in core and even more so in periphery countries. Sovereign bond yields rise for periphery but fall somewhat for core countries. Volatility in sovereign bond markets as measured by the sovereign Composite Index of Systemic Stress (CISS; Garcia-de Andoain and Kremer, 2017) rises in core and even more in periphery countries. Real activity and unemployment contract somewhat in periphery countries, but the estimates are not statistically significant. The stock of outstanding sovereign debt in periphery countries does not increase.

These patterns are consistent with intuition about the effects of a euro disaster risk shock and inconsistent with the effects that other macro-financial shocks would trigger. For example, the absence of an economic contraction and a drop in sovereign debt rule out negative demand or positive periphery debt supply shocks.

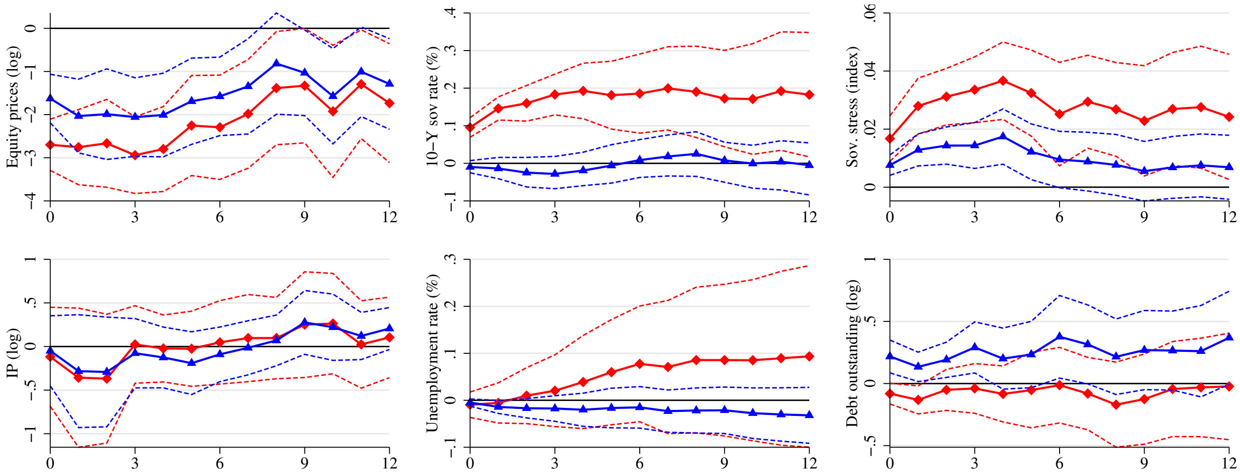
Figure 4 presents results for regional and global variables from time-series local projections

$$y_{t+\ell} = \gamma^{(\ell))} + \boldsymbol{d}_{t-1}\boldsymbol{\mu}^{(\ell))} + \widetilde{\lambda}^{(\ell)}\Delta(\overline{cds}_t^p - \overline{cds}_t^c) + \nu_t^{(\ell)}, \tag{13}$$

estimated with controls analogous to those in Equation (12).

Four observations stand out. First, the Economic Policy Uncertainty Index for Europe of Baker et al. (2016) increases. This is consistent with movements in the CDS spread in our sample reflecting euro-related, institutional rare disaster risk shocks rather than other common macro-financial shocks. Second, ECB monetary policy eases as measured by the shadow rate of Wu and Xia (2016) and—although not estimated precisely—the size of the ECB balance sheet

Figure 3: Effects of euro disaster risk shocks on macro-financial variables in euro area core (blue triangle) and periphery (red diamond) countries



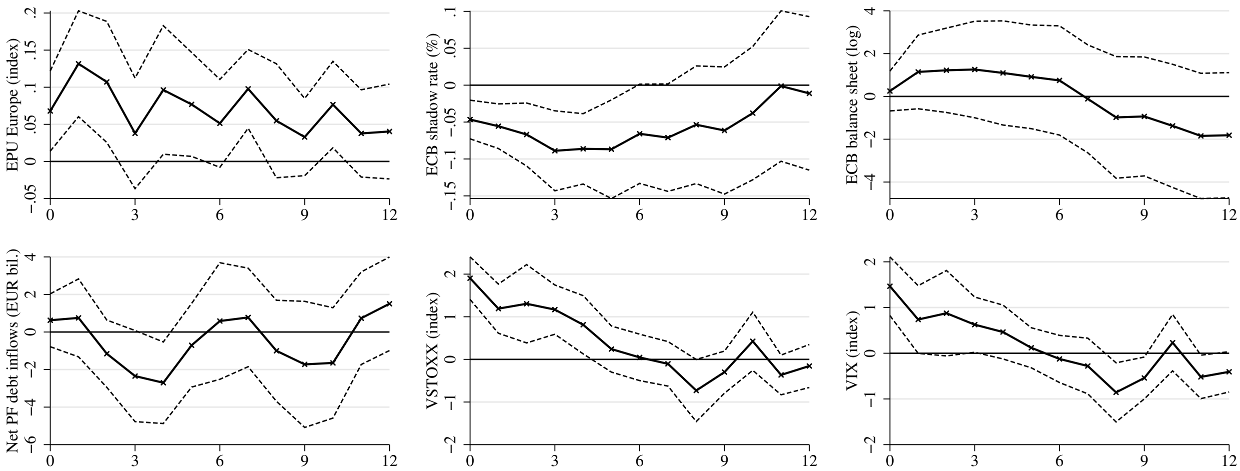
Note: The figure shows the estimated effects of a euro disaster risk shock on macroeconomic and financial variables at the monthly frequency. The effects are estimated from the country-level panel local projections in Equation (12). The impulse responses have to be interpreted relative to that of some reference variable (Stock and Watson, 2018; Plagborg-Møller and Wolf, 2021). For example, the impulse responses show the effect of a euro disaster risk shock that raises the periphery-core sovereign bond yield spread by 10 basis points on impact, which happens to be about one standard deviation of this variable in the data. Solid blue lines with triangles depict the point estimate of the effects on core countries, while solid red lines with diamonds the point estimate of the effects on periphery countries. The corresponding dashed lines represent 90% confidence bands based on Driscoll-Kraay standard errors robust to heteroskedasticity, autocorrelation and cross-sectional dependence.

(covered bonds and debt securities held for monetary policy purposes) rises.[6] This rules out that increases in the CDS spread in our sample period reflect an ECB monetary policy tightening that raises doubts about the sustainability of periphery public finances. Third, euro area net portfolio debt inflows fall, which is consistent with foreign investors shedding euro area sovereign debt as euro area assets and associated home-currency returns become more risky for foreign investors. Finally, financial-market volatility increases more strongly and more persistently in the euro area (VSTOXX) than in the US (VIX). This suggests the variation in the CDS spread reflects euro area shocks rather than spillovers from shocks in the rest of the world.[7]

[6] Data for ECB holdings of core and periphery sovereign bonds are not available separately due to confidentiality.

[7] Figure D.2 shows further that an increase in the CDS spread is followed by a depreciation of the euro against the dollar, an increase in euro area sovereign bond-market volatility, but no systematic change in US monetary policy.

Figure 4: Effects of euro disaster risk shocks on regional and global macro-financial variables



Note: The black dashed lines represent 90% confidence bands based on Newey-West standard errors robust to serial correlation. See also the note to Figure 3.

2.5 Estimation equation for investment fund-level effects

We again use the proxy-variable Equation (10) to substitute the euro disaster risk shock in Equation (7) and obtain

$$\begin{aligned} h_{fit} =& \gamma_{fi} + \rho_h h_{fi,t-1} + \boldsymbol{\beta x}_{f,t-1} + \boldsymbol{\delta w}_{i,t-1} + \tilde{\boldsymbol{\kappa}} \boldsymbol{\eta}_{t-1} \\ &+ \tilde{\boldsymbol{\varpi}}^w \left(\overline{\boldsymbol{w}}^p_{t-1} - \overline{\boldsymbol{w}}^c_{t-1}\right) + \left[\tilde{\psi} + \mathbb{1}(i \in \mathcal{C})\tilde{\chi}\right]\Delta(\overline{cds}^p_t - \overline{cds}^c_t) + \nu_{fit}, \end{aligned} \tag{14}$$

where $\tilde{\boldsymbol{\kappa}} \equiv \boldsymbol{\kappa} - \left[\psi + \mathbb{1}(i \in \mathcal{C})\chi\right]\boldsymbol{\varpi}^\eta/\alpha$, $\tilde{\boldsymbol{\varpi}}^w \equiv -\boldsymbol{\varpi}^w/\alpha$, $\tilde{\psi} \equiv \psi/\alpha$, $\tilde{\chi} \equiv \chi/\alpha$, and

$$\nu_{fit} \quad \equiv \quad u^d_{fit} + \boldsymbol{r}^x \boldsymbol{u}^x_{ft} + \boldsymbol{r}^w \boldsymbol{u}^w_{it} + (\tilde{\boldsymbol{r}}^\eta - \boldsymbol{\vartheta}^\eta/\alpha)\tilde{\boldsymbol{u}}^\eta_t. \tag{15}$$

Notice two observations. First, just as in the context of Section 2.4, using a proxy-variable approach does not allow us to identify ψ and χ in Equation (7), but only $\tilde{\psi}$ and $\tilde{\chi}$. This only means that we have to interpret the estimated effect on a variable of interest relative to that on some reference variable (Stock and Watson, 2018; Plagborg-Møller and Wolf, 2021). For example, recall that we estimate a euro disaster risk shock raises the periphery-core sovereign bond yield spread by 10 basis points on impact, which happens to be about one standard deviation of this variable in the data (Figure 3). Therefore, we could say that 'a euro disaster risk shock that increases the sovereign bond yield spread by about one standard deviation impacts another variable of interest by x'. Second, if the exogeneity condition $\boldsymbol{\vartheta}^\eta = \mathbf{0}$ holds as we argue in detail in Appendix A.2, our proxy-variable Equation (10) actually is

$$\Delta(\overline{cds}_t^p - \overline{cds}_t^c) \quad = \quad \varpi^w(\overline{\boldsymbol{w}}_{t-1}^p - \overline{\boldsymbol{w}}_{t-1}^c) + \varpi^\eta \boldsymbol{\eta}_{t-1} + \alpha\phi_t, \tag{16}$$

which implies the change in the CDS spread is uncorrelated with the error term ν_{fit} in Equation (15).

3 Bond holdings data

We exploit two granular security-level datasets on investment-fund holdings of euro area sovereign debt: The ECB's Security Holdings Statistics by Sector (SHSS) and Refinitiv Lipper (RL). The datasets are complementary for the purposes of our paper, as each offers unique advantages that compensate for the other's shortcomings. Table 1 summarizes their key features. We use RL for the analysis at the individual investment-fund level in Section 4, and SHSS for the analysis of cross-sectoral rebalancing in Section 5. In order to highlight their commonalities and differences, we discuss both datasets jointly in the following before we use them separately in the next two sections.

3.1 Data sources

SHSS provides information on holdings of euro area-domiciled investors at the holder-country × holder-sector × security × time level.[8] It covers the universe of holdings of euro-area domiciled investors and is available from 2013 at the quarterly frequency. SHSS is an administrative record collected based on Regulation ECB/2012/24 by euro area national central banks. Data are obtained directly from investors (mainly in case of the financial sector) and indirectly from custodians. In addition to holdings, the data is complemented with information on security and issuer characteristics from the ECB's Centralised Securities Database (CSDB). SHSS is available only to ECB staff.

RL provides information on holdings at the investment fund × security × time level. It covers a sample of funds domiciled in as well as outside the euro area and is available to us from 2007 at the monthly frequency. RL is a proprietary dataset compiled based on information collected from fund-management companies, regulators, and third-party sources. In addition to holdings, RL also provides information on time-varying fund variables—such as net flows (inflows less outflows) and assets under management—as well as on time-invariant fund characteristics—such as asset universe (mutual fund, exchange-traded fund, pension fund, or hedge fund), domicile,

[8] Holder-country and holder-sector definitions are based on the 2010 European System of Accounts (ESA). For more information see https://data.ecb.europa.eu/methodology/securities-holdings-statistics.

Table 1: Comparison of SHSS and RL datasets

	Dataset	
	SHSS	RL
Granularity	Holder-country × holder-sector × security × time	Fund × security × time
Cross-sectional coverage	Universe of euro area holder-sectors excl. Eurosystem	Sample of global funds
Time coverage	2013q4-2023q4	2007m1-2023m12
Data points	245 million	750 million
of which: central government debt	1.9 million	9.7 million
of which: held by investment funds	0.4 million	9.7 million
Data provider	Administrative	Commercial
Access	ECB staff	Proprietary

Note: The table provides information on SHSS and RL along the dimensions of investor entities covered, finest level of granularity, time periods and cross-sectional units covered, who collects and provides the data, and how access is governed.

investment asset class (e.g. bonds, equity, or mixed assets), and geographical focus (e.g. Global, Euro Area, Europe, individual countries).[9] RL is rather comprehensive in terms of the coverage of investment-fund holdings, at least towards the end of our sample period. For example, at end-2022 RL covers close to 60% of the total assets of euro area domiciled bond and mixed-asset funds as reported in the ECB's Investment Fund Statistics.[10,11]

In both SHSS and RL we work with securities at the International Securities Identification Number (ISIN) level. Moreover, in both datasets we focus on holdings in terms of nominal (face) values in order to account for mechanical valuation effects due to price and exchange-rate changes. We obtain nominal values by dividing market values by the corresponding prices. We take prices from the ECB's CSDB from September 2013 onwards and from Bloomberg before.

Both SHSS and RL only provide information on *direct* holdings of euro area government debt. For example, in SHSS indirect household holdings of sovereign debt through fund shares are reported only as direct holdings of the investment-fund sector. Similarly, RL does not provide exhaustive information on the investor universe of the shares in the funds in the sample, including fund-of-fund holdings.[12]

[9] For more information on RL see `https://www.lseg.com/en/data-analytics/financial-data/fund-data/lipper-fund-data`.

[10] See `https://www.ecb.europa.eu/stats/financial_corporations/investment_funds/html/index.en.html`.

[11] EPFR Global and Morningstar also provide fund-level information with similar granularity as RL. While Morningstar and RL are broadly similar, an advantage of RL relative to EPFR Global is greater fund coverage.

[12] For an analysis that 'looks through' such indirect holdings to determine ultimate ownership, see Beck et al. (2023). For an analysis of the role of within-fund-sector interconnectedness through fund-of-fund shares, see Allaire et al. (2023).

3.2 Sample definitions and stylized facts

In SHSS we aggregate the raw data into six holder-sectors: banks, insurance corporations, pension funds, investment funds (which includes open and closed-ended funds, real estate funds, funds-of-funds and hedge funds)[13], households, and an other-sectors-composite (general government, non-financial corporations, money market funds and other financial corporations). We start with about 250mn observations at the holder-country × holder-sector × security × time level. We then select central government debt holdings by filtering for issuances from the 2010 ESA sector S1311[14]; for brevity, in the following we refer to this as 'sovereign debt'. This reduces the dataset for all holder-sectors to about 1.9mn observations, of which about 0.4mn observations pertain to the investment-fund sector. Since SHSS only covers sovereign debt holdings of investors domiciled in the euro area, we calculate rest-of-the-world holdings as a residual. To do so, we use information on the outstanding amount for each security from the ECB's CSDB and subtract holdings of euro area-domiciled investors and the Eurosystem of Central Banks (which are available to us from 2014q2).[15]

In RL we start with about 750mn investment fund × security × time observations. We then keep only (i) holdings of euro area central government debt[16] by (ii) mutual funds (iii) labelled as bond or mixed-asset funds with (iv) geographical focus Global, Europe or Euro Area (we exclude funds focusing on individual euro area countries). Figure D.4 shows how these categories feature individually in the full RL dataset. The rationale for this selection is that we want to study actively managed and investable funds, for which holdings of euro area sovereign bonds are not trivial already by design. The median portfolio weight of euro area sovereign debt across the funds we select is around 15% (Figure D.3). Imposing these selection criteria narrows down the RL sample to around 6.7 million observations at the fund × security × time level. Aggregating holdings over ISINs for a given issuer yields a 'potential' regression sample of 1.4 million observations at the fund × issuer × time level. Cleaning for outliers and potential misreporting and given data availability for control variables we end up with the actual baseline

[13]Based on ESA 2010, we consider sector S124, which covers all collective investment schemes which are principally engaged in financial intermediation except money-market funds, see https://ec.europa.eu/eurostat/documents/3859598/5925693/KS-02-13-269-EN.PDF/44cd9d01-bc64-40e5-bd40-d17df0c69334 for details.

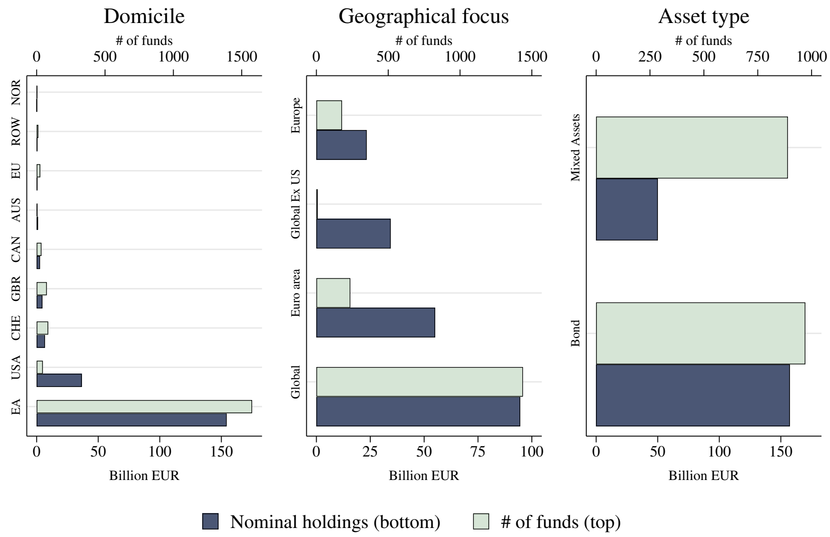
[14]We also filter out state-owned enterprises and government agencies by carefully checking all individual issuer names.

[15]Official data on the sectoral and geographical decomposition of foreign investors of euro area sovereign debt does not exist. Some work in the literature suggests that a large share of rest-of-the-world holdings are with non-euro area domiciled investment funds. For example, up to 50% of euro area portfolio inflows can be attributed to investment funds (see, e.g. Arslanalp and Tsuda, 2014; Kaufmann, 2023). In principle, such funds are sampled by RL.

[16]We classify central government debt holdings based on the RL holding type, country codes in ISINs and name searches. We cross-check our classification for the time period after 2013q3 based on ISIN and issuer information in RL with the corresponding information from the ECB's CSDB.

regression sample of around 0.8 million observations.[17] We will focus on this sample in the following exposition.

Figure 5: Distribution across fund characteristics in RL sample in 2022q4



Note: The panels show the distribution of total nominal holdings and the number of funds in the RL regression sample across different fund characteristics. The left-hand side panel shows the distribution across fund domicile, the middle panel across fund geographical focus, and the right-hand side panel across fund asset type. The bottom horizontal axis depicts the magnitude of total nominal holdings in EUR billion, and the top horizontal axis the number of funds.

Figure 5 shows the breakdown of fund holdings and fund counts for fund domicile, fund geographical focus and fund asset type in our baseline regression sample in 2022q4. The left-hand side column shows that around three quarters of the euro area sovereign debt in our data set is held by funds domiciled in the euro area. Sizable amounts are also held by funds domiciled in the US and, to a much lesser extent, in Switzerland and the UK. The number of funds domiciled in other jurisdictions as well as their amounts held are comparably small.

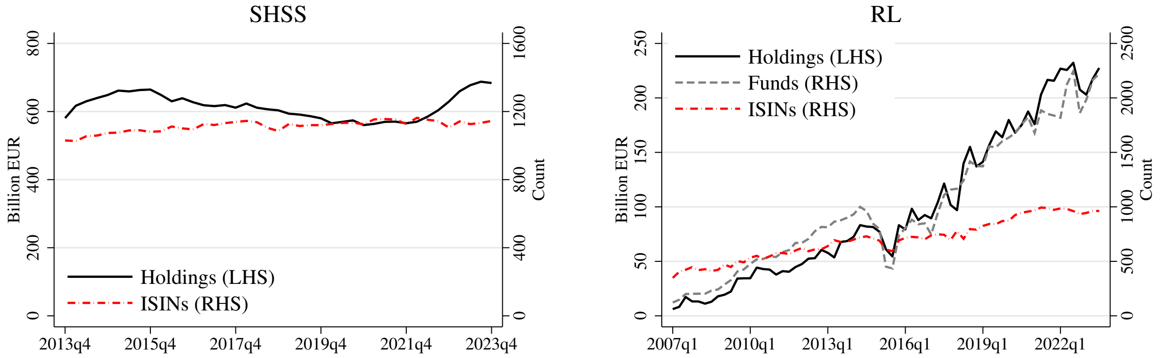
The middle column shows that about two thirds of euro area sovereign debt holdings are with funds with a global focus (with or without the US). The remaining amounts are held by funds with a focus on the euro area or Europe. In terms of fund counts, about three quarters of holdings are accounted for by funds with a global focus.

Finally, the right-hand side column shows that around three quarters of euro area sovereign debt holdings are with bond funds, while one quarter is with mixed-asset funds. In terms of fund counts, holdings are roughly equally accounted for by bond and mixed-asset funds.

Overall, our sample includes funds with relatively broad mandates, such as global bonds and equities as well as specialized funds focusing on specific segments of euro area sovereign bond markets.

[17] Figure D.5 shows how imposing our selection criteria narrows down the full RL dataset to the sample we use.

Figure 6: SHSS and RL coverage for investment-fund nominal holdings and ISIN/fund counts



Note: The left-hand side panel shows the evolution of euro area investment-fund-sector holdings of euro area sovereign debt and corresponding ISIN counts in SHSS. The right-hand side panel shows these statistics for RL, adding fund counts.

Figure 6 presents the coverage in terms of aggregated investment-fund holdings of euro area sovereign debt together with corresponding ISIN counts for SHSS (left-hand side) and additionally fund counts for RL (right-hand side). Two observations stand out.

First, nominal holdings and ISIN counts are higher in SHSS than in RL. Overall, this is because SHSS covers the universe of investment-fund holdings of euro area sovereign debt. At the same time, SHSS only covers euro area-domiciled investment funds, while RL also covers investment funds domiciled outside the euro area. However, to the extent this is representative, at least in RL the overwhelming majority of investment funds holding euro area sovereign debt is in fact domiciled in the euro area (Figure 5).

Second, nominal holdings, fund and ISIN counts in RL increase over time, while they are relatively stable in SHSS. This is because the types of funds we consider in each dataset differ—we can single out mutual funds in RL but not in SHSS—and because of a survivorship bias in RL. In particular, in the RL subscription available to us, a dataset retrieved in period t does not include funds that were liquidated or merged more than 40 days before period t. Such a survivorship bias is common in many widely-used micro-level datasets, such as the Orbis or Amadeus datasets on cross-country firm-level records (Kalemli-Ozcan et al., 2015).

Figure D.6 presents information on the distribution of investment-fund holdings by issuer in 2022q4 and on average over the sample period. We make two observations. First, the shares of outstanding sovereign debt held by investment funds, recorded in SHSS and sampled in RL are non-trivial. Second, the shares are systematically higher in SHSS than in RL, again because the former covers the universe of investment-fund holdings of euro area sovereign debt and because most of these are domiciled in the euro area. Figure D.7 shows the distribution of individual funds' holding shares for each issuer's outstanding debt in RL. Generally, the holdings of the funds in our sample are very granular compared to the outstanding amounts. This supports our assumption in Equations (2) and (3) that in general individual funds do not affect other funds and individual issuers, and that they can be treated as price-takers on euro area sovereign bond markets.

We next turn to the effects of euro disaster risk shocks on investor holdings of euro area sovereign debt. We first use RL to explore responses to euro disaster risk shocks at the individual investment-fund level. After that we use SHSS to explore how investment-fund responses compare to those of other holder-sectors and how debt holdings are rebalanced across holder sectors.

4 Investment-fund responses to euro disaster risk shocks

We first discuss our local-projection specification and then present estimates of the effect of euro disaster risk shocks on investment-fund holdings of euro area sovereign debt.

4.1 Local-projection specification

Against the background of Equation (14) we estimate fund $\times$ issuer panel local projections

$$h_{fi,t+\ell} - h_{fi,t-1} = \gamma_{fi}^{(\ell)} + \rho^{(\ell)} h_{fi,t-1} + \boldsymbol{\beta}^{(\ell)} \boldsymbol{x}_{f,t-1} + \boldsymbol{\delta}^{(\ell)} \boldsymbol{w}_{i,t-1} + \boldsymbol{\kappa}^{(\ell)} \boldsymbol{\eta}_{t-1} + \boldsymbol{\mu}^{(\ell)} \boldsymbol{d}_{t-1} + \left[\psi^{(\ell)} + \mathbb{1}(i \in \mathcal{C}) \chi^{(\ell)}\right] \Delta(cds_t^p - cds_t^c) + u_{fit}^{(\ell)}, \quad (17)$$

for horizons of $\ell = 0, 1, \ldots, 12$ months.[18] While holdings exhibit quite some inertia, funds adjust them frequently even over just one month (see Figure D.8).

In the fund-level controls $\boldsymbol{x}_{f,t-1}$, we include the lag of fund inflows scaled by lagged assets under management. In the issuer-level controls $\boldsymbol{w}_{i,t-1}$, we include lags of the logarithm of issuer i's average bond yield, year-on-year industrial production growth and the logarithm of central government debt outstanding. In the common controls $\boldsymbol{\eta}_{t-1}$ we include lags of the euro area and US shadow short rates of Wu and Xia (2016), the euro area CitiGroup Economic Surprise Index, the ten-year sovereign-bond yield spread between German Bunds and US Treasuries, and the VIX. Finally, in $\boldsymbol{d}_{t-1}$, we include the lagged level of the periphery-core CDS spread as well as lags of periphery-core spreads in year-on-year industrial production growth rates and the logarithms of central government debt outstanding. Table C.1 presents summary statistics of

[18] To robustify against extreme values for negative changes in holdings, instead of the log-difference $h_{fi,t+\ell} - h_{fi,t-1}$ as dependent variable we use the exact percent growth rate in fund f's nominal holdings of issuer i sovereign debt between period $t+\ell$ and $t-1$ denoted by $g_{fi,t+\ell}^h$; results hardly change though when we take log differences. We moreover: (i) focus on non-negative holdings $h_{fit} > 0$; (ii) set all observations $0 < h_{fit} < 10{,}000$EUR to missing, as we assume these are mis-reported by a factor of 10^x; (iii) trim the percent changes $g_{fi,t+\ell}^h$ at the 99% percentile.

the dependent and explanatory variables.

We use `reghdfe` in Stata (Correia, 2014) and cluster standard errors at the fund level and issuer-country × time level. The sample period is 2007m1 to 2023m12 (see Section 3.2).

4.2 Regression results

The black circled line in the left-hand side panel in Figure 7 presents the impulse response of the average fund's total euro area sovereign debt holdings to a euro disaster risk shock over a twelve-month horizon. Columns (1) and (2) in Table 2 provide more details on the regression results, including the total number of observations and the number of funds used. We find that the average fund sheds euro area sovereign debt in response to a euro disaster risk shock. The effect is statistically significant on impact, increases gradually over time, and reaches a trough after about seven months.

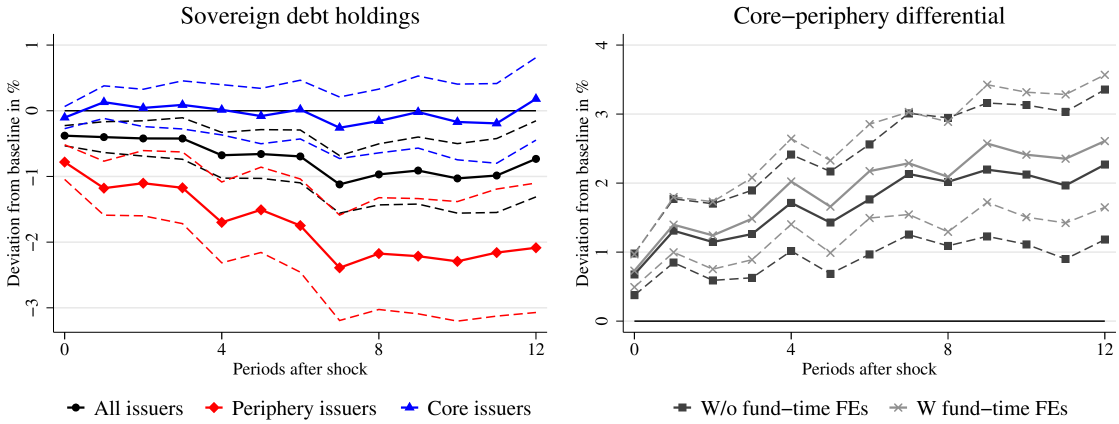
Recall the discussion about the scaling of the impulse responses in Section 2.5: Because a proxy-variable approach only identifies relative effects, we have to interpret the magnitude of the impulse response in Figure 7 relative to that of some benchmark variable; in Figure 3 we see that the euro disaster risk shock raises the periphery-core 10-year sovereign bond yield spread by about 10 basis points on impact. This corresponds to about one standard deviation of the latter's monthly change over the full sample period. The results in Figure 7 and Table 2 therefore imply that a euro disaster risk shock that raises the periphery-core 10-year sovereign bond yield spread by about one standard deviation induces the average fund to shed approximately 0.4% of its euro area sovereign debt holdings in the impact month and up to approximately 1% at the trough. In the following, we refer to a 'one-standard-deviation' euro disaster risk shock.

We next consider differences between the responses of fund holdings of core (Austria, Belgium, Estonia, Finland, France, Germany, Luxembourg, Netherlands) and periphery (Cyprus, Greece, Ireland, Italy, Portugal, Spain, Lithuania, Latvia, Malta, Slovakia, Slovenia) sovereign debt. Figure 8 presents the distribution of the number of euro area sovereign issuers of which funds hold debt. The majority of funds holds debt of more than one issuer (left-hand side panel). On average over the sample period, about 60% of funds held both core and periphery debt (right-hand side panel).

Figure 7 shows that the average fund sheds periphery (red diamond line, $\widehat{\psi}^{(\ell)}$ in Equation (17)) but does not accumulate core (blue triangle line, $\widehat{\chi}^{(\ell)} + \widehat{\psi}^{(\ell)}$) debt in response to a euro disaster risk shock. Columns (3) and (4) of Table 2 provide further information on the regression results.

The right-hand side panel in Figure 7 shows that the average fund's core-periphery differential response (black solid squared line, $\widehat{\chi}^{(\ell)}$ in Equation (17)) builds up gradually over time and

Figure 7: Effects of euro disaster risk shocks on investment-fund holdings of euro area sovereign debt



Note: The left-hand side panel shows the impulse response of fund holdings of euro area (black circle line), core (blue triangle line), and periphery (red diamond line) sovereign debt to a euro disaster risk shock that raises the periphery-core 10-year sovereign bond yield spread by one standard deviation. The impulse responses are obtained from regressions of Equation (17). The right-hand side panel shows the impulse response of the corresponding core-periphery differential. The dark grey solid squared line depicts the estimates without fund-time fixed effects from Equation (17), and the light grey solid crossed line the estimates with fund-time FEs from Equation (18). Dashed lines indicate 90% confidence bands. Standard errors are clustered at the fund level and issuer × time level. Periods refer to months.

reaches a peak at about 2%. The light grey crossed line shows that the differential is very similar when we add fund-time FEs α_{ft} in the spirit of Khwaja and Mian (2008) to Equation (17) and estimate

$$h_{fi,t+\ell} - h_{fi,t-1} = \gamma_{fi}^{(\ell)} + \rho^{(\ell)} h_{fi,t-1} + \boldsymbol{\delta}^{(\ell)} \boldsymbol{w}_{i,t-1} + \alpha_{ft} + \left[\psi^{(\ell)} + \mathbb{1}(i \in \mathcal{C})\chi^{(\ell)}\right]\Delta(cds_t^p - cds_t^c) + u_{fit}^{(\ell)}. \tag{18}$$

Columns (5) and (6) of Table 2 again provide further details. Note that in Equation (18) $\chi^{(\ell)}$ is identified by variation across holdings of core and periphery debt in response to a euro disaster risk shock *within* a given fund. In addition to the fund-level controls $\boldsymbol{x}_{f,t-1}$, the common controls $\boldsymbol{\eta}_{t-1}$ and the variables in $\boldsymbol{d}_{t-1}$, the fund-time FEs absorb all potentially unobserved drivers of changes in fund holdings, such as time variation in fund-manager risk aversion or the composition of the fund-investor base. The fact that we obtain very similar results for the differential with and without fund-time FEs suggests the controls we include in $\boldsymbol{x}_{f,t-1}$ and $\boldsymbol{\eta}_{t-1}$ account well for all empirically relevant time-varying determinants of fund holdings at the macro-financial and at the fund-level.

The effects we estimate in Figure 7 are economically meaningful. For example, for the largest euro disaster risk shock in the sample with a change in the CDS spread of about five standard

Table 2: Baseline regression results for effects of euro disaster risk shocks on fund holdings of euro area sovereign debt

	All debt		Periphery vs core debt			
	(1) On impact	(2) After $\bar{\ell}$ periods	(3) On impact	(4) After $\bar{\ell}$ periods	(5) On impact	(6) After $\bar{\ell}$ periods
$\Delta(cds_t^p - cds_t^c)$	-0.380***	-0.910***	-0.781***	-2.214***		
	(0.00)	(0.00)	(0.00)	(0.00)		
$\Delta(cds_t^p - cds_t^c) \times \mathbb{1}(i \in core)$			0.677***	2.194***	0.731***	2.573***
			(0.00)	(0.00)	(0.00)	(0.00)
Lagged holdings $h_{fi,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes
Proxy controls $\boldsymbol{d}_{t-1}$	Yes	Yes	Yes	Yes	No	No
Common controls $\boldsymbol{\eta}_{t-1}$	Yes	Yes	Yes	Yes	No	No
Issuer controls $\boldsymbol{w}_{i,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes
Fund controls $\boldsymbol{x}_{f,t-1}$	Yes	Yes	Yes	Yes	No	No
Fund-issuer FEs	Yes	Yes	Yes	Yes	Yes	Yes
Fund-time FEs	No	No	No	No	Yes	Yes
Total observations	775,328	588,175	775,328	588,175	883,631	664,552
Number of funds	4,668	3,868	4,668	3,868	3,794	3,196
Within R-squared	0.07	0.29	0.07	0.29	0.37	0.55
$\psi + \chi = 0$			−0.104	−0.020		
			(0.31)	(0.95)		

Note: The table reports results from the regression of Equation (17) without core-country dummy interaction in Columns (1) and (2), Equation (17) in Columns (3) and (4), and Equation (18) in Columns (5) and (6). Fund-level controls $\boldsymbol{x}_{f,t-1}$ include the lag of fund inflows relative to lagged assets under management. Issuer-level controls $\boldsymbol{w}_{i,t-1}$ include lags of the logarithm of issuer i's bond yield, year-on-year growth in industrial production and the logarithm of the stock of central government debt outstanding. Common controls $\boldsymbol{\eta}_{t-1}$ include lags of the euro area and US shadow short rates of Wu and Xia (2016), the euro area CitiGroup Economic Surprise, the ten-year sovereign-yield spread between German Bunds and US Treasuries, and the VIX. In $\boldsymbol{d}_{t-1}$ we include the lagged level of the CDS spread as well as lags of periphery-core spreads in year-on-year industrial production growth and the logarithm of the stock of central government debt outstanding. Standard errors are clustered at the fund level and issuer × time level. p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***).

deviations around May 2018, the results in Figure 7 imply that the average fund reduced its holdings of periphery sovereign debt by approximately 10%. Given that funds held about 13% of total outstanding euro area sovereign debt at the time (Figure D.1), this implies a shedding of about 1.3% of total outstanding amounts. This is economically large, and in fact close to the actual sales of about 1.7% of total outstanding amounts observed in 2018.

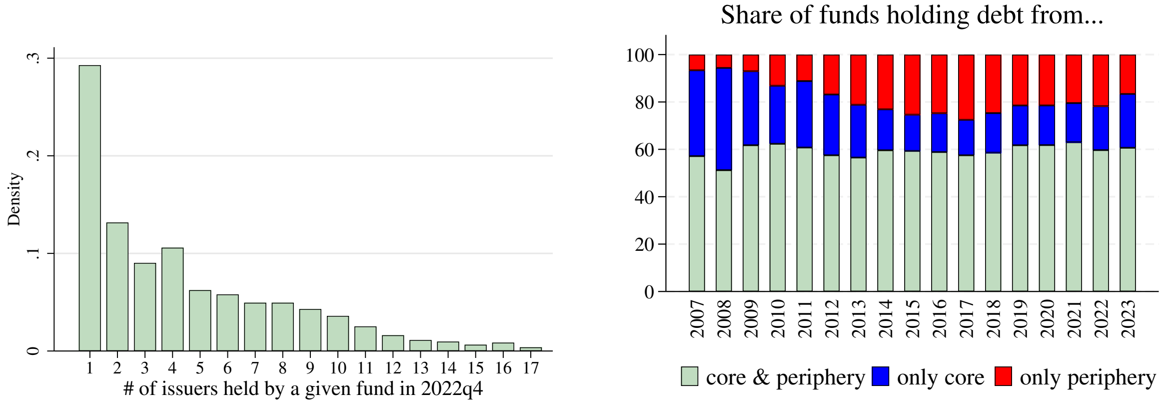
In Appendix E we document that virtually all adjustments in fund holdings of euro area sovereign debt in response to euro disaster risk shocks occur at the intensive rather than the extensive margin. In Appendices F and G we document that funds shed only periphery debt denominated in euro but not other currencies and with relatively long residual maturity beyond five years.

4.3 Robustness

Our results are robust to several relevant changes in the specification.

First, our results are robust to using a traditional IV rather than a proxy-variable approach.

Figure 8: Distribution of the number of euro area sovereign issuers held by funds



Note: The left-hand side panel shows a histogram for the number of euro area sovereign issuers of which funds hold debt in the regression sample. The right-hand side panel shows the evolution of the share of funds in the regression sample which hold both core and periphery (light green), only core (blue), or only periphery (red) sovereign debt.

In particular, similar in spirit to the empirical literature on the effects of fiscal policy (Mertens and Ravn, 2013), we treat the change in the CDS spread as a potentially endogenous variable and instrument it with a dummy variable that equals (minus) unity in the months with the five largest positive (negative) spikes (Table C.2). Recall that these spikes can be attributed straightforwardly to euro disaster risk events (Tables A.1 and A.2 as well as Figure A.2), and should therefore convincingly satisfy the relevance and exogeneity conditions in Equation (10) than the raw CDS spread change.

Second, our results do not change much when we consider alternative proxy variables for the euro disaster risk shock (Table C.3). Notably, these include (i) calculating the CDS spread using data for Portugal and Ireland in addition to those for Italy and Spain, (ii) cleansing the change in the CDS spread at the daily frequency by Bloomberg macro-release surprises before aggregating to monthly frequency, (iii) dropping all events during 2010-12 at the height of the euro area sovereign debt crisis, (iv) using the average CDS premium across euro area countries rather than the periphery-core spread, and (v) using the change in the periphery-core sovereign bond yield spread. Moreover, results do not change if we use only the five or ten largest spikes in the CDS spread change as proxy variable (Table C.4), or if we only use dummies in the months with these spikes as proxy variable instead of as an IV (Table C.5).

Third, three-year rolling-window regressions show that our baseline findings are not driven by a single stress event/period but emerge during the Global Financial Crisis, the European sovereign debt crisis, the period of the ECB's Asset Purchase Programme, and the COVID-19 pandemic (Figure D.9). Interestingly, in these rolling regressions we do find flight-from-periphery *and* flight-to-core in samples starting from early 2018, consistent with the episode in Figure 1.

Fourth, both positive and negative euro disaster risk shocks impact fund holdings of periphery debt (Table C.6). Moreover, results are unchanged if we weight observations by a fund's total holdings of euro area sovereign debt, and they apply across the entire fund-size distribution (Table C.7).

Fifth, our results are robust to alternative definitions of the core and periphery country groups (Table C.8) and are similar whether funds are domiciled in core or periphery countries (Table C.9).

Finally, our results do not change if we use only fund-issuer pairs with a large number of time-series observations to minimize the Nickell-bias (Herbst and Johannsen, 2024), if we include only funds that hold both core and periphery debt (Table C.10), and if we consider robust or alternative clusterings of standard errors (Table C.11).

We next explore whether investment-fund responses are driven by fund-manager or fund-investor decisions and what types of funds are more sensitive.

4.4 Who is driving the responses: fund-managers or fund-investors?

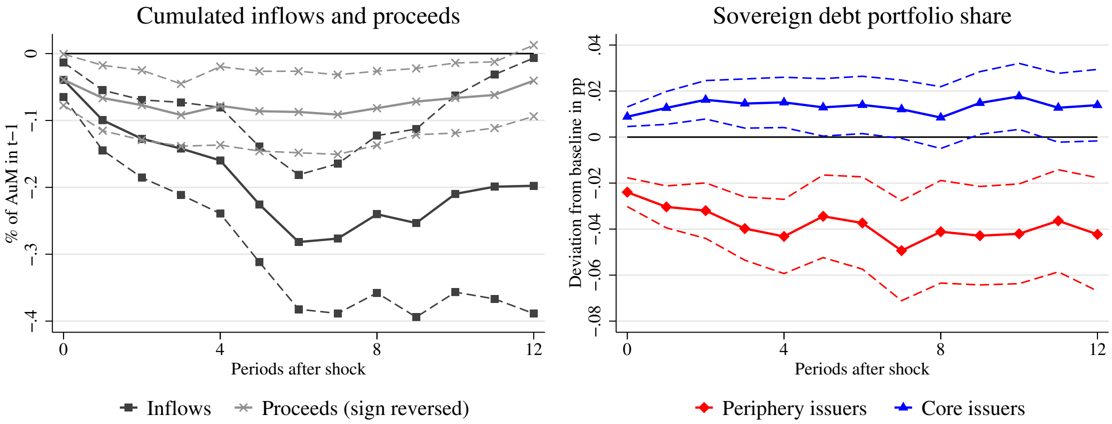
In general, investment-fund responses to euro disaster risk shocks may be driven by both fund-manager and fund-investor decisions. For example, fund-investors may decide to liquidate their fund shares and demand redemptions, which requires the fund to generate liquidity by shedding some of its assets. Given such outflows, the fund-manager may shed assets proportionately to initial portfolio weights or rebalance the portfolio.

The left-hand side panel in Figure 9 shows that the average fund indeed face sizable and persistent outflows from their investors (dark line with square markers). Therefore, the fund must be shedding periphery debt at least in part in order to accommodate fund-investor redemptions. Depending on the size of the proceeds from shedding periphery debt, the fund may also rebalance proceeds that exceed fund-investor redemptions to other assets. However, taking into account also price developments shows that the proceeds from shedding periphery debt are not enough to meet fund-investor redemption demands (grey line with cross markers, sign reversed for easier comparability). This means the fund must also be shedding assets other than periphery sovereign debt.

The right-hand side panel in Figure 9 shows that the shedding of periphery debt leads to a significant fall in its portfolio weight of up to 0.05 percentage points (across funds the median portfolio weight of individual periphery issuers is about 1.9%). Instead, the portfolio share of core debt increases slightly. In combination with the results in Section 4.2 this indicates that fund-managers make an active decision to reduce their relative exposure to periphery debt.

In order to show this more formally, we next adopt an approach introduced by Raddatz and

Figure 9: Effects of euro disaster risk shocks on inflows from fund-investors, proceeds from shedding periphery debt, and portfolio weights of euro area sovereign debt



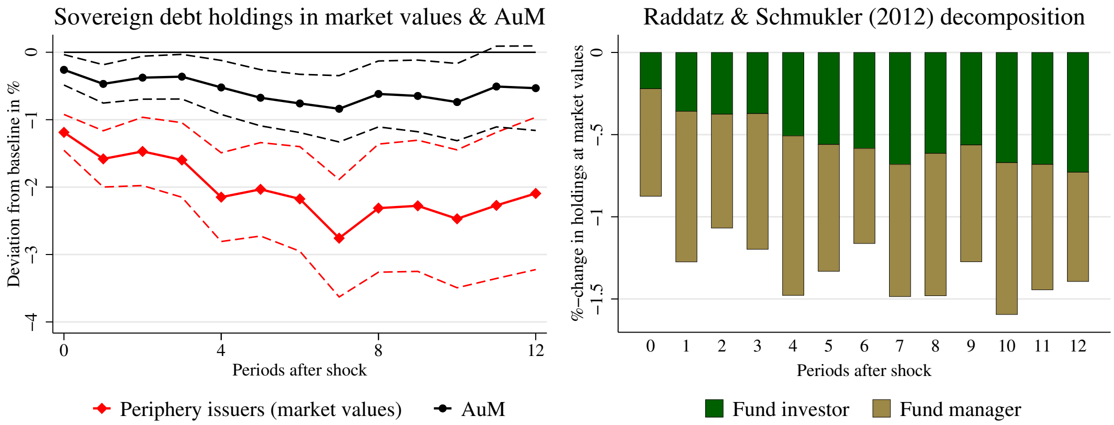
Note: The figure shows the impulse response of inflows from fund-investors and the proceeds from shedding periphery debt (left-hand side panel) and portfolio weights (right-hand side panel) of euro area core (blue triangle line) and periphery (red diamond line) sovereign debt to a one-standard-deviation euro disaster risk shock. The impulse responses are obtained from regressions of Equation (17). Dashed lines indicate 90% confidence bands. Standard errors are clustered at the fund level and issuer × time level. Periods refer to months.

Schmukler (2012) to decompose the response of fund holdings of periphery debt into components reflecting fund-investor and fund-manager decisions, respectively. Intuitively the decomposition works as follows. The fund's response is fully driven by fund-investor decisions if holdings of periphery debt fall by just as much as total assets under management in response to a euro disaster risk shock; in this case, the portfolio weight of periphery sovereign debt does not change. Instead, if holdings of periphery debt fall by more than total assets under management, the response is at least in part due to fund-manager decisions.

Figure 10 presents the results. The left-hand side panel shows that fund total assets under management (at market values) drop by up to about 1% (black solid line with circle markers). Intuitively, if we observed a drop in fund holdings of the same size this would suggest the fund response is entirely driven by fund-investor decisions. However, fund holdings of periphery debt (at market prices) drop by up to about 2 percentage points more than assets under management (red solid line with diamond markers). Intuitively, this suggests the fund-manager decides to rebalance the portfolio away from periphery debt (see also Figure 9).

The right-hand side panel in Figure 10 presents results from a formal version of this decomposition (see Equation (7) in Raddatz and Schmukler, 2012). The results indicate that on impact only about one quarter of the response of fund holdings of periphery debt are due to fund-investor decisions, while about three quarters are due to fund-manager decisions. The relative importance of fund-investor decisions grows over time, and one year after the shock they

Figure 10: Decomposition of changes in gross holdings of periphery debt due to fund-manager and fund-investor decisions



Note: The left-hand side panel shows the dynamic responses of fund holdings of periphery sovereign debt in market values (solid red diamond line) and total assets under management (solid black circle line) obtained from fund-level local projection regressions based on Equation (17). Dashed lines indicate 90% confidence bands. Standard errors are clustered at the fund and time level. See also the note to Figure 7. The right-hand side panel shows the decomposition of changes in holdings in market values into those driven by fund-manager and fund-investor decisions, respectively, proposed by Raddatz and Schmukler (2012).

account for about half of the shedding of periphery debt.[19] The finding that fund-managers shed periphery debt is not obvious *a priori*. In fact, periphery debt experiences valuation losses while core debt valuations actually rise (see Figure 3). Shedding periphery debt therefore materializes these valuation losses. This suggests that fund-managers deem that euro disaster risk shocks warrant a persistent portfolio rebalancing, potentially to also avoid further investor outflows who tend to be sensitive to fund's past performance (Chen et al., 2010).

Overall, our results suggest fund-managers liquidate periphery debt and other (non-core debt) asset holdings in response to euro disaster risk shocks to satisfy redemption demands. To this extent, the shedding of periphery debt is driven by fund-investor decisions. However, fund-managers shed periphery debt holdings disproportionately strongly relative to other asset holdings. Therefore, also fund-manager decisions drive the shedding of periphery debt. The right-hand side panel in Figure 10 shows how much fund-investor and fund-manager decisions account for the shedding of periphery over time.

[19]The contribution of fund-manager decisions could be further decomposed into changes in the periphery debt portfolio weight of the fund's benchmark and active deviations from this changing benchmark portfolio weight.

4.5 Which funds are more sensitive?

We next explore which types of funds are more sensitive to euro disaster risk shocks. To do so, we consider separately groups of funds that differ regarding fund domicile, geographical focus, asset universe and portfolio share. To shorten the exposition, we focus on the effects of euro disaster risk shocks after $\ell = 9$ months and on the core-periphery differential as a measure of sensitivity of fund holdings of periphery debt.

Results are reported in Table 3. Columns (2) and (3) indicate that mixed-assets funds are more sensitive. Columns (4) and (5) suggest that funds whose geographical focus is not confined to the euro area also respond more sensitively. Columns (6) to (9) indicate that funds that are domiciled outside Europe respond more sensitively. Interestingly, Column (7) shows that funds domiciled in European financial centers (Switzerland, the UK, Guernsey, Isle of Man, Jersey, Liechtenstein and Monaco), are more sensitive, which is consistent with them being hubs for global investors (see e.g. Beck et al., 2023). Finally, Columns (10) to (12) suggest that funds that have a smaller euro area sovereign debt portfolio share are more sensitive. Table C.12 documents that the sensitivity of inflows from fund-investors to euro disaster risk shocks varies in a very similar pattern with fund characteristics.

Table 3: Effects of euro disaster risk shocks on sovereign debt holdings for different fund groups

		Asset type		Geographic focus		Domicile				Portfolio weight		
	(1) Baseline	(2) Bonds	(3) Mixed assets	(4) EA	(5) Global	(6) EA	(7) Eur. fin. centers	(8) North America	(9) RoW	(10) $\omega < 25\%$	(11) $25\% < \omega < 75\%$	(12) $> 90\%$
$\Delta(cds^p_t - cds^c_t) \times \mathbb{1}(i \in core)$	2.573***	2.228***	3.310***	2.169***	2.817***	2.438***	3.658***	3.193*	6.879***	2.843***	2.441***	2.163***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)	(0.01)	(0.00)	(0.00)	(0.00)
Lagged holdings $h_{fi,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Issuer controls $\boldsymbol{w}_{i,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund-issuer FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund-time FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Total observations	664,552	424,199	240,353	157,266	437,476	553,369	67,322	31,977	3,781	344,389	222,316	54,591
Number of funds	3,196	1,618	1,578	465	2,439	2,650	350	118	27	2,243	717	132
Within R-squared	0.55	0.53	0.58	0.54	0.56	0.55	0.62	0.52	0.69	0.57	0.51	0.67

Note: The table reports results for the regression of Equation (18) for samples of funds with different asset types (Columns 2 and 3), different geographical focus (Columns 4 and 5), different domicile (Columns 6 to 9), and different euro area debt portfolio shares (Columns 10 to 12). European financial centers are: Switzerland, the UK, Guernsey, Isle of Man, Jersey, Liechtenstein and Monaco. p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). See also the notes to Table 2.

These findings suggest that funds with characteristics that arguably correlate with weaker expertise about euro area sovereign debt markets are more sensitive to euro disaster risk shocks. For example, it is plausible that a fund that specializes in euro area sovereign debt has more expertise than a fund with a minor euro area sovereign debt portfolio share. Analogously, all else equal, it is plausible that a fund that is domiciled in the euro area has more expertise than a fund that is domiciled in, say, South Africa. These results echo the literature on gravity in cross-border finance, which highlights the role of frictions, home bias and information asymmetries for investment patterns and the sensitivity of investor responsiveness to shocks (see e.g. Okawa and van Wincoop, 2012).

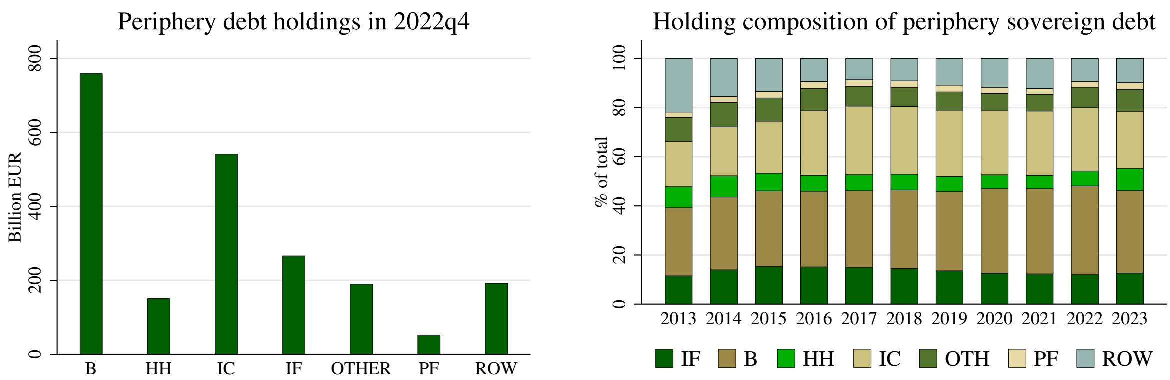
5 Are investment-fund responses special?

We next use SHSS to study how investment-fund responses compare to those of banks, insurance corporations, pension funds, households, and the rest of the world. This also allows us to explore which holder-sector picks up the periphery debt shed by investment funds. Before we present results, we discuss some stylized facts on periphery debt holdings across holder-sectors and holder-countries.

5.1 Stylized facts on euro area periphery sovereign debt holdings

Figure 11 presents the holdings of periphery sovereign debt by holder-sector in 2022q4 and the evolution of the corresponding holder shares over time. At the aggregate euro area holder-sector level and on average over time about 80% of periphery sovereign debt is held by banks (B), insurance corporations (IC), investment funds (IF), and households (HH). The other-sectors composite and pension funds (PF) account for about 10%, which is about as much as the rest-of-the-world residual (ROW). As discussed in Section 3.2, we cannot distinguish between holder-sectors within the latter, but evidence suggests that investment funds account for a large share of it (Arslanalp and Tsuda, 2014; Kaufmann, 2023).

Figure 11: Periphery sovereign debt holdings by holder-country-group in 2022q4 and holder-sector shares over time



Note: The left-hand side panel shows periphery sovereign debt holdings by holder-sector in SHSS in 2022q4; the holding shares refer to the free-float, i.e. total outstanding amounts excluding Eurosystem holdings. The right-hand side panel shows the evolution of the corresponding holding shares over time.

5.2 Effects of euro disaster risk shocks on investment-fund holdings in SHSS

To facilitate the exposition, we first focus on investment funds in order to compare responses estimated in RL and SHSS data, respectively. For consistency to the investment-fund level regressions in Section 4 based on RL data we would ideally carry out the analysis for other investors also at the holder-entity—such as the individual bank—level. However, recall that SHSS does not report information at the holder-entity level. Therefore, to maximize statistical power we leverage the granularity of SHSS and estimate holder-country × ISIN instead of holder-country × issuer panel local projections. It turns out that this increases the number of observations by more than a factor of 100. In particular, we estimate

$$\begin{aligned} h_{\mathcal{H},IF,\mathcal{I},t+\ell} - h_{\mathcal{H},IF,\mathcal{I},t-1} = & \gamma^{(\ell)}_{\mathcal{H},\mathcal{I}} + \varrho^{(\ell)} h_{\mathcal{H},IF,\mathcal{I},t-1} + \boldsymbol{\delta}^{(\ell)} \boldsymbol{w}_{i(\mathcal{I}),t-1} + \boldsymbol{\kappa}^{(\ell)} \boldsymbol{\eta}_{t-1} + \boldsymbol{\mu}^{(\ell)} \boldsymbol{d}_{t-1} \\ & + \left[\psi^{(\ell)} + \chi^{(\ell)} \mathbb{1}(i(\mathcal{I}) \in core)\right] \Delta(cds^p_t - cds^c_t) + u^{(\ell)}_{\mathcal{H},IF,\mathcal{I},t}, \end{aligned} \tag{19}$$

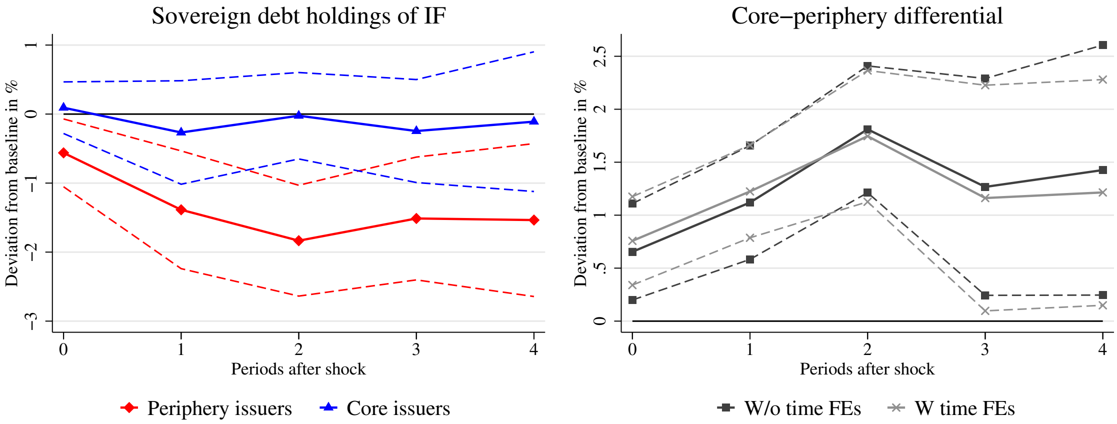
where $h_{\mathcal{H},IF,\mathcal{I},t+\ell}$ are holdings of ISIN $\mathcal{I}$ by holder-country $\mathcal{H}$'s investment-fund sector (IF) at horizon ℓ, and $i(\mathcal{I})$ is the issuer-country i associated with ISIN $\mathcal{I}$. In Equation (19), $\psi^{(\ell)}$ represents the average effect of euro disaster risk shocks on debt holdings of investment-fund sectors across all euro area holder-countries $\mathcal{H}$ and periphery-issuer ISINs, and $\psi^{(\ell)} + \chi^{(\ell)}$ denotes the respective effect on core-issuer ISINs. Table C.13 presents summary statistics for the dependent variable in Equation (19). When estimating Equation (19) we weight observations by the average holder-country holdings over the sample period, that is by $\omega_{\mathcal{H},IF,\mathcal{I}} = log(T^{-1} \sum_t \sum_{\mathcal{I}} h_{\mathcal{H},IF,\mathcal{I},t})$.[20]

Analogous to the fund-level regressions in Section 4, in $\boldsymbol{w}_{i(\mathcal{I}),t-1}$ we include lags of the logarithm of security $\mathcal{I}$'s yield, the year-on-year industrial production growth rate and the logarithm of the stock of central government debt outstanding, in $\boldsymbol{\eta}_{t-1}$ lags of the euro area and US shadow short rates of Wu and Xia (2016), the euro area CitiGroup Economic Surprise Index, the ten-year sovereign-bond yield spread between German Bunds and US Treasuries, and the VIX, and in $\boldsymbol{d}_{t-1}$ the lagged level of the CDS spread, lags of the spreads between year-on-year industrial production growth rates and the logarithms of central government debt outstanding. The sample period is 2013q4 to 2023q4. We cluster standard errors at the holder-country level and issuer-country × time level.

Figure 12 presents the results, which are consistent with our findings at the investment-fund level based on RL in Section 4 (see Figure 7). This is noteworthy given the differences in the

[20] To robustify our analysis against extreme values for negative changes in holdings, as dependent variable we again use the exact percent growth rate between periods $t+\ell$ and $t-1$, $g^h_{\mathcal{H},IF,\mathcal{I},t+\ell}$. Moreover, we focus on non-negative holdings and additionally trim positive percent growth rates $g^h_{\mathcal{H},IF,\mathcal{I},t}$ for each holder-sector at $min(p_{95}, \ell \times 75\%)$, where p_{95} represents the 95% percentile. We trim more generously because compared to the fund × *issuer* level in Section 4, at the holder-sector × holder-country × *ISIN* level a much larger share of observations exhibit extremely large growth rates as holdings rise starting from values very close to zero.

Figure 12: Effects of euro disaster risk shocks on investment-fund holdings of euro area sovereign debt from holder-country × ISIN panel local projections



Note: The left-hand side panel shows the impulse response of investment-fund holdings of core (blue triangle line) and periphery debt (red diamond line) to a euro disaster risk shock that raises the periphery-core 10-year sovereign bond yield spread by one standard deviation. The responses for horizon ℓ are obtained from weighted holder-country × ISIN panel regressions of Equation (19). Weights are given by average holder-country holdings over the sample period, that is $w_{\mathcal{H},\mathcal{I}} = log\left(T^{-1}\sum_t \sum_{\mathcal{I}} h_{\mathcal{H},\mathcal{I},t}\right)$. The right-hand side panel shows the corresponding core-periphery differential. The black (grey) solid squared line depicts the estimates without (with) holder-country × time FEs from Equation (19). Standard errors are clustered at the holder-country level and issuer-country × time level. Dashed lines indicate 90% confidence bands. Periods refer to quarters.

data frequency as well as the sample period, the funds covered, and the level of aggregation. We again find that on impact investment funds shed periphery but do not accumulate core debt. The effect on periphery debt holdings is persistent and increases over time.[21] Table 4 provides the underlying regression results for $\ell = 0, 3$ in Columns (1), (2) and (4) and (5), and for the average effect over $\ell = 0, 1, 2, 3$ in Columns (3) and (6), including information on the total number of observations and the number of ISINs.

To document robustness, Figure D.14 presents results from several alternative specifications in which: (i) we estimate un-weighted regressions; (ii) drop observations with Latvia, Lithuania, Estonia, Malta and Cyprus as rather small issuer and holder-countries; (iii) consider only a narrow set of issuer-countries; (iv) drop observations with Luxembourg and Ireland as holder-countries given their role as financial centers that manage wealth of ultimate investors domiciled elsewhere; (v) keep only or (vi) exclude Italy and Germany as the largest issuer countries; (vii) exclude Cyprus, Greece, Ireland and Portugal as issuer and holder-countries given they went through a Troika program. The results for these alternative specifications are all similar to the baseline in Figure 12.

[21] To further demonstrate the consistency of the investment fund results in both data sets, Figure D.12 compares results for SHSS from Figure 12 from analogous regressions using RL for euro-area domiciled funds aggregated to the fund-domicile-country level and to quarterly frequency. Using RL data, Figure D.13 compares results at the individual investment-fund level estimated for the full RL sample period from 2007m1-2023m12 as in Figure 7 with the same estimation, but for the sample period from 2013m10-2023m12 available in SHSS.

Table 4: Results for holder-country × ISIN panel regressions for effects of euro disaster risk shocks on investment-fund holdings of euro area sovereign debt

	(1) $\ell = 0$	(2) $\ell = 3$	(3) $\ell = 0,1,2,3$	(4) $\ell = 0$	(5) $\ell = 3$	(6) $\ell = 0,1,2,3$
$\Delta(cds_t^p - cds_t^c)$	-0.562*	-1.513**	-1.763***			
	(0.08)	(0.01)	(0.00)			
$\Delta(cds_t^p - cds_t^c) \times \mathbb{1}(i(\mathcal{I}) \in core)$	0.654**	1.267*	1.661***	0.758***	1.162*	1.579***
	(0.03)	(0.06)	(0.00)	(0.01)	(0.09)	(0.00)
Lagged holdings $h_{fi,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes
Proxy controls $\boldsymbol{d}_{t-1}$	Yes	Yes	Yes	No	No	No
Common controls $\boldsymbol{\eta}_{t-1}$	Yes	Yes	Yes	No	No	No
Issuer controls $\boldsymbol{w}_{i,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes
Holder-country x ISIN FEs	Yes	Yes	Yes	Yes	Yes	Yes
Holder-country x time FEs	No	No	No	Yes	Yes	Yes
Total observations	216,711	176,886	175,684	216,705	176,875	175,671
Number of holder-countries	19	19	19	19	19	19
Number of ISINs	2,149	1,888	1,882	2,149	1,888	1,882
Within R-squared	0.14	0.32	0.32	0.17	0.34	0.34
$\psi + \chi = 0$	0.093	−0.246	−0.102			
	(0.69)	(0.60)	(0.79)			

Note: The table reports results from holder-country × ISIN panel regressions in Equation (19) for horizons $\ell = 0, 3$ and the average effect over $\ell = 0, 1, 2, 3$ using SHSS data. Columns (4) to (6) include holder-country × time FEs. The last row reports results for $H_0 : \psi + \chi = 0$. p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). Standard errors are clustered at the holder-country level and issuer-country × time level.

We next estimate the effects of euro disaster risk shocks on sovereign debt holdings for banks, households, insurance corporations, pensions funds, the other-sectors-composite, and the rest of the world. From here on we focus on periphery debt holdings.

5.3 Comparison of effects across all holder-sectors

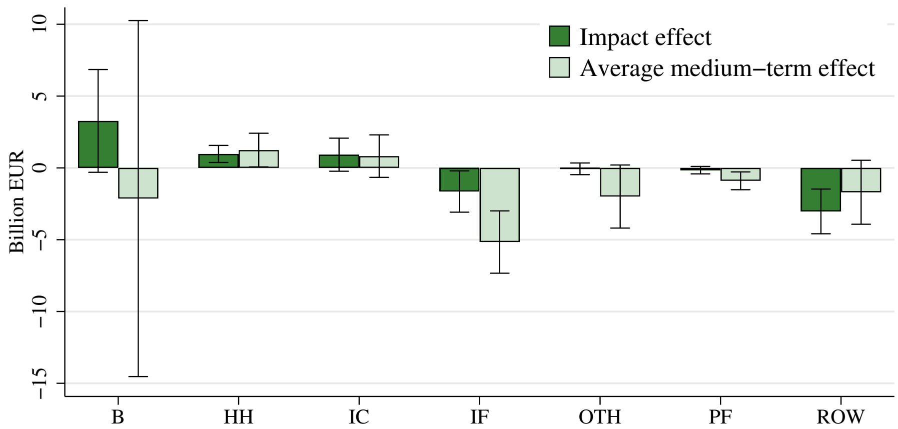
We estimate separately for each holder-sector $\mathcal{S}$

$$h_{\mathcal{H},\mathcal{S},\mathcal{I},t+\ell} - h_{\mathcal{H},\mathcal{S},\mathcal{I},t-1} = \gamma^{(\ell)}_{\mathcal{H},\mathcal{S},\mathcal{I}} + \varrho^{(\ell)}_{\mathcal{S}} h_{\mathcal{H},\mathcal{S},\mathcal{I},t-1} + \boldsymbol{\delta}^{(\ell)}_{\mathcal{S}} \boldsymbol{w}_{i(\mathcal{I}),t-1} + \boldsymbol{\kappa}^{(\ell)}_{\mathcal{S}} \boldsymbol{\eta}_{t-1} + \boldsymbol{\mu}^{(\ell)}_{\mathcal{S}} \boldsymbol{d}_{t-1} + \left[\psi^{(\ell)}_{\mathcal{S}} + \chi^{(\ell)}_{\mathcal{S}} \mathbb{1}(i(\mathcal{I}) \in core)\right] \Delta(cds^p_t - cds^c_t) + u^{(\ell)}_{\mathcal{H},\mathcal{S},\mathcal{I},t}, \tag{20}$$

where $\mathcal{S} \in \{B, HH, IC, IF, PF, OTH, ROW\}$ indexes banks, households, insurance corporations, investment funds, pension funds, the other-sectors-composite, and the rest of the world. We focus on $\psi^{(\ell)}_{\mathcal{S}}$, which denotes the effect of euro disaster risk shocks on periphery debt holdings of holder-sector $\mathcal{S}$.

Figure 13 presents the results. To simplify the exposition, we show only the impact effects (dark green bars) and the average effect over horizons $\ell = 0, 1, 2, 3$ (light green bars). To allow a direct comparison of adjustments in holdings and hence cross-sectoral rebalancing, we present these results in terms of absolute euro amounts.[22] Four observations stand out.

Figure 13: Effects of euro disaster risk shocks on periphery sovereign debt holdings across euro area holder-sectors



Note: The figure shows the effects of a euro disaster risk shock that raises the periphery-core 10-year sovereign bond yield spread by one standard deviation on periphery debt holdings across holder-sectors, namely banks (B), households (HH), insurance corporations (IC), investment funds (IF), an other-sectors-composite (OTH), pension funds (PF), and the rest of the world (ROW). The dark-shaded (light-shaded) green bars present results for the impact period (average effect over the impact and the three following periods). Bars indicate point estimates and whiskers 90% confidence bands. The estimates are obtained from weighted holder-country × ISIN panel local-projection regressions of Equation (20) run separately for each holder-sector. Weights are given by average holder-country holdings over the sample period, that is $w_{\mathcal{H},\mathcal{I}} = log\left(T^{-1}\sum_t \sum_{\mathcal{I}} h_{\mathcal{H},\mathcal{I},t}\right)$. *Standard errors are clustered at the issuer-country × time level. The effects shown are expressed in euro amounts, obtained by first calculating average holdings of a given holder-sector over the sample period, holder-countries and ISINs. These are then multiplied by the number of ISINs held by that holder-sector and by the percentage-change effects estimated from the local projections in Equation (20).*

First, on impact investment funds and the rest-of-the-world are the only holder-sectors that shed non-trivial amounts of periphery debt. Recall that investment funds domiciled in the rest of the world account for such portfolio debt flows to a large extent (Arslanalp and Tsuda, 2014; Kaufmann, 2023).[23]

Second, investment funds increase their shedding of periphery debt over time. In contrast, the shedding by rest-of-the-world investors is reduced in the medium term. Pensions funds also shed periphery debt in the medium term, but the amounts are smaller.

Third, although not precisely estimated statistically, in the short-term especially banks and—to a lesser degree—also households and insurance corporations pick up the periphery debt shed by investment funds and the rest of the world.

Fourth, although again not estimated precisely, in the medium term insurance corporations and especially households pick up the periphery debt shed by investment funds, pensions funds,

[22] To do so, we first calculate average holdings of a given holder-sector over the sample period, holder-countries and ISINs, and then multiply these by the average number of ISINs held by that holder-sector and the percentage-change effects estimated from the local projections in Equation (20). Figure D.15 presents the underlying impulse responses for all holder-sectors in relative deviations from baseline holdings.

[23] We discuss the response of these funds in Section 4.5. Recall that we also find there that funds domiciled outside respond stronger than funds domiciled in the euro area.

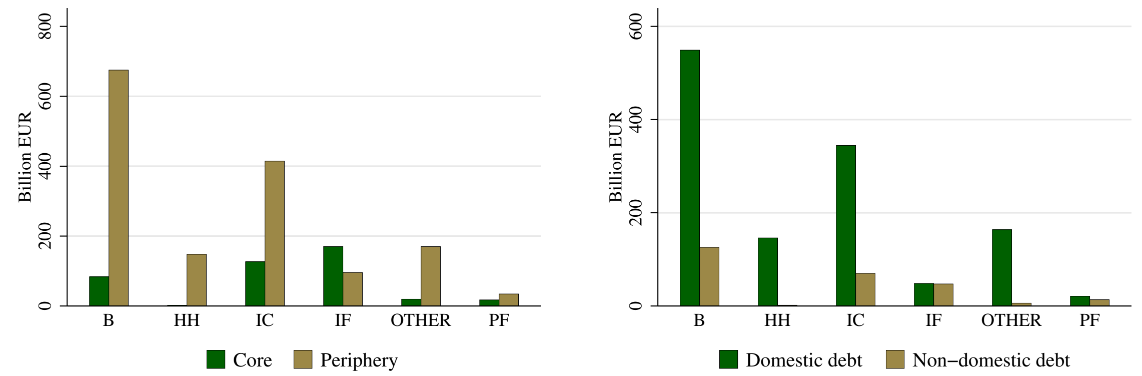
and the rest of the world.[24]

Figure D.16 shows that the results from the alternative specifications discussed before are consistent with the baseline in Figure 13.

5.4 Periphery versus core-domiciled holder-sector responses

The estimates in Figure 13 might mask important heterogeneity of holder-sector responses across domiciles, e.g. across core and periphery banks or core and periphery households. The left-hand side panel in Figure 14 presents periphery debt holdings by holder-sector and holder-country-group in 2022q4. Three observations stand out.

Figure 14: Periphery debt holdings by holder-country-group and by domestic/non-domestic debt in 2022q4



Note: The left-hand side panel shows periphery sovereign debt holdings by holder-sector across holder-country-groups. The right-hand side panel shows domestic and non-domestic periphery debt holdings by periphery holder-sector. The data are taken from SHSS.

First, banks and insurance corporations domiciled in the periphery are by far the largest holders of periphery sovereign debt. These patterns have been stable over the sample period (Figure D.10).

Second, there is strong home bias as periphery holder-sectors account for the lion's share of total euro area investor holdings of periphery sovereign debt. This home bias is particularly pronounced for periphery households, banks, and insurance corporations.

Third, investment-fund holdings are more evenly distributed across regions. Core investment funds even hold more periphery debt than periphery investment funds. Recall though that the domicile of the ultimate investor may be different from that of the investment fund (Beck et al.,

[24]In the estimations we do not impose that the sum of the responses across holder-sectors adds to zero. As such, due to estimation uncertainty there may be non-zero residuals when summing up responses across holder-sectors. Moreover, due to confidentiality we cannot estimate the response of the holdings of the Eurosystem of Central Banks, which may account for any non-zero residual in the sum of the responses across holder-sectors in Figure 13 even if there was no estimation uncertainty.

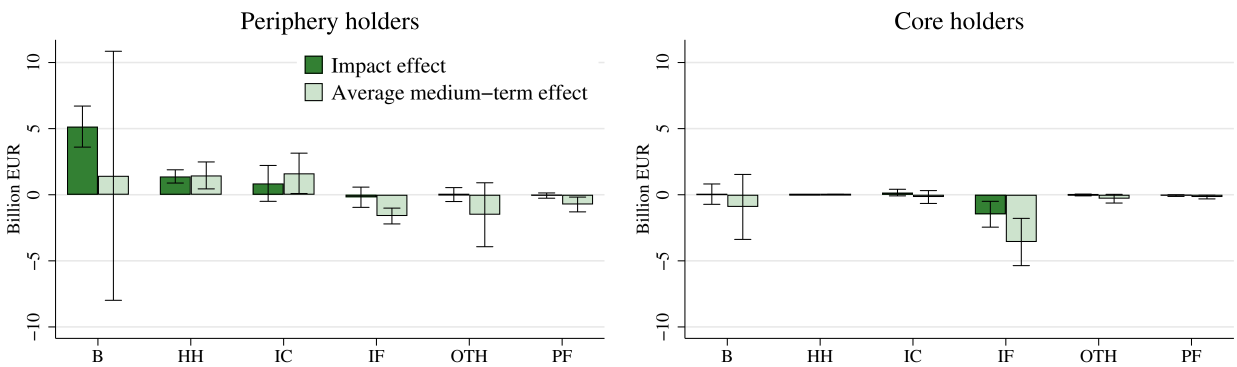
2023). For example, a disproportionately large share of investment-fund holdings of euro area sovereign debt is with funds domiciled in the core in Luxembourg.

We explore the role of holder-sector domicile by extending Equation (20) to

$$\begin{aligned} h_{\mathcal{H},\mathcal{S},\mathcal{I},t+\ell} - h_{\mathcal{H},\mathcal{S},\mathcal{I},t-1} =& \gamma^{(\ell)}_{\mathcal{H},\mathcal{S},\mathcal{I}} + \varrho^{(\ell)}_{\mathcal{S}} h_{\mathcal{H},\mathcal{S},\mathcal{I},t-1} + \boldsymbol{\delta}^{(\ell)}_{\mathcal{S}} \boldsymbol{w}_{i(\mathcal{I}),t-1} + \boldsymbol{\kappa}^{(\ell)}_{\mathcal{S}} \boldsymbol{\eta}_{t-1} + \boldsymbol{\mu}^{(\ell)}_{\mathcal{S}} \boldsymbol{d}_{t-1} \\ &+ [\psi^{(\ell)}_{\mathcal{S}} + \chi^{(\ell)}_{\mathcal{S}} \mathbb{1}(i(\mathcal{I}) \in core) + \overline{\chi}^{(\ell)}_{\mathcal{S}} \mathbb{1}(i(\mathcal{H}) \in core) \\ &+ \widetilde{\chi}^{(\ell)}_{\mathcal{S}} \mathbb{1}(i(\mathcal{I}) \in core) \mathbb{1}(i(\mathcal{H}) \in core)] \Delta(cds^p_t - cds^c_t) + u^{(\ell)}_{\mathcal{H},\mathcal{S},\mathcal{I},t} \,. \end{aligned} \tag{21}$$

We estimate Equation (21) again separately for each holder-sector $\mathcal{S}$. For example, in Equation (21) $\psi^{(\ell)}_B$ denotes the effect of euro disaster risk shocks on periphery debt holdings of periphery-domiciled banks, and $\psi^{(\ell)}_B + \overline{\chi}^{(\ell)}_B$ the effect on periphery debt holdings of core-domiciled banks.

Figure 15: Effects of euro disaster risk shocks on periphery sovereign debt holdings across core and periphery-domiciled holder-sectors



Note: The figure shows the effects of a euro disaster risk shock that raises the periphery-core 10-year sovereign bond yield spread by one standard deviation on periphery debt holdings across holder-sectors, namely banks (B), households (HH), insurance corporations (IC), investment funds (IF), the other-sectors-composite (OTH), and pension funds (PF). The left-hand (right-hand) side panel presents results for holders domiciled in the periphery (core). The dark-shaded (light-shaded) green bars present results for the impact period (average effect over the impact and the three following periods). Bars indicate point estimates and whiskers 90% confidence bands. The estimates are obtained from weighted holder-country × ISIN panel local projection regressions of Equation (21), run separately for each holder-sector. Weights are given by average holder-country holdings over the sample period, that is $w_{\mathcal{H},\mathcal{I}} = log\left(T^{-1}\sum_t \sum_{\mathcal{I}} h_{\mathcal{H},\mathcal{I},t}\right)$. Standard errors are clustered at the issuer-country × time level. The effects shown are expressed in euro amounts, obtained by first calculating average holdings of a given holder-sector over the sample period, holder-countries and ISINs. These are then multiplied by the number of ISINs held by that holder-sector and by the percentage-change effects estimated from the local projections in Equation (21) for a given holder-sector and holder-country.

The left-hand side panel of Figure 15 shows results for periphery-domiciled holder-sectors (based on $\widehat{\psi}^{(\ell)}_{\mathcal{S}}$) and the right-hand side panel for core-domiciled holder-sectors (based on $\widehat{\psi}^{(\ell)}_{\mathcal{S}} + \widehat{\overline{\chi}}^{(\ell)}_{\mathcal{S}}$).

The results show that the periphery debt shed by investment funds is absorbed exclusively by periphery-domiciled holder-sectors. On impact, periphery-domiciled banks and—to a lesser extent also—households increase their periphery debt holdings. Over the medium term, only periphery-domiciled insurance corporations and households increase their periphery debt holdings. The responses of investors domiciled in the core are negligible. The only exception is core-domiciled investment funds, which shed larger amounts of periphery debt than their periphery analogues. This is consistent with the observation that investment funds are the only holder-sector that is not subject to home bias, as core investment funds—many of which domiciled in Luxembourg—hold more periphery debt than periphery-domiciled investment funds (Figure 11). Overall, when accounting for heterogeneity across holder-sector domiciles, the estimates in Figure 15 are more precise than those in Figure 13.

Figure D.17 shows that the results are similar in the alternative specifications discussed above.

5.5 The role of domestic investors

We next zoom in further focusing on heterogeneity across domestic and non-domestic periphery debt holdings. The right-hand side panel of Figure 14 shows the distribution of domestic and non-domestic holdings of periphery debt across periphery holder-sectors in 2022q4. The largest holder-sectors of periphery debt—periphery-domiciled banks and insurance corporations—hold predominantly domestic debt. Periphery-domiciled households hold virtually no non-domestic periphery sovereign debt. Only periphery-domiciled investment funds and—to a lesser degree—pension funds hold similar amounts of domestic and non-domestic periphery debt. The right-hand side panel shows that this dominance of domestic debt holdings across periphery holder-sectors is stable over the sample period.

In order to compare the effects of euro disaster shocks across domestic and non-domestic debt holdings across periphery holder-sectors, we extend Equation (21) and estimate

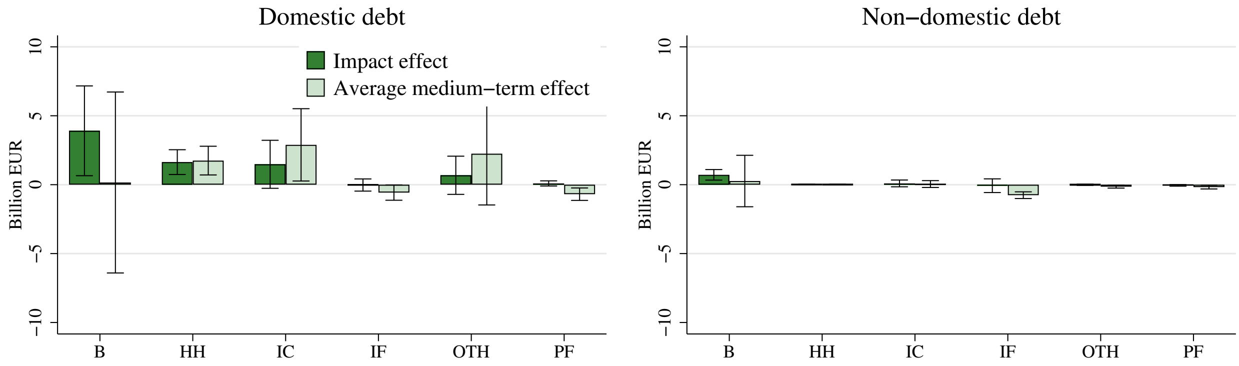
$$\begin{aligned} h_{\mathcal{H},\mathcal{S},\mathcal{I},t+\ell} - h_{\mathcal{H},\mathcal{S},\mathcal{I},t-1} =& \gamma^{(\ell)}_{\mathcal{H},\mathcal{S},\mathcal{I},\mathcal{Z}} + \varrho^{(\ell)}_{\mathcal{S},\mathcal{Z}} h_{\mathcal{H},\mathcal{S},t-1} + \boldsymbol{\delta}^{(\ell)}_{\mathcal{S},\mathcal{Z}} \boldsymbol{w}_{i(\mathcal{I}),t-1} + \boldsymbol{\kappa}^{(\ell)}_{\mathcal{S},\mathcal{Z}} \boldsymbol{\eta}_{t-1} + \boldsymbol{\mu}^{(\ell)}_{\mathcal{S},\mathcal{Z}} \boldsymbol{d}_{t-1} \\ & + [\psi^{(\ell)}_{\mathcal{S},\mathcal{Z}} + \chi^{(\ell)}_{\mathcal{S},\mathcal{Z}} \mathbb{1}(i(\mathcal{I}) \in core) + \overline{\chi}^{(\ell)}_{\mathcal{S},\mathcal{Z}} \mathbb{1}(i(\mathcal{H}) \in core) \\ & + \widetilde{\chi}^{(\ell)}_{\mathcal{S},\mathcal{Z}} \mathbb{1}(i(\mathcal{I}) \in core) \mathbb{1}(i(\mathcal{H}) \in core)] \Delta(cds^p_t - cds^c_t) + u^{(\ell)}_{\mathcal{H},\mathcal{S},\mathcal{I},t} \end{aligned} \tag{22}$$

separately not only for each holder-sector $\mathcal{S}$ but also for each $\mathcal{Z} \in \{\mathcal{D}, \mathcal{N}\}$, where $\mathcal{D}$ indicates domestic debt for which the issuer-country coincides with the holder-country so that $i(\mathcal{I}) = i(\mathcal{H})$ and $\mathcal{N}$ indicates non-domestic debt for which $i(\mathcal{I}) \neq i(\mathcal{H})$.[25] For example, in Equation (22) $\psi^{(\ell)}_{\mathcal{B},\mathcal{D}}$ denotes the effect of a euro disaster risk shock on domestic debt holdings of periphery banks, and $\psi^{(\ell)}_{\mathcal{B},\mathcal{F}}$ the effect on non-domestic debt holdings of periphery banks.

Figure 16 presents the results. The left-hand side panel shows results for domestic debt

[25] While focusing on periphery-domiciled holders in the exposition, for the estimation we keep core issuers and holders for comparability with results in Figures 15 and 13 and maximize statistical power.

Figure 16: Effects of euro disaster risk shocks on periphery sovereign debt holdings across domestic and non-domestic periphery-domiciled holder-sectors



Note: The figure shows the effects of a euro disaster risk shock that raises the periphery-core 10-year sovereign bond yield spread by one standard deviation on periphery debt holdings across holder-sectors, namely banks (B), households (HH), insurance corporations (IC), investment funds (IF), the other-sectors-composite (OTH), and pension funds (PF). The left-hand (right-hand) side panel present results for domestic (non-domestic) periphery debt. The dark-shaded (light-shaded) green bars present results for the impact period (average effect over the impact and the three following periods). Bars indicate point estimates and whiskers 90% confidence bands. The estimates are obtained from weighted holder-country × ISIN panel local projections in Equation (22), run separately for each holder-sector $\mathcal{S}$, domestic debt $\mathcal{Z} = \mathcal{D}$ and non-domestic debt $\mathcal{Z} = \mathcal{N}$, respectively. Weights are given by average holder-country holdings over the sample period, that is $w_{\mathcal{H},\mathcal{S},\mathcal{I}} = T^{-1}\sum_{\mathcal{I}}\sum_t h_{\mathcal{H},\mathcal{S},\mathcal{I},t}$. Standard errors are clustered at the issuer-country × time level. The effects shown are expressed in euro amounts, obtained from calculating average holdings of a given holder-sector and holder-country over the sample period and ISINs, and then multiplied by the percentage-change effects estimated from the local projections in Equation (22) for a given holder-sector and holder-country.

holdings (based on $\widehat{\psi}^{(\ell)}_{B,\mathcal{D}}$) and the right-hand side panel for non-domestic debt holdings (based on $\widehat{\psi}^{(\ell)}_{B,\mathcal{N}}$). Essentially all of the adjustments in periphery debt holdings of periphery holder-sectors in response to euro disaster risk shocks play out among domestic investors. Specifically, we find that on impact periphery banks, insurance corporations and households all significantly increase their holdings of domestic debt (for example, Italian banks purchase Italian debt). Households and insurance corporations continue increasing their portfolio holdings of domestic debt significantly also over the medium term. In contrast, periphery holder-sectors hardly adjust their holdings of non-domestic periphery debt (for example, Italian banks dot not purchase Spanish debt). Overall, when accounting for heterogeneity across domestic and non-domestic debt holdings, the estimates in Figure 16 gain further precision.

Figure D.18 shows that the results are similar in the alternative specifications discussed above.

6 Conclusion

Investment funds have become important players in world financial markets. As a result, developments in the investment-fund sector may be increasingly relevant for the broader economy, monetary policy and regulation. At the same time, our understanding of how investment funds impact the transmission of shocks is incomplete. Against this background, in this paper we study empirically the behaviour of investment funds and their interaction with other investors, focusing on euro area sovereign debt markets and euro disaster risk shocks.

Using two granular datasets of euro area sovereign debt holdings at the security level we find that: (i) in response to euro disaster risk shocks investment funds exhibit flight-from-periphery but no flight-to-core; (ii) investment funds shed periphery debt to meet redemptions and to rebalance their portfolios; (iii) only investment funds shed periphery debt in response to euro disaster risk shocks; (iv) banks pick up periphery sovereign debt in the short term, and households and insurance corporations in the medium term; (v) the cross-sectoral re-balancing from investment funds to households and insurance corporations via banks involves mostly domestic holder-sectors and domestic sovereign debt.

Overall, our findings suggest that investment funds play a procyclical role in euro area sovereign debt markets during stress episodes. Moreover, the results show that investment funds behave systematically different compared to all other investor types.

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A Conceptual framework

A.1 Derivation of the proxy-variable equation

Consider K^w issuer-specific variables $\boldsymbol{w}_{it}$ and K^η common variables $\boldsymbol{\eta}_t$ and assume they evolve according to

$$\boldsymbol{R}_0^w \boldsymbol{w}_{it} = \boldsymbol{R}_1^w \boldsymbol{w}_{i,t-1} + \mathbb{1}(i \in \mathcal{P})\boldsymbol{\Lambda}^{w,p}\boldsymbol{\eta}_t + \mathbb{1}(i \in \mathcal{C})\boldsymbol{\Lambda}^{w,c}\boldsymbol{\eta}_t + \boldsymbol{u}_{it}^w, \tag{A.1}$$

$$\boldsymbol{R}_0^\eta \boldsymbol{\eta}_t = \boldsymbol{R}_1^\eta \boldsymbol{\eta}_{t-1} + \boldsymbol{u}_t^\eta. \tag{A.2}$$

The reduced form of Equation (A.2) is

$$\boldsymbol{\eta}_t = \boldsymbol{\mathcal{R}}_1^\eta \boldsymbol{\eta}_{t-1} + \boldsymbol{\mathcal{R}}_0^\eta \boldsymbol{u}_t^\eta, \tag{A.3}$$

where $\boldsymbol{\mathcal{R}}_1^\eta \equiv (\boldsymbol{R}_0^\eta)^{-1}\boldsymbol{R}_1^\eta$ and $\boldsymbol{\mathcal{R}}_0^\eta \equiv (\boldsymbol{R}_0^\eta)^{-1}$.

Then, of the $i = 1, 2, \ldots, N_i$ issuers, order the $N_{i,p}$ periphery issuers $i \in \mathcal{P}$ before all $N_{i,c}$ core issuers $i \in \mathcal{C}$ so that $\boldsymbol{w}_t \equiv (\boldsymbol{w}'_{1t}, \boldsymbol{w}'_{2t}, \ldots, \boldsymbol{w}'_{N_{i,p}t}, \boldsymbol{w}'_{N_{i,p}+1,t}, \boldsymbol{w}'_{N_{i,p}+2,t}, \ldots, \boldsymbol{w}'_{N_{i,p}+N_{i,c},t})'$, and stack Equation (A.1) for all issuers using matrix notation

$$(\boldsymbol{I}_{N_i} \otimes \boldsymbol{R}_0^w)\,\boldsymbol{w}_t = (\boldsymbol{I}_{N_i} \otimes \boldsymbol{R}_1^w)\,\boldsymbol{w}_{t-1} + \begin{bmatrix} \boldsymbol{e}_{N_{i,p}} \otimes \boldsymbol{\Lambda}^{w,p} \\ \boldsymbol{e}_{N_{i,c}} \otimes \boldsymbol{\Lambda}^{w,c} \end{bmatrix} \boldsymbol{\eta}_t + \boldsymbol{u}_t^w, \tag{A.4}$$

where $\boldsymbol{e}_k$ is a $k \times 1$ vector of ones for some positive number k. Solving for the reduced form gives

$$\boldsymbol{w}_t = \left[\boldsymbol{I}_{N_i} \otimes (\boldsymbol{R}_0^w)^{-1}\boldsymbol{R}_1^w\right]\boldsymbol{w}_{t-1} + \begin{bmatrix} \boldsymbol{e}_{N_{i,p}} \otimes (\boldsymbol{R}_0^w)^{-1}\boldsymbol{\Lambda}^{w,p} \\ \boldsymbol{e}_{N_{i,c}} \otimes (\boldsymbol{R}_0^w)^{-1}\boldsymbol{\Lambda}^{w,c} \end{bmatrix} \boldsymbol{\eta}_t + \left[\boldsymbol{I}_{N_i} \otimes (\boldsymbol{R}_0^w)^{-1}\right]\boldsymbol{u}_t^w. \tag{A.5}$$

Then use the reduced form in Equation (A.3) to substitute the contenporaneous common variables $\boldsymbol{\eta}_t$ in Equation (A.5)

$$\begin{aligned} \boldsymbol{w}_t &= \left[\boldsymbol{I}_{N_i} \otimes (\boldsymbol{R}_0^w)^{-1}\boldsymbol{R}_1^w\right]\boldsymbol{w}_{t-1} + \begin{bmatrix} \boldsymbol{e}_{N_{i,p}} \otimes (\boldsymbol{R}_0^w)^{-1}\boldsymbol{\lambda}^{\psi,p} \\ \boldsymbol{e}_{N_{i,c}} \otimes (\boldsymbol{R}_0^w)^{-1}\boldsymbol{\lambda}^{\psi,c} \end{bmatrix} \left(\boldsymbol{\mathcal{R}}_1^\eta \boldsymbol{\eta}_{t-1} + \boldsymbol{\mathcal{R}}_0^\eta \boldsymbol{u}_t^\eta\right) + \left[\boldsymbol{I}_{N_i} \otimes (\boldsymbol{R}_0^w)^{-1}\right]\boldsymbol{u}_t^w \\ &= \left[\boldsymbol{I}_{N_i} \otimes (\boldsymbol{R}_0^w)^{-1}\boldsymbol{R}_1^w\right]\boldsymbol{w}_{t-1} + \begin{bmatrix} \boldsymbol{\Pi}^{\eta,p} \\ \boldsymbol{\Pi}^{\eta,c} \end{bmatrix} \boldsymbol{\eta}_{t-1} + \begin{bmatrix} \boldsymbol{\Phi}^{\eta,p} \\ \boldsymbol{\Phi}^{\eta,c} \end{bmatrix} \boldsymbol{u}_t^\eta + \left[\boldsymbol{I}_{N_i} \otimes (\boldsymbol{R}_0^w)^{-1}\right]\boldsymbol{u}_t^w. \end{aligned} \tag{A.6}$$

Next, define a selection vector $\boldsymbol{s}$ so that we obtain the periphery-core CDS spread

$$\boldsymbol{s}\boldsymbol{w}_t = \frac{1}{N_{i,p}} \sum\nolimits_{i \in \mathcal{P}} cds_{it} - \frac{1}{N_{i,p}} \sum\nolimits_{i \in \mathcal{C}} cds_{it} \equiv \overline{cds}_t^p - \overline{cds}_t^c, \tag{A.7}$$

that is $\boldsymbol{s}$ features $\frac{1}{N_{i,p}}$ at those positions that correspond to positions of the CDS spread for periphery issuer countries in $\boldsymbol{w}_t$, and $-\frac{1}{N_{i,c}}$ at those positions that correspond to positions of the CDS spread for core issuer countries in $\boldsymbol{w}_t$, and zeros elsewhere. Then, when left-multiplying Equation (A.6) by $\boldsymbol{s}$ and defining ℓ the position of the CDS spread in $\boldsymbol{w}_{it}$, we get for each individual component on the right-hand side

$$\begin{aligned}
\boldsymbol{s}\left[\boldsymbol{I}_{N_i}\otimes(\boldsymbol{R}_0^w)^{-1}\boldsymbol{R}_1^w\right]\boldsymbol{w}_{t-1} &= \boldsymbol{s}\left[\boldsymbol{I}_{N_i}\otimes\boldsymbol{\mathcal{W}}\right]\boldsymbol{w}_{t-1} \\
&= \frac{1}{N_{i,p}}\sum_{i\in\mathcal{P}}\sum_{j=1}^{K^w}\mathcal{W}_{\ell,j}w_{ij,t-1} - \frac{1}{N_{i,c}}\sum_{i\in\mathcal{C}}\sum_{j=1}^{K^w}\mathcal{W}_{\ell,j}w_{ij,t-1} \\
&= \sum_{j=1}^{K^w}\mathcal{W}_{\ell,j}\left(\overline{w}_{j,t-1}^p - \overline{w}_{j,t-1}^c\right) \\
&= \boldsymbol{\varpi}\left(\overline{\boldsymbol{w}}_{t-1}^p - \overline{\boldsymbol{w}}_{t-1}^c\right), \qquad \text{(A.8)}
\end{aligned}$$

and

$$\begin{aligned}
\boldsymbol{s}\begin{bmatrix}\boldsymbol{\Pi}^{\eta,p}\\ \boldsymbol{\Pi}^{\eta,c}\end{bmatrix}\boldsymbol{\eta}_{t-1} &= \frac{1}{N_{i,p}}\sum_{i\in\mathcal{P}}\sum_{j=1}^{K^\eta}\Pi_{\ell,j}^{\eta,p}\eta_{j,t-1} - \frac{1}{N_{i,c}}\sum_{i\in\mathcal{C}}\sum_{j=1}^{K^\eta}\Pi_{\ell,j}^{\eta,c}\eta_{j,t-1} \\
&= \sum_{j=1}^{K^\eta}\left(\frac{1}{N_{i,p}}\sum_{i\in\mathcal{P}}\Pi_{\ell,j}^{\eta,p} - \frac{1}{N_{i,c}}\sum_{i\in\mathcal{C}}\Pi_{\ell,j}^{\eta,c}\right)\eta_{j,t-1} \\
&= \sum_{j=1}^{K^\eta}\overline{\Pi}_{\ell,j}^{\eta}\eta_{j,t-1} \\
&= \overline{\boldsymbol{\pi}}^\eta\boldsymbol{\eta}_{t-1} \qquad \text{(A.9)}
\end{aligned}$$

and

$$\begin{aligned}
\boldsymbol{s}\begin{bmatrix}\boldsymbol{\Phi}^{\eta,p}\\ \boldsymbol{\Phi}^{\eta,c}\end{bmatrix}\boldsymbol{u}_t^\eta &= \frac{1}{N_{i,p}}\sum_{i\in\mathcal{P}}\sum_{j=1}^{K^\eta}\Phi_{\ell,j}^{\eta,p}u_{jt}^\eta - \frac{1}{N_{i,c}}\sum_{i\in\mathcal{C}}\sum_{j=1}^{K^\eta}\Phi_{\ell,j}^{\eta,c}u_{jt}^\eta \\
&= \sum_{j=1}^{K^\eta}\left(\frac{1}{N_{i,p}}\sum_{i\in\mathcal{P}}\Phi_{\ell,j}^{\eta,p} - \frac{1}{N_{i,c}}\sum_{i\in\mathcal{C}}\Phi_{\ell,j}^{\eta,c}\right)u_{jt}^\eta \\
&= \sum_{j=1}^{K^\eta}\overline{\Phi}_j^\eta u_{jt}^\eta \\
&= \overline{\boldsymbol{\varphi}}^\eta\boldsymbol{u}_t^\eta \qquad \text{(A.10)}
\end{aligned}$$

and finally

$$\begin{aligned}
\boldsymbol{s}\left[\boldsymbol{I}_{N_i}\otimes(\boldsymbol{R}_0^w)^{-1}\right]\boldsymbol{u}_t^w &= \boldsymbol{s}\left[\boldsymbol{I}_{N_i}\otimes\boldsymbol{\mathcal{R}}_0^w\right]\boldsymbol{u}_t^w \\
&= \frac{1}{N_{i,p}}\sum_{i\in\mathcal{P}}\sum_{j=1}^{K^w}\mathcal{R}_{0,\ell,j}^w u_{ijt}^w - \frac{1}{N_{i,c}}\sum_{i\in\mathcal{C}}\sum_{j=1}^{K^w}\mathcal{R}_{0,\ell,j}^w u_{ijt}^w \\
&= \sum_{j=1}^{K^w}\mathcal{R}_{0,\ell,j}^w\left(\frac{1}{N_{i,p}}\sum_{i\in\mathcal{P}}u_{ijt} - \frac{1}{N_{i,c}}\sum_{i\in\mathcal{C}}u_{ijt}^c\right) \\
&= \overline{\boldsymbol{r}}^w\left(\overline{\boldsymbol{u}}_t^{w,p} - \overline{\boldsymbol{u}}_t^{w,c}\right). \qquad \text{(A.11)}
\end{aligned}$$

Using the latter equations, the evolution of the periphery-core CDS spread obtained from multiplying Equation (A.6) by $\boldsymbol{s}$ (recall Equation (A.7)) is given by

$$\overline{cds}_t^p - \overline{cds}_t^c \quad = \quad \boldsymbol{\varpi}\left(\overline{\boldsymbol{w}}_{t-1}^p - \overline{\boldsymbol{w}}_{t-1}^c\right) + \overline{\boldsymbol{\pi}}^\eta \boldsymbol{\eta}_{t-1} + \overline{\boldsymbol{\varphi}}^\eta \boldsymbol{u}_t^\eta + \overline{\boldsymbol{r}}^w \left(\overline{\boldsymbol{u}}_t^{w,p} - \overline{\boldsymbol{u}}_t^{w,c}\right), \tag{A.12}$$

which is the proxy variable Equation (10) in the main text, apart from subtracting the lagged CDS spread from both sides and singling out the euro disaster risk shock from the common shocks $\boldsymbol{u}_t^\eta$.

A.2 Is the CDS spread a valid proxy variable?

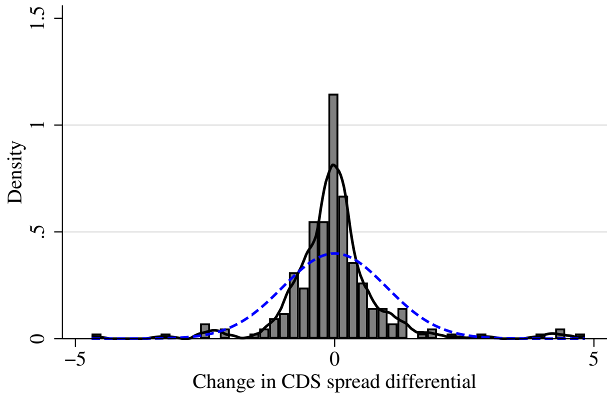
We put forth three pieces of evidence to argue that the change in the CDS spread satisfies the relevance condition $\alpha \neq 0$ and the exogeneity condition $\boldsymbol{\vartheta}^\eta = \boldsymbol{0}$ in Equation (10) and hence is a valid proxy variable for euro disaster risk shocks: (i) the CDS spread usually hardly moves, but when it does then it changes a lot and at these spikes a narrative analysis of intra-daily real-time news articles archived by the ECB Communications department indicates the drivers are events related to euro disaster risk and not other common macro-financial shocks ($\alpha \neq 0$, $\boldsymbol{\vartheta}^\eta = \boldsymbol{0}$); (ii) also over the full sample period the CDS spread is not correlated with industry-standard measures of common macro-financial shocks ($\boldsymbol{\vartheta}^\eta = \boldsymbol{0}$), while (iii) it is correlated with industry-standard measures of disaster risk shocks ($\alpha \neq 0$).

A.2.1 Drivers of CDS spread variation at the largest spikes

Figure A.1 shows that the change in the CDS spread has fat tails: it usually changes little at the monthly frequency, but there are a few instances when it changes quite drastically. A growing empirical literature shows that such departures from Gaussianity can be exploited for shock identification (Lanne et al., 2017; Jarociński, 2024). Roughly speaking, under non-Gaussianity the occasional spikes in the data are the key identifying variation. Thus, we next focus on these and argue that they can all be attributed to events interpreted by financial markets first and foremost as signals about the probability of a euro-related, institutional rare disaster rather than some other common macro-financial shock. In other words, we argue that in the months with the largest spikes in the CDS spread we have $\alpha \neq 0$ and $\boldsymbol{\vartheta}^\eta = \boldsymbol{0}$ in Equation (10).

Consider the months with the three largest spikes in the CDS spread differential. In July 2011, Moody's, Standard & Poor's, and Fitch downgraded the sovereign credit ratings for Greece, Portugal, and Ireland. In the case of Greece, the downgrade did not occur because of a deliberate government decision to raise new debt, but because rating agencies reached the view that European policymakers would impose a debt restructuring and involve private bondholders. Similarly, in May 2012 Greece held a general election which resulted in a fragmented parliament and difficulties forming a coalition government that would continue honoring the country's obli-

Figure A.1: Distribution of changes in the CDS spread



Note: The figure shows the histogram of monthly changes in the CDS spread. The black solid line is a kernel density estimate and the blue dashed line a fitted normal distribution.

gations vis-à-vis the Troika institutions. And in May 2018 the announced snap elections after political deadlock between Italy's Prime Minister and President over a cabinet appointment were widely expected to deliver an even stronger mandate for anti-establishment, euro-sceptic parties.

Table A.1 provides more detail on the key events during the months with the five largest positive spikes in the CDS spread differential. It suggests that these are all related to unexpected election outcomes, resignations, disagreements between national governments and international institutions, regulatory/supervisory events, or discontinuous actions of private agents such as rating agencies. None of these events is related to debt supply or common macro-financial shocks other than euro disaster risk shocks. Figure A.2 presents the terms that appeared most frequently in Real-time News reports on the days with the largest changes in the CDS spreads discussed in Table A.1. Almost all terms relate quite intuitively to euro disaster risk.

Analogous to Table A.1, Table A.2 considers the largest negative changes in the CDS spread. These events typically coincide with news about progress in reaching a political consensus on crisis responses and prevention such as the formation of the European Stability Mechanism (ESM) or the Single Supervisory Mechanism (SSM), agreements between national governments and international institutions, or ECB interventions. For example, the largest drop in the CDS spread occurred in October 2012 when the ECB's Governing Council announced the modalities of the Outright Monetary Transactions (OMT) program.

It is important to emphasize that although many of the events highlighted in Tables A.1 and A.2 were country specific in terms of their geographical origin, given the frequency and time horizons of our analysis they are more usefully seen as common shocks. In particular, we treat geographically country-specific shocks that induce large and synchronized spillovers

Figure A.2: Most frequent words in intra-daily real-time news reports on the days with the largest spikes in the CDS spread differential

Note: The figure shows a word cloud with the 150 terms that appeared most frequently in Real-time News reports on the days with the largest changes in the CDS spread discussed in Table A.1. The frequency of words is calculated using the Term-Document Matrix (TDM). TDM rows represent terms (words) and columns documents. The frequency of each word is calculated by summing the values in each row. The words are selected and plotted in different sizes based on their frequency. Words are excluded based on a list of common stopwords and additional specified terms, such as articles, conjunctions, prepositions, and other unimportant words like "and," "the," "or," month and day names, common verbs and words repeated in the Real-time News disclaimers.

Table A.1: Prominent events occurring in the months with the five largest spikes in the periphery-core CDS spread

Date	$\Delta(\overline{cds}_t^p - \overline{cds}_t^c)$	Event
2018 May	*138.4bp*	
05/16	12.9bp	(Wed) Reports of draft agenda of the likely coalition parties of the populist, anti-establishment and euro-sceptic Five-Star Movement and the League that includes demands for the ECB to forgive EUR 250 billion of its Italian sovereign debt holdings (about 10% of outstanding stock) acquired under the Asset Purchase Program and a mechanism to allow leaving the euro if voters demand it.
05/21	16.1bp	(Mon) Reports the Five-Star Movement and the League leaders Luigi Di Maio and Matteo Salvini have agreed on forming coalition government with political newcomer Giuseppe Conte as Prime Minister to lead government coalition between the Five-Star Movement and the League.
05/23	15.3bp	(Wed) Uncertainty about whether President Sergio Mattarella will appoint Giuseppe Conte as Prime Minister.
05/25	16.5bp	(Fri) After President Sergio Mattarella appointed him as Prime Minister late on 05/23, Giuseppe Conte fails to agree on cabinet appointments with the Five-Star Movement and the League, including Paolo Savona as economy minister known for having questioned Italy's commitment to the euro area.
05/29	103.5bp	(Tue) After the withdrawal of Giuseppe Conte as Prime Minister due to the rejection of Paolo Savona as economy minister by President Sergio Mattarella, former IMF official Carlo Cottarelli is appointed as interim Prime Minister tasked with planning snap elections, which investors expect will deliver an even stronger mandate for the Five-Star Movement and the League.
2011 Jul	*119.6bp*	
07/06	19.2bp	(Wed) Moody's downgrades Portugal's sovereign credit rating to junk status Ba2 on 07/05.
07/08-11	30.7/41.6bp	(Fri/Mon) Euro area leaders and finance ministers in their meetings in Brussels on 07/08-10 (Friday-Sunday) discuss the ongoing sovereign debt crisis and possibilities for a restructuring of Greece's sovereign debt with private sector involvement.
07/18	20.4bp	(Mon) 5 Spanish and 2 Greek banks fail European Banking Authority (EBA) stress test, 16 others just passed.
07/25	25.7bp	(Mon) Euro area heads of state reach agreement on second bailout package for Greece on 07/21 (Thursday), including private sector participation (banks and other private investors to contribute to the bailout by taking a haircut on Greek debt holdings). Moody's downgrades Greece's sovereign credit rating arguing the proposed debt swap is equivalent to a default.
2012 May	*101.5bp*	
05/14	14.6bp	(Mon) After general election on 05/06 with fragmented parliament as outcome negotiations between party leaders of conservative New Democracy, Socialist Pasok and radical-leftist Syriza and Greek President Karolos Papoulias to form coalition government fail.
05/15	16.6bp	(Tue) President Karolos Papoulias announces new general elections must be held and caretaker government will be announced the next day.
05/23	20.6bp	(Wed) Outgoing Greek Prime Minister Lucas Papademos tells Wallstreet Journal on 05/22 risk of Greek exit from the euro area is "real" and he cannot rule out others might be preparing for return to the drachma. Reports that finance ministers decided at Eurogroup teleconference that euro area countries have to prepare contingency plans for Greek exit from the euro and ECB has put together team to prepare for this possibility. Bundesbank states euro area could cope with Greece backing out of the bailout program.
05/30	24.7bp	(Wed) Reports ECB rejected Spanish government plans to recapitalize troubled lender Bankia indirectly using ECB funds.
05/31	14.3bp	(Thu) Reports that the central bank of Greece refused to provide Emergency Liquidity Assistance (ELA) to French Credit Agricole for its Emporiki subsidiary that has recorded losses of EUR 6 billion.
2010 Aug	*85.0bp*	
08/11	14.1bp	(Wed) Slovak parliament reverses its previous decision and withdraws participation in the EU's bailout of Greece.
08/16	15.6bp	(Mon) Release of weak economic data accentuates concerns about the sustainability of Greece's public debt.
08/20	14.9bp	(Fri) EU Commission announces Greece should cut government spending by an additional EUR 4 billion to offset revenue shortfalls due to deepening recession.
08/24-25	12.8/12.9bp	(Tue-Wed) S&P downgrades Ireland's sovereign credit rating.
2010 Nov	*92.45bp*	
11/05	10.5bp	(Friday) Greece's opposition and ruling Socialist parties turn local elections on coming Sunday into referendum on the government's austerity measures. Prime Minister George Papandreou states he would have no choice but to call an early national election if voters reject austerity measures.
11/08	10.3bp	(Monday) German Chancellor Angela Merkel's coalition backs proposals to force private bondholders to participate in future bailouts of euro area countries.
11/22	12.7bp	(Monday) Ireland requests international bailout (on Sunday, 21 Nov).
11/23	10.4bp	(Tuesday) Ireland's coalition government under internal pressure of losing majority while it has to have the budget approved in parliament in order to receive assistance under the requested bailout. German Chancellor Angela Merkel states "Ireland is a cause for great concern" and the "euro is in an exceptionally serious situation", and German Finance Minister Schäuble states that "In this context, I want to say very clearly that our common currency is at risk".
11/26	14.0bp	(Friday) Euro area governments and the ECB reported to be urging Portugal to request a bailout. IMF and EU reported to be examining how senior bondholders could be compelled to participate in the costs of bailing out Ireland's banks.
11/29	21.3bp	(Monday) Ireland's Prime Minister Cowen announces Irish bailout (Sunday 11/28). Spain's and Portugal's sovereign CDS spreads soar to record highs through contagion.
11/30	11.1bp	(Tuesday) Borrowing costs for Portugal, Spain, Italy rise sharply through contagion as investors digest the implications of euro area finance ministers' decisions to impose losses on private bondholders.

Note: The table lists and provides information on key euro disaster risk events during the months with the five largest spikes in the CDS spread.

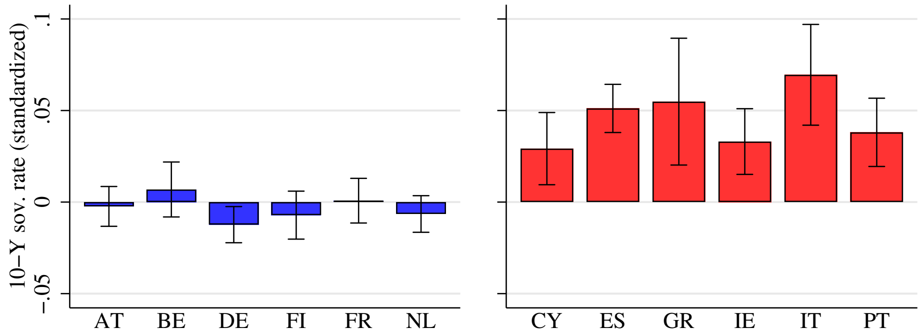
Table A.2: Prominent events occurring in the months with the five largest *negative* spikes in the periphery-core CDS spread

Date	$\Delta(cds_t^p - cds_t^c)$	Event
2012 Sep	*-99.9bp*	
09/03-05	-59.7bp	(Mon-Wed) ECB President Draghi and senior ECB officials communicate that the ECB buying euro area government bonds with maturities of up to three years would not violate European treaties. Draghi says the ECB's primary mandate compels it to intervene in bond markets to regain control of interest rates and ensure the euro's survival. FInancial markets expect an official ECB announcement for a bond-buying programme this week.
09/06	-42.5bp	(Thu) The ECB communicates the modalities of the Outright Monetary Transactions (OMT) programme, involving unlimited purchases of government debt that will be sterilized to assuage concerns about monetary financing. ECB President Draghi states that the OMT addresses bond market distortions and the unfounded fears of investors about the euro's irreversibility.
09/07	-39.5bp	(Fri) European heads of state praise the ECB's OMT announcement. German Finance Minister Wolfgang Schäuble bolsters the ECB announcement by saying its independence is something to value highly.
09/12	-18.8bp	(Wed) Germany's constitutional court rejects bids to halt the ratification of the European Stability Mechanism (ESM) treaty and the associated EUR 500 billion euro backstop. The EU publishes proposals for euro area bank oversight that require unprecedented cooperation between the ECB and national regulators.
2011 Jan	*-69.9bp*	
01/11-13	-38.3bp	(Tue-Thu) Greece, Spain and Portugal successfully auctioned EUR 1.95 billion, EUR 3 billion and EUR 1.25 billion respectively of government debt, calming financial market fears that Spain is on the brink of seeking a bailout.
2012 Jun	*-52.7bp*	
06/06-07	-30.7bp	(Wed-Thu) Reports that Spain is exploring the possibility of requesting up to 100 EUR billion in precautionary credit lines from the European Financial Stability Facility (EFSF) to support its ailing banks. German Chancellor Angela Merkel plays down expectations that a European summit at the end of the month could produce a master plan for the future of Europe but says it would come up with an agenda to integrate further.
06/19-20	-40.2bp	(Tue-Wed) Reports indicate that European leaders agree to move towards a more integrated banking system to stem a debt crisis that threatens the survival of the euro. After formally receiving an exploratory mandate from Greek President Karolos Papoulias, conservative New Democracy leader Antonis Samaras meets with other party heads to form an alliance to keep the promised reform policies on course.
06/29	-52.4bp	(Fri) European leaders agree to create the single supervisory mechanism (SSM) for euro area banks and to allow them to be recapitalized directly by the currency area's rescue funds without adding to government debt. European leaders also agree to ease repayment rules for emergency loans to Spanish banks and to relax conditions on potential help for Italy.
2012 Oct	*-51.8bp*	
10/05	-14.7bp	(Fri) Senior officials explain the ECB envisions buying large volumes of sovereign bonds for one to two months after the launch of its OMT programme.
10/16	-15.0bp	(Tue) Spanish Finance ministry gives first details of the country's plan for seeking help with its debt problems from the newly founded European Stability Mechanism (ESM).
10/17	-38.4bp	(Wed) Troika institutions assess that Greece has made substantial progress on reform package needed to unlock further financial aids. European leaders spell out leading role for ECB in new euro area banking supervisory framework.
2013 Apr	*-29.1bp*	
04/02	-10.7bp	(Tue) The Cypriot government announced on Tuesday that the country has concluded negotiations with its international creditors on the terms of its EUR 10 billion bailout and is set to receive its first installment of aid in May. Also, the International Monetary Fund reported that Latvia's "economic recovery is now well established," and the fund will close its resident representative office in Riga "in the summer of 2013."
04/10	-8.6bp	(Thu) European Central Bank President Mario Draghi indicated that the Governing Council is nearing action on interest rates and non-standard measures due to the struggling euro area economy. He mentioned extensive discussions about lowering borrowing costs and noted that economic weakness is spreading to more stable countries.
04/23	-11.7bp	(Tue) The European Commission reported a rise in its preliminary estimate for the headline measure of consumer confidence. Moreover, comments from European Central Bank policymakers, emphasizing falling inflation and poor growth prospects in the euro zone, suggest the ECB may consider a further cut in its main refinancing rate. ECB Vice-President Vitor Constancio noted that inflation had fallen and that a rate cut was "always a possibility."

Note: The table lists and provides information on key euro disaster risk events during the months with the five largest negative spikes in the CDS spread.

and contagion already *within* the impact period t—a month in our case—as common shocks. Indeed, Figure A.3 documents that in the data we analyze increases in the CDS spread triggered an immediate, synchronized increase in sovereign bond yields in key periphery but not core countries. In other words, spikes in the CDS spread typically sparked financial-market fears about *all* periphery countries' future in and thereby the *overall* integrity of the euro area.

Figure A.3: Contemporaneous changes in sovereign bond yields in response to increases in the CDS spread



Note: The panels show the impact-month effect of an increase in the CDS spread on 10-year sovereign bond yields in core (left-hand side) and periphery (right-hand side) countries. Estimates are obtained from country-specific local projections estimated with monthly data. Whiskers indicate 90% confidence bands.

In sum, given that the largest spikes in the CDS spread can straightforwardly be attributed to events associated with euro disaster risk but not other common macro-financial shocks implies that at least on these key dates $\alpha \neq 0$ and $\boldsymbol{\vartheta}^{\eta} = \mathbf{0}$ in Equation (10).

A.2.2 Drivers of CDS spread variation over the full sample period

We next argue that also for our overall sample period the variation in the CDS spread is not due to common macro-financial shocks other than euro disaster risk shocks (i.e., $\boldsymbol{\vartheta}^{\eta} = \mathbf{0}$ in Equation (10)). To do so, we estimate the proxy-variable Equation (10) with industry-standard measures of key common macro-financial shocks and show that none of them systematically affects the CDS spread differential.

Suppose we have measures for common macro-financial shocks other than euro disaster risk shocks

$$\widehat{\tilde{\boldsymbol{u}}}_t^{\eta} = \tilde{\boldsymbol{u}}_t^{\eta} + \boldsymbol{\tau}_t^{\tilde{u}}, \tag{A.13}$$

where $\boldsymbol{\tau}_t^{\tilde{u}}$ is a classical measurement error. Against the background of the proxy-variable Equation (10), we estimate

$$\Delta(\overline{cds}_t^p - \overline{cds}_t^c) = \boldsymbol{\varpi} \boldsymbol{d}_{t-1} + \boldsymbol{\vartheta}^{\eta} \widehat{\tilde{\boldsymbol{u}}}_t^{\eta} + \nu_t, \tag{A.14}$$

where $\boldsymbol{d}_{t-1} \equiv (\boldsymbol{w}_{t-1}^{p\prime} - \boldsymbol{w}_{t-1}^{c\prime}, \boldsymbol{\eta}_{t-1^{\prime}})^{\prime}$, $\boldsymbol{\varpi} \equiv (\boldsymbol{\varpi}^{w\prime}, \boldsymbol{\varpi}^{\eta\prime})^{\prime}$, and $\nu_t \equiv \alpha \phi_t - \boldsymbol{\vartheta}^{\eta} \boldsymbol{\tau}_t^{\tilde{u}}$. Our goal is to show that we cannot reject $H_0 : \boldsymbol{\vartheta}^{\eta} = \mathbf{0}$. Note that in general, Equation (A.14) is subject to attenuation bias in $\widehat{\boldsymbol{\vartheta}}^{\eta}$ as $Cov(\widehat{\widehat{\boldsymbol{u}}}_t^{\eta}, \nu_t) \neq 0$ by construction. However, the measures of the common macro-financial shocks we use are the industry standard in the literature and thus believed to be strong instruments with little measurement error (see e.g. Jarociński and Karadi, 2020; Caldara and Iacoviello, 2022; Känzig, 2021).

Table A.3 shows the results. In Columns (1) and (2) we include the measures for conventional monetary policy (CMP) shocks and central bank information (CBI) effects for the US and the euro area from Jarociński and Karadi (2020); Column (1) uses the poor man's approach and Column (2) the rotational sign restrictions approach to construct these from asset price surprises around monetary policy announcements. Columns (3) and (4) additionally include unconventional monetary policy (UMP) shock measures. In particular, for the US, in Column (3) we include the conventional Federal funds rate, forward guidance and quantitative easing shock measures of Swanson (2021), and in Column (4) we include the conventional Federal funds rate, forward guidance, quantitative easing as well as the Delphic forward guidance (CBI effect) shock measures of Jarociński (2024). For the euro area we consider the target, timing, forward guidance and quantitative easing shock measures of Altavilla et al. (2019). In all columns, we also include the geopolitical risk acts and threats shock measures of Caldara and Iacoviello (2022) as well as the oil supply shock measure of Känzig (2021). All shock measures are signed so that a positive value is contractionary/adverse. While some estimates are statistically significant, the patterns are not systematic across specifications (Columns 1 and 2) or have the wrong sign (Column 4).

In sum, using industry-standard measures for key common macro-financial shocks, we cannot reject the hypothesis that the exogeneity condition $\boldsymbol{\vartheta}^{\eta} = \mathbf{0}$ in Equation (10) is satisfied also in the sample period overall.

A.2.3 Direct comparison to existing measures for disaster risk shocks

Finally, we argue that the variation in the CDS spread is due to euro disaster risk shocks ($\alpha \neq 0$ in Equation (10)) over the whole sample period and not only on the key events discussed in Section A.2.1. To do so, we estimate the proxy-variable Equation (10) with industry-standard measures of broadly-defined disaster risk shocks and show that they systematically affect the CDS spread.

Suppose that analogously to Equation (A.14) we have a measure for euro disaster risk shocks

$$\widehat{\phi}_t = \phi_t + \tau_t^{\phi}, \tag{A.15}$$

where τ_t^{ϕ} is again classical measurement error; the latter may capture that $\widehat{\phi}_t$ reflects the risk

Table A.3: Correlation between the CDS spread differential and standard measures of common macro-financial shocks

	(1) CMPs (poor man's)	(2) CMPs (rotational)	(3) UMPs (Altavilla et al) (Swanson)	(4) UMPs (Altavilla et al) (Jarocinski)
ECB pure monetary policy shock	-0.002	0.114*		
	(0.97)	(0.10)		
ECB information effect	-0.068	-0.217**		
	(0.44)	(0.04)		
Fed pure monetary policy shock	-0.061	-0.055		
	(0.23)	(0.23)		
Fed information effect	-0.067*	-0.037		
	(0.08)	(0.49)		
ECB conventional MP shock			-0.099	-0.079
			(0.24)	(0.36)
ECB timing factor shock			0.004	0.011
			(0.93)	(0.82)
ECB forward guidance shock			-0.019	-0.016
			(0.77)	(0.80)
ECB QE shock			-0.033	-0.022
			(0.69)	(0.80)
Fed conventional policy shock			-0.090	-0.117*
			(0.16)	(0.08)
Fed forward guidance shock			-0.040	-0.014
			(0.58)	(0.78)
Fed QE shock			-0.104	-0.073
			(0.16)	(0.20)
Fed Delphic forward guidance shock				-0.068
				(0.27)
Oil supply shock	0.023	0.048	0.019	0.024
	(0.51)	(0.13)	(0.58)	(0.49)
Geopolitical risk shock: Threats	0.061	0.060	0.052	0.047
	(0.49)	(0.53)	(0.57)	(0.61)
Geopolitical risk shock: Actions	-0.008	-0.041	-0.010	-0.019
	(0.93)	(0.68)	(0.91)	(0.84)
$\boldsymbol{d}_{t-1}$	Yes	Yes	Yes	Yes
Observations	197	197	197	197

Note: The table reports results for regressions of Equation (A.14) with various measures of common macro-financial shocks other than euro disaster risk shocks on the right-hand side in $\tilde{\boldsymbol{u}}_t^{\eta}$. In Columns (1) and (2) we include the pure monetary policy shocks and central bank information effects for the US and the euro area from Jarociński and Karadi (2020); Column (1) uses the poor man's approach and Column (2) the rotational sign restrictions approach to construct these. Columns (3) and (4) distinguish between conventional and unconventional monetary policy shocks. For the euro area we include the target, timing, forward guidance and quantitative easing factor surprises of Altavilla et al. (2019). For the US, in Column (3) we includes the conventional Federal funds rate, forward guidance and quantitative easing factors of Swanson (2021), and in Column (4) we include the conventional Federal funds rate, forward guidance, quantitative easing factors as well as the Delphic forward guidance (central bank information) effect of Jarociński (2024). In all columns we also include the geopolitical risk shocks in terms of acts and threats from Caldara and Iacoviello (2022) and the oil supply news from Känzig (2021). p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). In $\boldsymbol{d}_{t-1}$ we include the lagged level of the CDS spread as well as lags of periphery-core spreads in year-on-year industrial production growth and the logarithm of the stock of central government debt outstanding.

of a broader than only euro-related, institutional disaster. Against the background of the proxy variable Equation (10) we extend Equation (A.14) and estimate

$$\Delta(\overline{cds}_t^p - \overline{cds}_t^c) = \boldsymbol{\varpi} \boldsymbol{d}_{t-1} + \alpha \widehat{\phi}_t + \boldsymbol{\vartheta}^\eta \widehat{\tilde{\boldsymbol{u}}}_t^\eta + \nu_t, \tag{A.16}$$

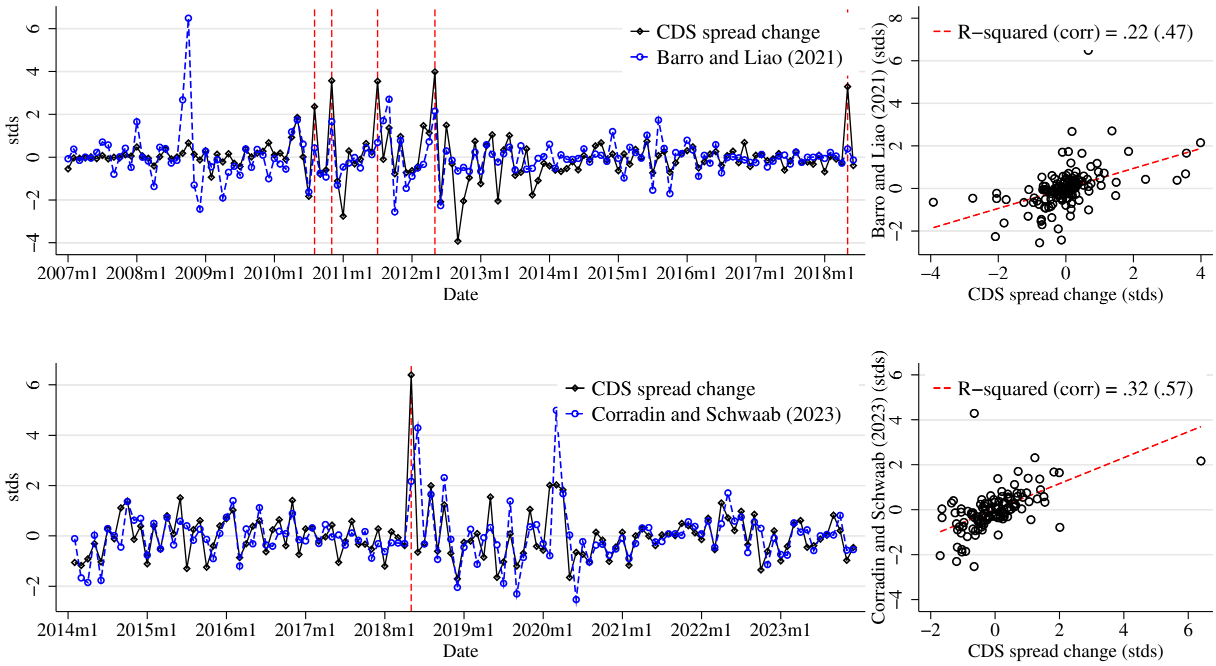
where now $\nu_t \equiv -\alpha \tau_t^\phi - \boldsymbol{\vartheta}^\eta \boldsymbol{\tau}_t^{\tilde{u}}$. For $\widehat{\phi}_t$ we consider the rare disaster risk measures of Barro and Liao (2021) and Corradin and Schwaab (2023), respectively. Barro and Liao (2021) estimate monthly rare disaster probabilities until June 2018 for several countries, including the euro area, based on stock market data and an options-pricing formula with recursive preferences. Corradin and Schwaab (2023) estimate an unobserved components model that decomposes sovereign bond yields into premia in terms of latent factors, of which we consider the sum of default and redenomination risk premia (identified using the so-called ISDA basis). For these components we then calculate the difference between the average for Italy and Spain and the average for Germany and France.

Figure A.4 compares the CDS spread with the measure of Barro and Liao (2021) from January 2007 to December 2018 and the measure of Corradin and Schwaab (2023) from January 2014 to December 2023. The correlation between the CDS spread differential and these disaster risk measures is striking, especially given that the estimators, data, and sample periods are quite different.

Table A.4 presents the results of the estimation of Equation (A.16); recall that the number of observations is reduced relative to Table A.3 because the data of Barro and Liao (2021) end in June 2018. The coefficient estimates of the change in the disaster risk measure of Barro and Liao (2021) reported in the first row are highly statistically significant in all regressions. At the same time, the coefficients on all other common macro-financial shock measures are not statistically significant.

In sum, we interpret our findings in Sections A.2.1 to A.2.3 as suggesting that the CDS spread is a valid proxy variable for euro disaster risk shocks as $\alpha \neq 0$ and $\boldsymbol{\vartheta}^\eta = \mathbf{0}$ in Equation (10).

Figure A.4: Comparison of the CDS spread change with changes in existing euro area rare disaster risk measures



Note: The panels compare the change in the CDS spread to changes in the euro area rare disaster risk measures of Barro and Liao (2021) in the top row and the periphery-core in the (updated) redenomination/default risk premia measures of Corradin and Schwaab (2023) in the bottom row. In each row, the left-hand side panel plots the CDS spread and the existing rare disaster risk measure together over time and the the right-hand side presents a scatter plot of one against the other.

Table A.4: Correlation between CDS spread and standard measures of common macro-financial shocks including euro area rare disaster risk change measures

	(1) CMPs (poor man's)	(2) CMPs (rotational)	(3) UMPs (Altavilla et al) (Swanson)	(4) UMPs (Altavilla et al) (Swanson)
Barro & Liao (2021) rare disaster risk change	0.652***	0.558***	0.584***	0.589***
	(0.00)	(0.00)	(0.00)	(0.00)
ECB pure monetary policy shock	-0.033	0.105		
	(0.59)	(0.20)		
ECB information effect	0.009	-0.100		
	(0.95)	(0.49)		
Fed pure monetary policy shock	-0.173*	-0.143*		
	(0.07)	(0.05)		
Fed information effect	0.172	-0.074		
	(0.16)	(0.26)		
ECB conventional MP shock			-0.133	-0.130
			(0.31)	(0.32)
ECB timing factor shock			0.086	0.069
			(0.15)	(0.26)
ECB forward guidance shock			-0.006	0.000
			(0.94)	(1.00)
ECB QE shock			-0.097	-0.091
			(0.34)	(0.38)
Fed conventional policy shock			0.032	-0.064
			(0.65)	(0.27)
Fed forward guidance shock			-0.120	-0.063
			(0.19)	(0.51)
Fed QE shock			-0.057	-0.073
			(0.50)	(0.24)
Fed Delphic forward guidance shock				0.038
				(0.64)
Oil supply shock	0.098	0.154	0.132	0.117
	(0.20)	(0.16)	(0.16)	(0.17)
Geopolitical risk shock: Threats	0.278	0.337	0.258	0.246
	(0.18)	(0.15)	(0.25)	(0.27)
Geopolitical risk shock: Actions	-0.004	-0.046	-0.000	0.009
	(0.96)	(0.67)	(1.00)	(0.93)
$\boldsymbol{d}_{t-1}$	Yes	Yes	Yes	Yes
Observations	137	137	137	137

Note: The table reports results for regressions of Equation (A.16) with the euro rare disaster risk shock measure of Barro and Liao (2021) and the various measures of common shocks other than euro disaster risk shocks. See also the notes to Table A.3.

B Endogeneity bias due to country-specific shocks u^w_{it}

Suppose we have $N = N_1 + N_2$ countries with $\omega \equiv N_1/N$ out of two groups $\mathcal{G}_j$, $j = 1, 2$. Suppose further we order $i = 1, 2, \ldots, N_1, N_1+1, \ldots, N$, and that for each country i we have T time-series observations on y_{it}, x_{it} and w_{it} generated by the data-generating process

$$
\begin{aligned}
y_{it} &= \beta x_{it} + u_{it}, \quad u_{it} \overset{i.i.d.}{\sim} (0, \sigma^2_{u,i}), && \text{(B.1)}\\
x_{it} &= \gamma w_{it} + \left(\frac{1}{N_1} \sum_{j=1}^{N_1} u_{jt} - \frac{1}{N_2} \sum_{j=N_1+1}^{N} u_{jt} \right), && \text{(B.2)}\\
w_{it} &\sim (0, \sigma^2_w), \quad Cov(w_{it}, u_{it}) = 0, && \text{(B.3)}
\end{aligned}
$$

corresponding to the proxy-variable Equation (10) in the main text. In general, Equation (B.1) is subject to an endogeneity problem, as in Equation (B.2) x_{it} is in part determined by the country-specific shocks u_{it}. Note that unlike the change in the CDS spread in Equation (10), in Equation (B.1) we assume that the variable of interest x_{it} is cross-section specific. This is without loss of generality, and we do this in order to be able to compare the endogeneity bias in our setup to a textbook benchmark

$$
\begin{aligned}
\widetilde{y}_{it} &= \widetilde{\beta}\widetilde{x}_{it} + u_{it}, && \text{(B.4)}\\
\widetilde{x}_{it} &= \gamma w_{it} + u_{it}, && \text{(B.5)}\\
w_{it} &\sim (0, \sigma^2_w) \quad Cov(w_{it}, u_{it}) = 0. && \text{(B.6)}
\end{aligned}
$$

The ordinary least squares estimator of β in Equation (B.1) is

$$
\begin{aligned}
\widehat{\beta} &= \beta + \frac{\frac{1}{NT}\sum_i \sum_t u_{it} x_{it}}{\frac{1}{NT}\sum_i \sum_t x^2_{it}}\\
&= \beta + \frac{\frac{1}{NT}\sum_i \sum_t \gamma u_{it} w_{it}}{\frac{1}{NT}\sum_i \sum_t x^2_{it}} + \frac{\frac{1}{NT}\sum_i \sum_t u_{it}\left(\frac{1}{N_1}\sum_{j=1}^{N_1} u_{jt} - \frac{1}{N_2}\sum_{i=N_1+1}^{N} u_{jt}\right)}{\frac{1}{NT}\sum_i \sum_t x^2_{it}}. && \text{(B.7)}
\end{aligned}
$$

Because w_{it} and u_{it} are uncorrelated by assumption $plim_{N,T}((NT)^{-1}\sum_t u_{it} w_{it}) = 0$, the determinant of interest for the endogeneity bias in our setup in Equations (B.1) to (B.3) is the numerator of the second term on the right-hand side in Equation (B.7). In particular, because u_{it} is $i.i.d.$ over time by assumption we have that

$$
\frac{1}{N}\left(\frac{1}{N_1}\sum_{i=1}^{N} \frac{1}{T}\sum_t \sum_{j=1}^{N_1} u_{it}u_{jt} - \frac{1}{N_2}\sum_{i=1}^{N} \frac{1}{T}\sum_t \sum_{i=N_1+1}^{N} u_{it}u_{jt} \right) \overset{T\to\infty}{\longrightarrow} \frac{1}{N}\left(\frac{1}{N_1}\sum_{i=1}^{N_1} \sigma^2_{u,i} - \frac{1}{N_2}\sum_{i=N_1+1}^{N} \sigma^2_{u,i} \right) \quad \text{(B.8)}
$$

We distinguish three cases. First, under *homoskedasticity* with $\sigma_{u,i} = \sigma_u$ we have that Equation

(B.8) becomes

$$\frac{1}{N}\left(\frac{1}{N_1}\sum_{i=1}^{N_1}\sigma^2_{u,i} - \frac{1}{N_2}\sum_{i=N_1+1}^{N}\sigma^2_{u,i}\right) = \frac{1}{N}\left(\frac{N_1}{N_1}\sigma^2_u - \frac{N_2}{N_2}\sigma^2_u\right) = 0, \tag{B.9}$$

for any N as $T \to \infty$. Thus and notably, under homoskedasticity the endogeneity bias *vanishes with T for any N*. In other words, the two terms $\overline{u}_t^{(1)}$ and $\overline{u}_t^{(2)}$ in Equation (B.2) that generate the endogeneity bias in Equation (B.1) cancel each other out as $T \to \infty$ regardless of N.

Second, under *general heteroskedasticity* with $\sigma_{u,i} \overset{i.i.d.}{\sim} (\mu_{\sigma_u}, s^2_{\sigma_u})$, recalling that $E(x^2) = Var(x) + E(x)^2$, we have that Equation (B.8) becomes

$$\frac{1}{N}\left(\frac{1}{N_1}\sum_{i=1}^{N_1}\sigma^2_{u,i} - \frac{1}{N_2}\sum_{i=N_1+1}^{N}\sigma^2_{u,i}\right) = \frac{1}{N}\left(\mu^2_{\sigma_u} + s^2_{\sigma_u} + o_p(1) - \mu^2_{\sigma_u} - s^2_{\sigma_u} - o(1)\right) = o_p(N^{-1}), \tag{B.10}$$

which means that even as $T \to \infty$ there will be a bias. However, this bias vanishes fast at rate N^2 (with fixed country group shares ω and $1-\omega$).

Third, under homoskedasticity within but heterskedasticity across country groups with $\sigma_{u,i} = \sigma_u^{(j)}$ for $i \in \mathcal{G}_j$, $i = 1, 2, \ldots, N$, $j = 1, 2$, and $\sigma_u^{(1)} \neq \sigma_u^{(2)}$, we have that Equation (B.8) becomes

$$\frac{1}{N}\left(\frac{1}{N_1}\sum_{i=1}^{N_1}\sigma^2_{u,i} - \frac{1}{N_2}\sum_{i=N_1+1}^{N}\sigma^2_{u,i}\right) = \frac{1}{N}\left(\frac{N_1}{N_1}(\sigma_u^{(1)})^2 - \frac{N_2}{N_2}(\sigma_u^{(2)})^2\right) = o_p(1), \tag{B.11}$$

which again means that even as $T \to \infty$ there will be a bias. The bias again vanishes with growing N, at rate N however not as fast as in the case of general heteroskedasticity in Equation (B.10).

It is reassuring that the endogeneity bias in our setup in Equations (B.1) to (B.3) vanishes when $T \to \infty$ even with fixed N at least when there is homoskedasticity. However, in the cases of general and cross-country heteroskedasticity the bias vanishes only when both $T \to \infty$ and $N \to \infty$. Therefore, we assess how large the bias may be in setups comparable to ours in terms of sample size, and also how large it is relative to the textbook setup in Equations (B.5) and (B.6). Using Monte Carlo experiments, we next show that in most configurations there is no visible finite sample bias in our setup, and even when it exists it is much smaller compared to that in the textbook setup in Equations (B.4) to (B.6).

For the simulations we set $\beta = 1$, $\sigma_w = 1$, $\gamma = 1$, and consider various T, N, ω, as well as assumptions regarding $\sigma_{u,i}$. We choose β and σ_w so as to target realistic population R^2's in Equations (B.1) and (B.2) for the case of homoskedasticity.[26] We consider 50,000 replications. Figure B.1 presents the results. The green bars depict the distribution of the finite sample bias for our setup in Equations (B.1) to (B.3) and the red bars for the textbook setup in Equations (B.4) to (B.6).

[26] Note that $Var(x_{it}) = \gamma^2\sigma^2_w + \sigma^2_u\left(N_1^{-1} + N_2^{-1}\right)$, $Var(y_{it}) = \beta^2 Var(x_{it}) + \sigma^2_u$.

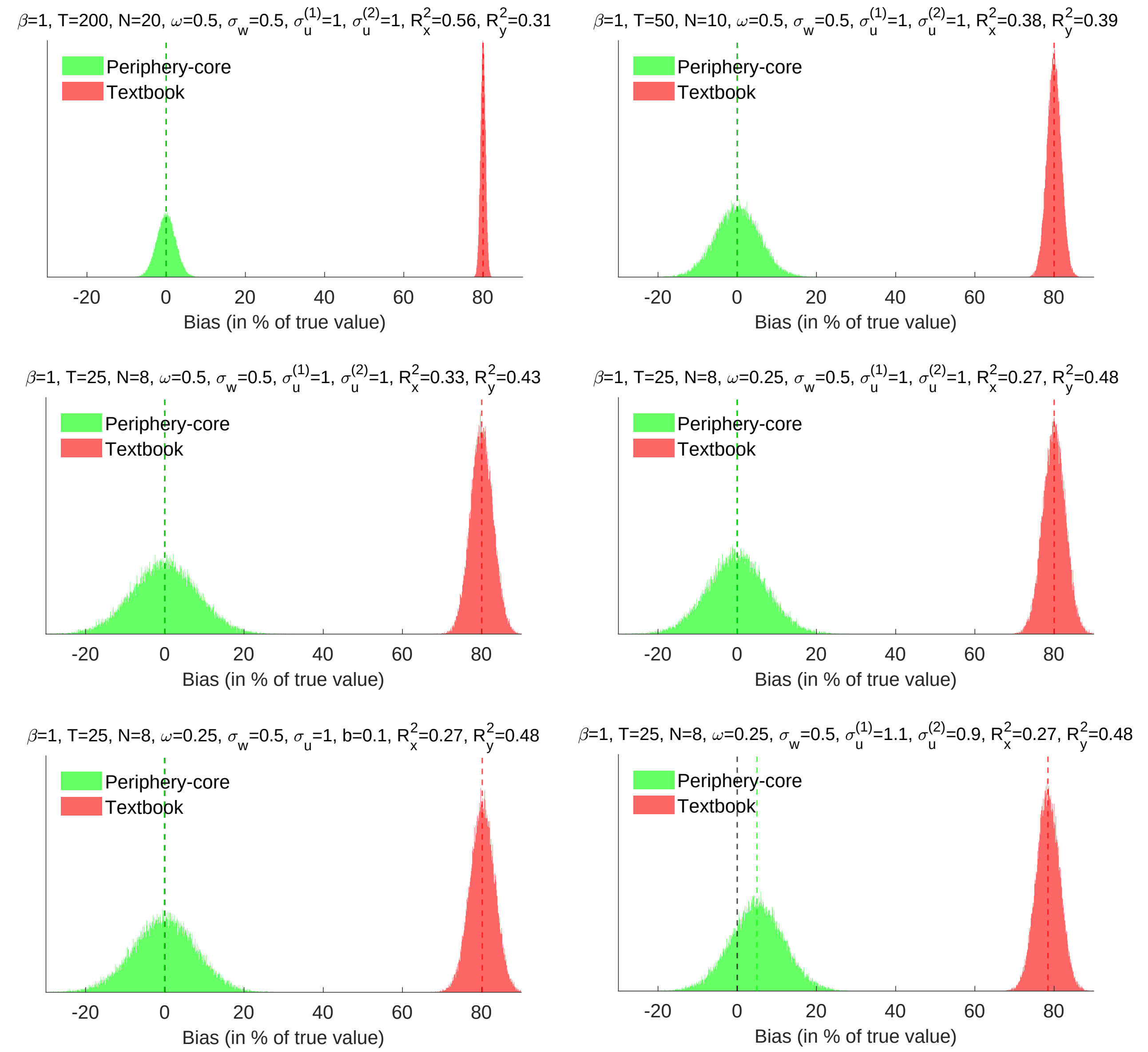
The first panel presents results for an ideal empirical case in the context of our setup in the main text of this paper, namely a relatively large $T = 200$ corresponding to about 17 years of monthly data (i.e. the maximum possible T in our empirical analysis for January 2007 to December 2023), $N = 20$ (i.e. about the number of euro area countries), equal country group sizes $\omega = 0.5$ (comparable to the total numbers of core and periphery countries in the data), and homoskedasticity $\sigma_{u,i} = \sigma_u = 1$. As T is relatively large, there is no noticeable bias in $\widehat{\beta}$ for our setup in Equation (B.1) (recall Equation (B.9)), while $\widehat{\widehat{\beta}}$ for the textbook setup in Equation (B.4) exhibits a large bias. Indeed, note that the bias in $\widehat{\widehat{\beta}}$ in the textbook setup Equation (B.4) is relatively large with 80% of the true value and does *not* vanish even asymptotically as $T \to \infty$.

The second panel in the first row considers smaller $T = 50$ and $N = 10$, and the first panel in the second row reduces them further to $T = 25$ and $N = 8$. The second panel in the second row further reduces the size of the periphery country group to just $N_1 = 2$ for given $N = 8$, which is the most typical configuration in our empirical analysis in the main text of this paper. $\widehat{\beta}$ remains unbiased, which is remarkable given that $T = 25$ only.

We next consider the two cases of heteroskedasticity. In the first case, we consider general heteroskedasticity $\sigma_{u,i} \sim unif(\sigma_u - 2b, \sigma_u + 2b)$, under which—for closer comparability with the second case—the first 50% of the probability mass is centered around $\sigma_u - b$ and the remaining 50% around $\sigma_u + b$. We choose b so that in the second case with cross-group heteroskedasicity ($\sigma_{u,i} = \sigma_u^{(j)}$ for $i \in \mathcal{G}_j$, $j = 1, 2$) we have $\frac{\sigma_u^{(1)}}{\sigma_u^{(2)}} = \frac{\sigma_u + b}{\sigma_u - b} = \sqrt{1.5}$, meaning that the variance of the country-specific shocks in the periphery group is 50% larger than in the core group.

The first panel in the third row shows that in the case of general heteroskedasticity there is no noticeable bias, even with $N = 8$ only (recall Equation (B.10)). The second panel in the third row shows that while in the case of cross-group heteroskedasticity there is a bias also in our setup in Equations (B.1) to (B.3) when $N = 8$ only (recall Equation (B.11)), it is an order of magnitude smaller compared to the textbook setup in Equation (B.4).

Figure B.1: Finite sample bias of $\widehat{\beta}$ in our setup in Equation (B.1) and $\widehat{\widehat{\beta}}$ in the textbook setup in Equation (B.4)



Note: The figure shows Monte Carlo experiment results for the finite sample distribution of the estimate for β in our setup in Equation (B.1) (green histograms) and in the textbook setup in Equation (B.4) (red histograms). The horizontal axis depicts the bias in % of the true value of β. The black dashed vertical line is drawn at 0, the red and the green at the mean of the estimates across the $r = 1, 2, \ldots, 50,000$ replications. The parameterizations related to the standard deviations reported in the panel titles are rounded to the second decimal digit.

C Tables

Table C.1: Summary statistics of dependent and explanatory variables for RL local-projection regressions

	mean	min	p5	p50	p95	max	sd	count
$100 \times (h_{fi,t+0} - h_{fi,t-1})/h_{fi,t-1}$ (trimmed)	-1.43	-100.0	-44.4	0.0	29.6	181.5	26.92	775,328
$100 \times (h_{fi,t+9} - h_{fi,t-1})/h_{fi,t-1}$ (trimmed)	3.31	-100.0	-100.0	-1.0	162.0	782.1	94.62	584,505
$log(h_{fi,t-1})$	123.72	-460.5	-203.2	124.5	446.8	901.5	197.01	775,328
$\Delta(cds_t^p - cds_t^c)$ (un-standardized)	-0.61	-99.9	-22.8	-1.7	26.4	103.2	19.37	775,328
Issuer i IP y-o-y change in t −1	0.75	-58.0	-12.2	0.3	13.6	58.5	9.63	775,328
Total amount outstanding in $t-1$	1307.37	753.7	1017.3	1362.7	1463.0	1470.5	143.67	775,328
Average bond yield in $t-1$	5.18	-10889.0	-14.5	6.7	21.5	90.0	56.43	775,328
Fund inflows relative to lagged AuM (lagged)	0.52	-15.0	-3.2	-0.0	4.0	36893.9	132.53	775,328
Euro area shadow short rate in $t-1$	-3.07	-7.8	-7.6	-4.1	3.6	4.3	3.68	775,328
US shadow short rate in $t-1$	0.88	-3.0	-2.4	0.3	5.1	5.3	2.06	775,328
VIX in $t-1$	20.01	9.5	11.6	18.1	34.2	59.9	7.59	775,328
EA-US 10-year rate spread $t-1$	-1.50	-2.8	-2.5	-1.6	-0.1	0.7	0.69	775,328
EA CitiGroup Economic Surprise in $t-1$	4.60	-275.6	-92.4	1.4	156.0	188.5	78.77	775,328
Periph-core IP growth spread (lagged)	-1.22	-27.1	-6.7	-1.0	3.0	24.8	5.03	775,328
Periph-core debt stock spread (lagged)	111.34	82.4	95.5	113.1	119.7	120.4	7.50	775,328
CDS spread in $t-1$	0.13	-1.1	-0.6	-0.1	2.0	4.1	0.81	775,328
$\mathbb{1}(i \in core)$	0.53	0.0	0.0	1.0	1.0	1.0	0.50	775,328

Note: The table reports summary statistics of the dependent and explanatory variables used in the fund-level regressions using RL data.

Table C.2: Instrumental variable regressions

	Baseline		IV: ± spikes dummy		IV: + spikes dummy	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta(cds_t^p - cds_t^c)$	-2.214***		-2.059***		-2.190***	
	(0.00)		(0.01)		(0.01)	
$\Delta(cds_t^p - cds_t^c) \times \mathbb{1}(i \in core)$	2.194***	2.573***	1.958**	2.943***	1.808*	3.494***
	(0.00)	(0.00)	(0.01)	(0.00)	(0.06)	(0.00)
Lagged holdings $h_{fi,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes
Proxy controls $\boldsymbol{d}_{t-1}$	Yes	No	Yes	Yes	Yes	Yes
Common controls $\boldsymbol{\eta}_{t-1}$	Yes	No	Yes	No	Yes	No
Issuer controls $\boldsymbol{w}_{i,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes
Fund controls $\boldsymbol{x}_{f,t-1}$	Yes	No	Yes	No	Yes	No
Fund-issuer FEs	Yes	Yes	Yes	Yes	Yes	Yes
Fund-time FEs	No	Yes	No	Yes	No	Yes
Total observations	588,175	664,552	588,175	664,552	588,175	664,552
Number of funds	3,868	3,196	3,868	3,196	3,868	3,196
Within R-squared	0.29	0.55	0.13	0.15	0.13	0.15
Kleibergen-Paap LM p-value test for underidentification			0.00	0.00	0.00	0.00
Kleibergen-Paap F-statistic for weak identification			362.43	1125.60	1074.73	2534.29

Note: The table reports results for regressions of Equation (17) using instrumental variables for the change in the CDS spread. Columns (1) and (2) report results for the baseline. Columns (3) and (4) report results for an instrumental variables regression in which we use a variable that equals 1 (−1) in the months of the five largest positive (negative) spikes in the CDS spread and zero else. In Columns (5) and (6) we use an instrumental variable that equals 1 in the months of the five largest positive spikes in the CDS spread and zero else. The last two lines report the test statistics for the Kleibergen-Paap test for under-identification (instrument relevance) and for the Kleibergen-Paap test for weak instruments. p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). See also the notes to Table 2.

Table C.3: Alternative proxy variables for the euro disaster risk shock

	Baseline		More countries		BBG surprises		Excl. 2010/12		EA average CDS		Bond spread	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\Delta(cds^p_t - cds^c_t)$	-2.214***											
	(0.00)											
$\Delta(cds^p_t - cds^c_t) \times \mathbb{1}(i \in core)$	2.194***	2.573***										
	(0.00)	(0.00)										
CDS premia for more countries			-3.643***									
			(0.00)									
$\times \mathbb{1}(i \in core)$			3.556***	3.986***								
			(0.00)	(0.00)								
Cleansed by BBG surprises					-2.220***							
					(0.00)							
$\times \mathbb{1}(i \in core)$					2.171***	2.579***						
					(0.00)	(0.00)						
P-C CDS spread excl. 2010-12							-1.315***					
							(0.00)					
$\times \mathbb{1}(i \in core)$							1.580***	1.579***				
							(0.00)	(0.00)				
Average euro-area CDS premium									-2.970***			
									(0.00)			
$\times \mathbb{1}(i \in core)$									3.098***	3.357***		
									(0.00)	(0.00)		
P-C sovereign bond spread											-4.564***	
											(0.00)	
$\times \mathbb{1}(i \in core)$											3.940***	4.329***
											(0.00)	(0.00)
Lagged holdings $h_{fi,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Proxy controls $\boldsymbol{d}_{t-1}$	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Common controls $\boldsymbol{\eta}_{t-1}$	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Issuer controls $\boldsymbol{w}_{i,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund controls $\boldsymbol{x}_{f,t-1}$	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Fund-issuer FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund-time FEs	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Total observations	588,175	664,552	588,175	664,552	588,175	664,552	588,175	664,552	588,175	664,552	588,175	664,552
Number of funds	3,868	3,196	3,868	3,196	3,868	3,196	3,868	3,196	3,868	3,196	3,868	3,196
Within R-squared	0.29	0.55	0.29	0.55	0.29	0.55	0.29	0.55	0.29	0.55	0.29	0.55

Note: The table reports results for regressions of Equation (17) using alternative proxy variables for the euro disaster risk shock on the left-hand side of Equation (9). Columns (1) and (2) report results for the baseline. Columns (3) and (4) report results for a specification in which use CDS premia for additional issuers to calculate the periphery-core spread. In Columns (5) and (6) the changes in the CDS spread are first cleansed at the daily frequency from periphery and core countries' Bloomberg macro surprises and then aggregated to monthly frequency. In Columns (7) and (8) we use as proxy variable changes in the CDS spread during 2010-12 at the height of the sovereign debt crisis are ignored. In Columns (9) and (10) we use as proxy variable changes the average CDS premium across euro area countries. In Columns (11) and (12) we use as proxy variable changes in the periphery-core 10-year sovereign bond spread. p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). See also the notes to Table 2.

Table C.4: Only the largest spikes in the CDS spread change as proxy variables for the euro disaster risk shock

	Baseline		10 largest spikes				5 largest spikes			
	(1)	(2)	(3) + & −	(4) + & −	(5) Only +	(6) Only +	(7) + & −	(8) + & −	(9) Only +	(10) Only +
$\Delta(cds_t^p - cds_t^c)$	-2.214*** (0.00)									
$\Delta(cds_t^p - cds_t^c) \times \mathbb{1}(i \in core)$	2.194*** (0.00)	2.573*** (0.00)								
Largest spikes in P-C CDS spread			-2.078*** (0.00)		-2.062** (0.02)		-1.969*** (0.01)		-2.146** (0.02)	
$\times\mathbb{1}(i \in core)$			1.946*** (0.00)	2.619*** (0.00)	1.445 (0.14)	3.225*** (0.00)	1.842** (0.02)	2.861*** (0.00)	1.732* (0.09)	3.438*** (0.00)
Lagged holdings $h_{fi,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Proxy controls $\boldsymbol{d}_{t-1}$	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Common controls $\boldsymbol{\eta}_{t-1}$	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Issuer controls $\boldsymbol{w}_{i,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund controls $\boldsymbol{x}_{f,t-1}$	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Fund-issuer FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund-time FEs	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Total observations	588,175	664,552	588,175	664,552	588,175	664,552	588,175	664,552	588,175	664,552
Number of funds	3,868	3,196	3,868	3,196	3,868	3,196	3,868	3,196	3,868	3,196
Within R-squared	0.29	0.55	0.29	0.55	0.29	0.55	0.29	0.55	0.29	0.55

Note: The table reports results for regressions of Equation (17) using alternative proxy variables for the euro disaster risk shock on the left-hand side of Equation (9). Columns (1) and (2) report results for the baseline. Columns (3) and (4) report results for a specification in which use the ten largest positive and negative spikes, and in Columns (5) and (6) only the ten largest positive spikes. In Columns (7) to (10) we analogously use only the five largest spikes in the CDS spread change. p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). See also the notes to Table 2.

Table C.5: Dummy variables at the dates with the largest spikes in the CDS spread change as proxy variables for the euro disaster risk shock

	Baseline		10 largest spikes				5 largest spikes			
	(1)	(2)	(3) + & −	(4) + & −	(5) Only +	(6) Only +	(7) + & −	(8) + & −	(9) Only +	(10) Only +
$\Delta(cds_t^p - cds_t^c)$	-2.214***									
	(0.00)									
$\Delta(cds_t^p - cds_t^c) \times \mathbb{1}(i \in core)$	2.194***	2.573***								
	(0.00)	(0.00)								
Dummies for largest spikes in P-C CDS spread			-6.524***		-7.234**		-8.026***		-9.628***	
			(0.00)		(0.02)		(0.00)		(0.01)	
$\times \mathbb{1}(i \in core)$			6.134***	7.263***	4.697	10.700***	7.720**	11.492***	7.895*	15.418***
			(0.01)	(0.00)	(0.18)	(0.00)	(0.01)	(0.00)	(0.06)	(0.00)
Lagged holdings $h_{fi,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Proxy controls $\boldsymbol{d}_{t-1}$	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Common controls $\boldsymbol{\eta}_{t-1}$	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Issuer controls $\boldsymbol{w}_{i,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund controls $\boldsymbol{x}_{f,t-1}$	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Fund-issuer FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund-time FEs	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Total observations	588,175	664,552	588,175	664,552	588,175	664,552	588,175	664,552	588,175	664,552
Number of funds	3,868	3,196	3,868	3,196	3,868	3,196	3,868	3,196	3,868	3,196
Within R-squared	0.29	0.55	0.29	0.55	0.29	0.55	0.29	0.55	0.29	0.55

Note: The table reports results for regressions of Equation (17) using alternative proxy variables for the euro disaster risk shock on the left-hand side of Equation (9). Columns (1) and (2) report results for the baseline. Columns (3) and (4) report results for a specification in which we use positive and negative dummy variables for the monthly dates with the ten largest positive and negative spikes, and in Columns (5) and (6) only for the monthly dates with the ten largest positive spikes. In Columns (7) to (10) we analogously use dummies only for the monthly dates with the five largest spikes in the CDS spread change. p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). See also the notes to Table 2.

Table C.6: The role of euro disaster risk shock sign

	(1)	(2)	(3)	(4)
$\Delta(cds_t^p - cds_t^c)$	-2.214***			
	(0.00)			
$\times \mathbb{1}(\Delta(cds_t^p - cds_t^c) > 0)$		-0.490		
		(0.54)		
$\times \mathbb{1}(\Delta(cds_t^p - cds_t^c) < 0)$		-4.767***		
		(0.00)		
$\Delta(cds_t^p - cds_t^c) \times \mathbb{1}(i \in core)$	2.194***		2.573***	
	(0.00)		(0.00)	
$\times \mathbb{1}(\Delta(cds_t^p - cds_t^c) > 0)$		-0.056		1.846**
		(0.95)		(0.03)
$\times \mathbb{1}(\Delta(cds_t^p - cds_t^c) < 0)$		5.378***		3.591***
		(0.00)		(0.00)
Lagged holdings $h_{fi,t-1}$	Yes	Yes	Yes	Yes
Proxy controls $\boldsymbol{d}_{t-1}$	Yes	Yes	No	No
Common controls $\boldsymbol{\eta}_{t-1}$	Yes	Yes	No	No
Issuer controls $\boldsymbol{w}_{i,t-1}$	Yes	Yes	Yes	Yes
Fund controls $\boldsymbol{x}_{f,t-1}$	Yes	Yes	No	No
Fund-issuer FEs	Yes	Yes	Yes	Yes
Fund-time FEs	No	No	Yes	Yes
Total observations	588,175	588,175	664,552	664,552
Number of funds	3,868	3,868	3,196	3,196
Within R-squared	0.29	0.29	0.55	0.55

Note: The table reports results for the regression of Equation (17) for positive and negative euro disaster risk shocks. p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). See also the notes to Table 2.

Table C.7: Effects of euro disaster risk shocks on fund holdings of euro area sovereign debt across fund-size distribution

	(1) Baseline	(2) Weighted by fund size	(3) Below 25% percentile	(4) Below median fund size	(5) Below 75% percentile	(6) Below 95% percentile	(7) Above 95% percentile
$\Delta(cds_t^p - cds_t^c)$	-2.214***	-2.770***	-1.767***	-2.039***	-2.133***	-2.162***	-3.466***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
$\Delta(cds_t^p - cds_t^c) \times \mathbb{1}(i \in core)$	2.194***	2.817***	2.019***	1.946***	1.999***	2.173***	2.725*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)
Lagged holdings $h_{fi,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Proxy controls $\boldsymbol{d}_{t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Common controls $\boldsymbol{\eta}_{t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Issuer controls $\boldsymbol{w}_{i,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund controls $\boldsymbol{x}_{f,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund-issuer FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Total observations	588,175	588,064	147,280	294,399	440,865	558,416	29,502
Number of funds	3,868	3,865	1,734	2,571	3,201	3,723	144
Within R-squared	0.29	0.30	0.35	0.31	0.29	0.29	0.29
$\psi + \chi = 0$	-0.020	0.047	0.252	-0.093	-0.133	0.012	-0.741
	(0.95)	(0.93)	(0.58)	(0.81)	(0.71)	(0.97)	(0.41)

Note: The table reports results for the regression of Equation (17) for regressions weighting observations by fund size (Column 2) and for samples of funds with different size (Columns 3 and 7). p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). See also the notes to Table 2.

Table C.8: Results for different core/periphery definitions

	Baseline		No DE/IT		DE/IT		+ FR/+ ES		+ NL/+ PT		+FI/+ GR	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\Delta(cds_t^p - cds_t^c)$	-2.214***		-2.109***		-2.303**		-2.202***		-2.243***		-2.390***	
	(0.00)		(0.00)		(0.01)		(0.00)		(0.00)		(0.00)	
$\Delta(cds_t^p - cds_t^c) \times \mathbb{1}(i \in core)$	2.194***	2.573***	2.183***	2.658***	2.234**	2.700***	2.300***	2.681***	2.038***	2.411***	2.239***	2.615***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)
Lagged holdings $h_{fi,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Proxy controls $\boldsymbol{d}_{t-1}$	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Common controls $\boldsymbol{\eta}_{t-1}$	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Issuer controls $\boldsymbol{w}_{i,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund controls $\boldsymbol{x}_{f,t-1}$	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Fund-issuer FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund-time FEs	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Total observations	588,175	664,552	421,916	469,785	166,259	128,286	301,577	315,882	377,481	410,109	417,716	460,199
Number of funds	3,868	3,196	3,202	2,655	3,454	2,058	3,671	2,823	3,724	2,955	3,785	3,051
Within R-squared	0.29	0.55	0.30	0.58	0.28	0.70	0.28	0.64	0.28	0.60	0.28	0.59
$\psi + \chi = 0$	-0.020		0.075		-0.069		0.098		-0.205		-0.151	
	(0.95)		(0.84)		(0.91)		(0.85)		(0.64)		(0.70)	

Note: The table reports results for the regression of Equation (17) for different definitions of core and periphery country samples. p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). See also the notes to Table 2.

Table C.9: Results for investment funds domiciled across core and periphery

	Baseline		Core		Periphery	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta(cds_t^p - cds_t^c)$	-2.214***		-3.110***		-2.870***	
	(0.00)		(0.00)		(0.00)	
$\Delta(cds_t^p - cds_t^c) \times \mathbb{1}(i \in core)$	2.194***	2.573***	2.933***	2.945***	2.279*	4.045***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)	(0.00)
Lagged holdings $h_{fi,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes
Proxy controls $\boldsymbol{d}_{t-1}$	Yes	No	Yes	No	Yes	No
Common controls $\boldsymbol{\eta}_{t-1}$	Yes	No	Yes	No	Yes	No
Issuer controls $\boldsymbol{w}_{i,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes
Fund controls $\boldsymbol{x}_{f,t-1}$	Yes	No	Yes	No	Yes	No
Fund-issuer FEs	Yes	Yes	Yes	Yes	Yes	Yes
Fund-time FEs	No	Yes	No	Yes	No	Yes
Total observations	588,175	664,552	170,601	195,420	37,072	42,602
Number of funds	3,868	3,196	980	845	460	351
Within R-squared	0.29	0.55	0.28	0.53	0.31	0.54
$\psi + \chi = 0$	−0.020		−0.177		−0.592	
	(0.95)		(0.69)		(0.56)	

Note: The table reports results for regressions of Equation (17) separately for funds domiciled in euro area core and periphery countries, respectively. Columns (1) and (2) report results for the baseline, without and with fund-time FEs, respectively. Columns (3) and (4) report results for funds domiciled in euro area core countries, and Columns (5) and (6) for funds domiciled in periphery countries. p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). See also the notes to Table 2.

Table C.10: Results for regressions with long time series and with dual holders

	Baseline		$T_{fi} > 25$		$T_{fi} > 50$		Dual holders	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta(cds_t^p - cds_t^c)$	-2.214***		-2.302***		-2.419***		-2.309***	
	(0.00)		(0.00)		(0.00)		(0.00)	
$\Delta(cds_t^p - cds_t^c) \times \mathbb{1}(i \in core)$	2.194***	2.573***	2.291***	2.543***	2.567***	2.559***	2.231***	2.571***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Lagged holdings $h_{fi,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Proxy controls $\boldsymbol{d}_{t-1}$	Yes	No	Yes	No	Yes	No	Yes	No
Common controls $\boldsymbol{\eta}_{t-1}$	Yes	No	Yes	No	Yes	No	Yes	No
Issuer controls $\boldsymbol{w}_{i,t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund controls $\boldsymbol{x}_{f,t-1}$	Yes	No	Yes	No	Yes	No	Yes	No
Fund-issuer FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund-time FEs	No	Yes	No	Yes	No	Yes	No	Yes
Total observations	588,175	664,552	457,027	520,556	298,836	334,735	512,827	596,840
Number of funds	3,868	3,196	1,545	1,499	851	752	3,241	2,922
Within R-squared	0.29	0.55	0.22	0.51	0.20	0.51	0.30	0.54
$\psi + \chi = 0$	−0.020		−0.011		0.147		−0.078	
	(0.95)		(0.98)		(0.70)		(0.83)	

Note: The table reports results for the regression of Equation (17) for funds with at least 25 (50) consecutive observations or funds that hold both core and periphery debt. p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). See also the notes to Table 2.

Table C.11: Results for alternative clustering

			Clustering at level of				
	(1) Baseline	(2) Robust stds	(3) fund	(4) fund-time	(5) fund & issuer	(6) issuer-time	(7) time
$\Delta(cds_t^p - cds_t^c) \times \mathbb{1}(i \in core)$	2.573***	2.573***	2.573***	2.573***	2.573***	2.573***	2.573***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Lagged holdings	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Issuer controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund-issuer FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund-time FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Total observations	664,552	664,552	664,552	664,552	664,552	664,552	664,552
Number of funds	3,196	3,196	3,196	3,196	3,196	3,196	3,196
Within R-squared	0.55	0.55	0.55	0.55	0.55	0.55	0.55

Note: The table reports results for the regression of Equation (18) with variations in the clustering of standard errors. p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). See also the notes to Table 2.

Table C.12: Effects of euro disaster risk shocks on inflows for different fund groups

	Inflows	Asset type		Geographic focus		Domicile				Portfolio weight		
	(1) Inflows baseline	(2) Bonds	(3) Mixed assets	(4) EA	(5) Global	(6) EA	(7) Eur. fin. centers	(8) North America	(9) RoW	(10) $\omega < 25\%$	(11) $25\% < \omega < 50\%$	(12) $> 90\%$
$\Delta(cds_t^p - cds_t^c)$	-3.835**	0.156	-9.031***	-0.022	-3.587*	-4.579***	2.326	-0.439	-37.963	-5.504**	-0.692***	-0.301
	(0.02)	(0.94)	(0.00)	(0.99)	(0.06)	(0.00)	(0.67)	(0.95)	(0.44)	(0.03)	(0.00)	(0.47)
Lagged inflows	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Proxy controls $\boldsymbol{d}_{t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Common controls $\boldsymbol{\eta}_{t-1}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fund FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Total observations	98,706	56,400	42,306	16,653	72,085	81,567	9,762	5,341	271	65,065	25,417	4,293
Number of funds	3,301	1,638	1,663	439	2,540	2,758	343	117	18	2,358	698	133
Within R-squared	0.40	0.30	0.49	0.24	0.42	0.37	0.48	0.38	0.34	0.40	0.18	0.19

Note: The table reports results for the regression of Equation (18) with cumulated fund inflows scaled by the lag of the market value of euro area sovereign debt holdings as dependent variable for samples of funds with different asset types (Columns 2 and 3), different geographical focus (Columns 4 and 5), different domicile (Columns 6 to 9), and different euro area debt portfolio shares (Columns 10 to 12). Scaling by the lag of the market value of euro area sovereign debt holdings is done in order to control for fund heterogeneity regarding the portfolio share of euro area sovereign debt. p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). See also the notes to Table 2.

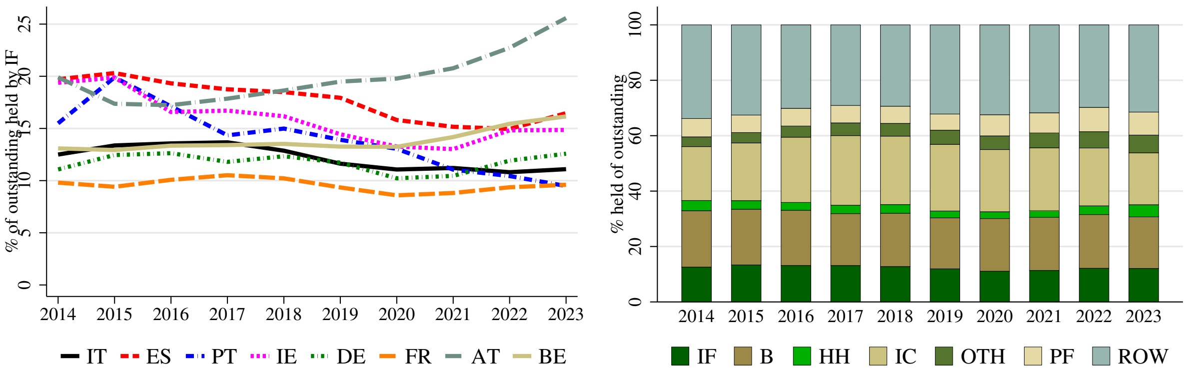
Table C.13: Summary statistics for the dependent variable given by growth rates in holdings at the holder-country × ISIN level used in the local-projection regressions

	mean	min	p1	p5	p50	p95	p99	max	sd	count
$h_{\mathcal{H},\mathcal{S},\mathcal{I},t} - h_{\mathcal{H},\mathcal{S},\mathcal{I},t-1}$, $\mathcal{H}$ =B	-8.20	-100.0	-99.5	-85.1	-0.1	38.5	65.1	75.0	32.28	123,574
$h_{\mathcal{H},\mathcal{S},\mathcal{I},t} - h_{\mathcal{H},\mathcal{S},\mathcal{I},t-1}$, $\mathcal{H}$ =IF	-3.62	-100.0	-92.8	-53.1	-0.3	36.6	63.3	75.0	25.33	191,534
$h_{\mathcal{H},\mathcal{S},\mathcal{I},t} - h_{\mathcal{H},\mathcal{S},\mathcal{I},t-1}$, $\mathcal{H}$ =HH	-2.35	-100.0	-87.3	-41.1	-0.1	27.0	58.2	72.2	20.65	126,064
$h_{\mathcal{H},\mathcal{S},\mathcal{I},t} - h_{\mathcal{H},\mathcal{S},\mathcal{I},t-1}$, $\mathcal{H}$ =IC	-2.67	-100.0	-87.2	-34.4	-0.0	17.0	38.1	48.8	17.49	193,995
$h_{\mathcal{H},\mathcal{S},\mathcal{I},t} - h_{\mathcal{H},\mathcal{S},\mathcal{I},t-1}$, $\mathcal{H}$ =PF	-3.15	-100.0	-92.1	-55.1	-0.0	35.4	63.7	75.0	24.95	79,387
$h_{\mathcal{H},\mathcal{S},\mathcal{I},t} - h_{\mathcal{H},\mathcal{S},\mathcal{I},t-1}$, $\mathcal{H}$ =OTHER	-5.65	-100.0	-99.2	-69.3	-0.0	31.8	62.3	75.0	27.06	106,243
$h_{\mathcal{H},\mathcal{S},\mathcal{I},t} - h_{\mathcal{H},\mathcal{S},\mathcal{I},t-1}$, $\mathcal{H}$ =ROW	-3.12	-100.0	-80.6	-42.1	-0.2	26.4	49.2	59.8	20.18	21,330
Average change over $t+\ell$ and $t-1$, $\mathcal{H}$ =B	16.14	-100.0	-93.9	-67.4	0.0	174.5	330.9	400.0	73.26	108,056
Average change over $t+\ell$ and $t-1$, $\mathcal{H}$ =IF	4.99	-100.0	-82.2	-54.6	-0.7	98.0	182.1	224.8	45.58	166,218
Average change over $t+\ell$ and $t-1$, $\mathcal{H}$ =HH	2.65	-100.0	-81.4	-49.5	-0.6	80.4	172.9	221.7	39.66	115,276
Average change over $t+\ell$ and $t-1$, $\mathcal{H}$ =IC	2.28	-100.0	-73.9	-40.8	-0.0	58.9	118.9	148.9	29.33	177,972
Average change over $t+\ell$ and $t-1$, $\mathcal{H}$ =PF	9.20	-100.0	-83.4	-54.7	-0.0	116.8	224.2	274.7	51.75	73,828
Average change over $t+\ell$ and $t-1$, $\mathcal{H}$ =OTHER	9.84	-100.0	-92.6	-60.3	-0.0	130.8	298.3	400.0	62.26	94,642
Average change over $t+\ell$ and $t-1$, $\mathcal{H}$ =ROW	-2.89	-100.0	-67.3	-43.3	-0.9	34.4	64.8	76.4	22.56	16,554

Note: The table reports summary statistics of the dependent variables used in the holder-country × ISIN panel regressions for the investment fund-sector in Equation (19) and more generally for all holder-sectors in Equation (20) using SHSS data.

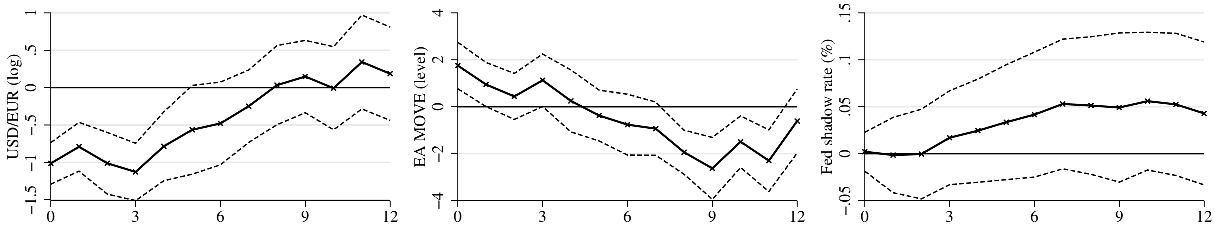
D Figures

Figure D.1: Holding composition in euro area sovereign debt markets



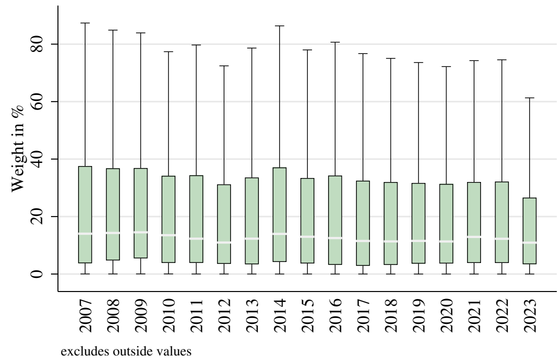
Note: The left-hand side panel shows the evolution of the shares of outstanding amounts of sovereign debt held by euro area domiciled investment funds for Italy (IT), Spain (ES), Portugal (PT), Ireland (IE), Germany (DE), France (FR), Austria (AT), and Belgium (BE). The right-hand side panel shows the evolution of the shares of the sum euro area sovereign debt across issuers held by euro area domiciled investment funds (IF), banks (B), households (HH), insurance corporations (IC), and other sectors composite (OTH), pension funds (PF) and the rest of the world (ROW). The In both panels central-bank holdings are excluded from outstanding amounts. The data are taken from the ECB's Securities Holding Statistics by Sector (SHSS). Section 3 provides more details on the data.

Figure D.2: Effects of changes in the CDS spread on further regional and global macro-financial variables



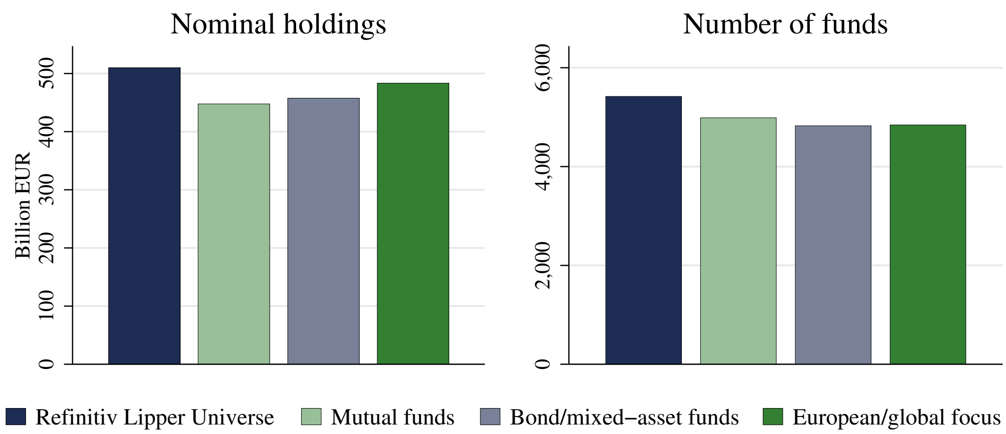
Note: The black dashed lines represent 90% confidence bands based on Newey-West standard errors robust to serial correlation. See also the note to Figure 3.

Figure D.3: Distribution of individual funds' euro area central government debt portfolio share over time



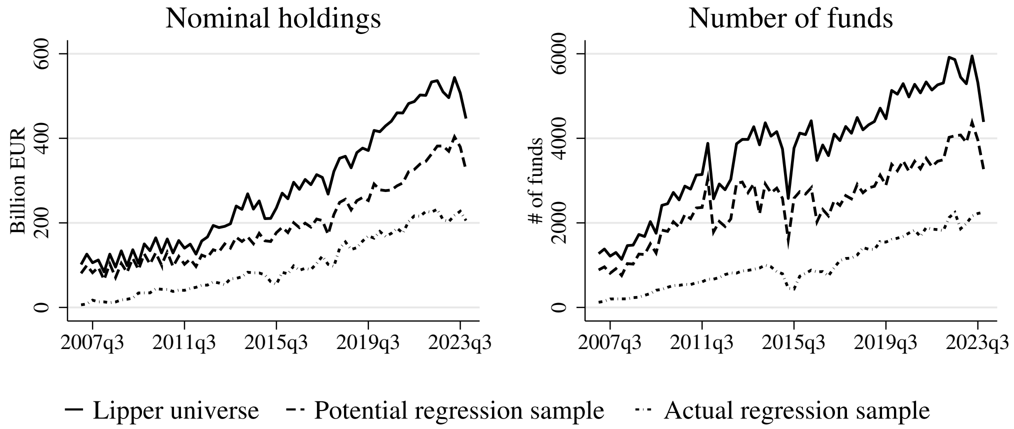
Note: The figure depicts box plots of investment-funds' euro area central government debt portfolio weight distribution. We consider only mutual funds that are characterized as bond or mixed-asset funds with a European/euro area or global geographical focus. The horizontal bright line in each box represents the median, the upper and lower ends of the dark boxes the 25% and 75% percentiles and the whiskers the adjacent values (i.e. the upper whisker includes all data points within 1.5 times the inter-quartile range of the upper quartile and stops at the largest such value); outside values above and below the adjacent values are not plotted.

Figure D.4: Lipper data coverage for euro area sovereign debt for different fund types and asset focuses in 2022q4



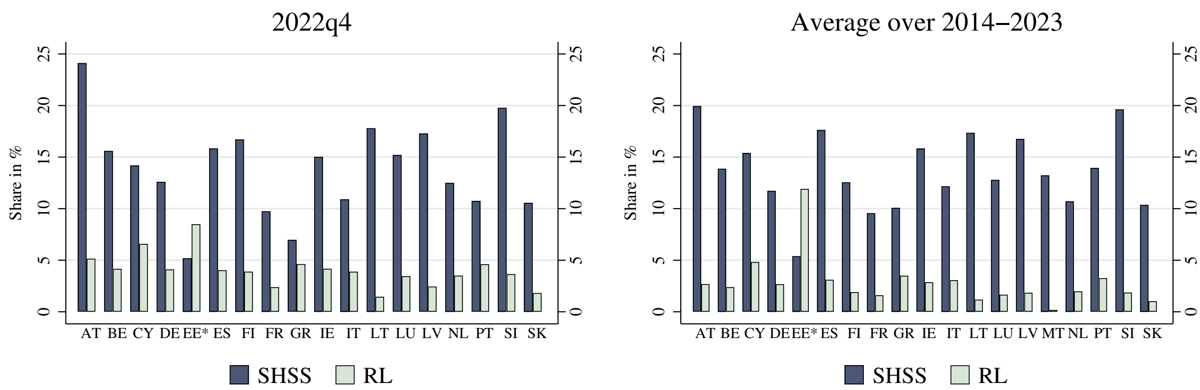
Note: The left-hand side panel shows the coverage of investment funds' total nominal holdings of euro area sovereign debt in RL for five (sub-)samples. The first bar shows total nominal holdings of all sovereign debt securities by all investment funds in RL. The second bar shows total nominal holdings of all sovereign debt securities by mutual funds. The third bar shows total nominal holdings of all sovereign debt securities by bond and mixed-asset funds funds. The last bar shows total nominal holdings of all sovereign debt securities by funds with a European/euro area or global focus. The right-hand side panel shows analogous statistics in terms of the number of funds rather than total nominal holdings.

Figure D.5: Coverage of the RL universe and the regression sample



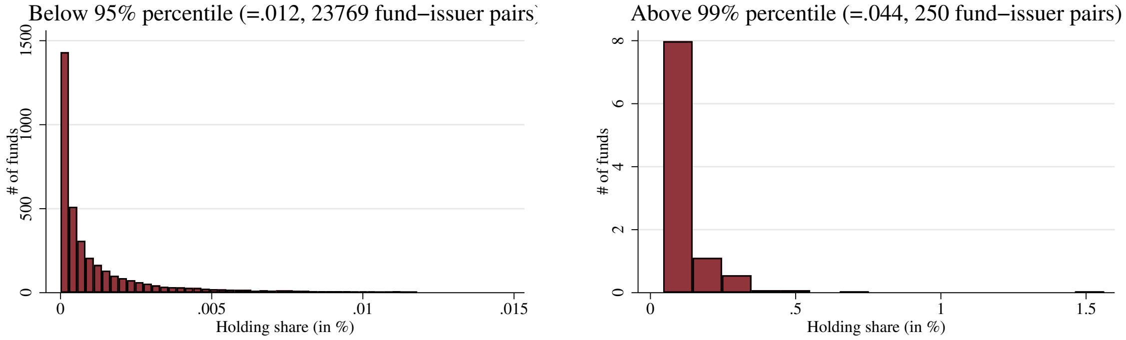
Note: The left-hand side panel shows investment funds' total nominal holdings of euro area sovereign debt in RL for three (sub-)samples. The solid line depicts total nominal holdings of all investment funds and all government debt securities in RL, the dashed line total nominal holdings of central government debt of funds that satisfy our selection criteria (mutual, mixed-asset or bond funds with a geographical focus on Europe/euro area or the World), and the dash-dotted line total nominal holdings of central government debt of funds that enter our baseline regression depending on data availability for controls. The right-hand side panel shows analogous statistics in terms of the number of funds rather than total nominal holdings.

Figure D.6: Share of outstanding sovereign debt held by investment funds in SHSS and RL



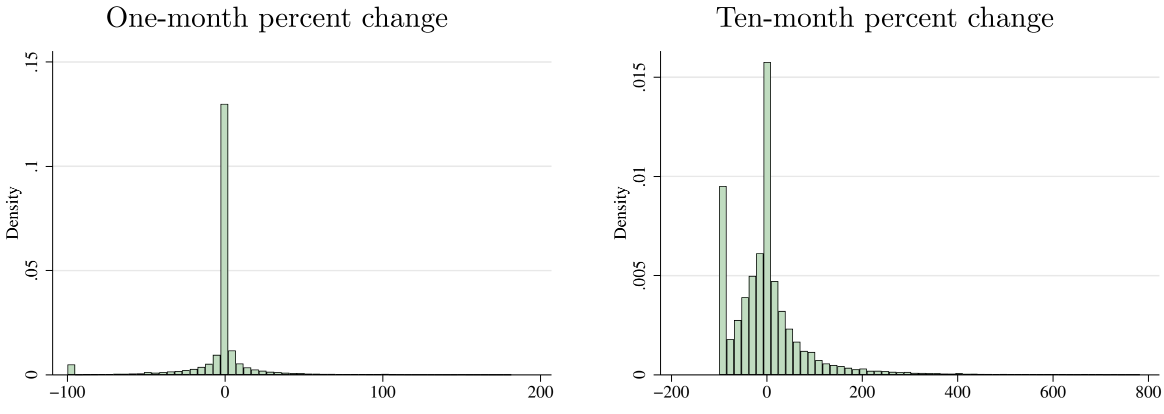
Note: The dark-colored (light-colored) bars show the share of sovereign debt covered by issuer in SHSS (RL). The left-hand side panel shows the statistics for 2022q4 and the right-hand side panel for the average over 2014 to 2023. The SHSS shares for Estonia (EE) are divided by ten. Holdings of bonds issued by Malta are excluded due to confidentiality reasons. Outstanding amounts are given by the sum of holdings of euro area-domiciled holder-sectors and the rest of the world, excluding Eurosystem holdings.

Figure D.7: Distribution of individual funds' holding share in issuers' total outstanding debt



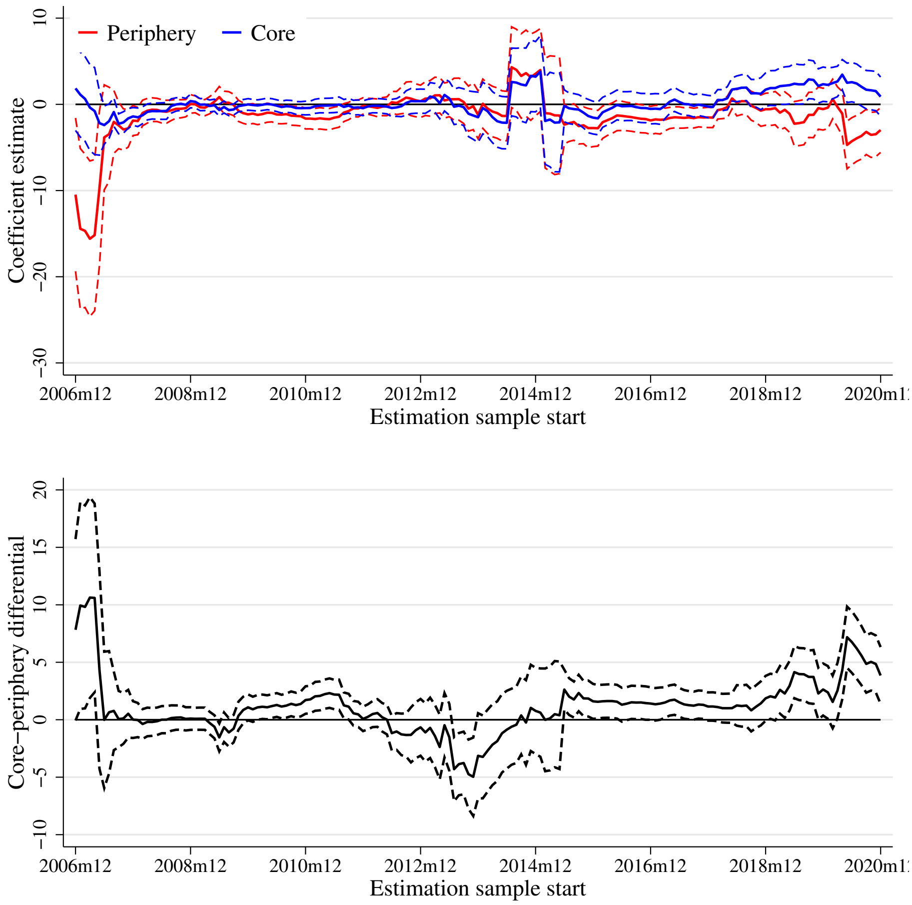
Note: The left-hand side panel (right-hand side) shows the distribution of the holding share of euro area sovereign debt accounted for by individual funds in our regression sample for the bottom 95% (top 1%) of the distribution.

Figure D.8: Distribution of the percent change in individual fund holdings of euro area sovereign debt



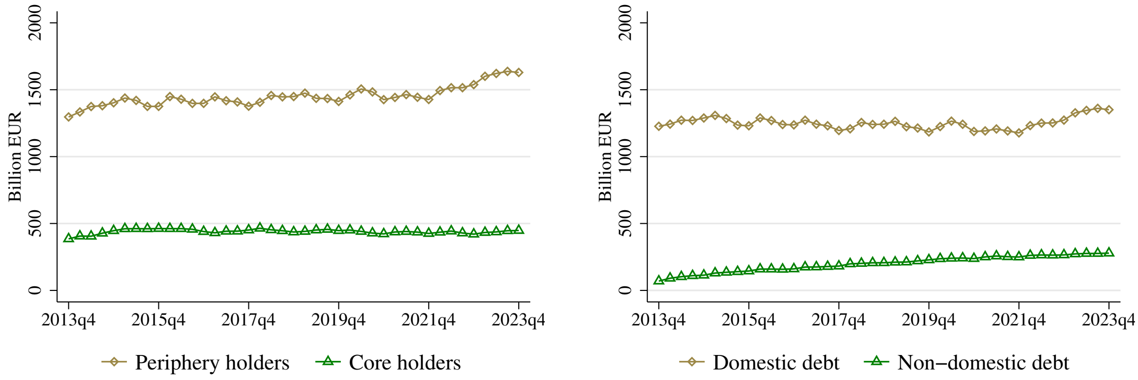
Note: The figure depicts the distribution of the dependent variable $g^h_{fi,t+\ell} \equiv 100 \times (h_{fi,t+\ell} - h_{fi,t-1})/h_{fi,t-1}$ *in our regressions, that is the growth rate in fund holdings of euro area countries' sovereign debt. The left-hand side panel depicts the distribution for* $\ell = 0$*, and the right-hand side for* $\ell = 9$.

Figure D.9: Time-varying estimate of core-periphery differential from rolling-window regressions



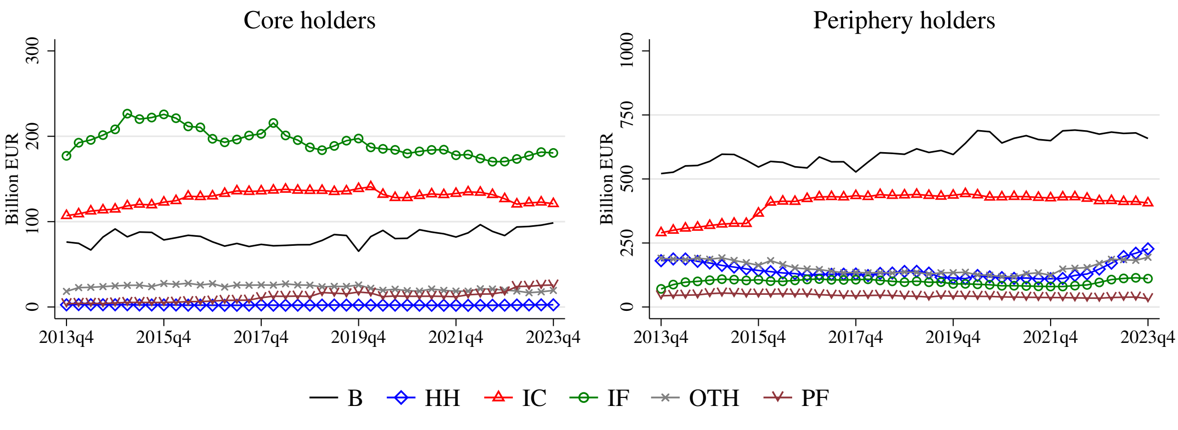
Note: In the top panel, the red (blue) solid line indicates the time-varying response of the average fund's periphery (core) sovereign debt holdings to a euro disaster risk shock in Equation (17). In the bottom panel, the black solid line depicts the time-varying estimate of the average fund's core-periphery differential of the effect of a euro disaster risk shock in Equation (18). The estimates are obtained from rolling regressions with a window length of three years. The responses refer to a horizon of six months after the shock; we choose a shorter horizon than in Table 2 in order to be able to obtain rolling-window estimates closer to the end of the sample. Dashed lines indicate 90% confidence bands. The date depicted on the horizontal axis indicates the first period included in the rolling window.

Figure D.10: Periphery debt holdings by holder-country-group and by domestic/non-domestic debt over time



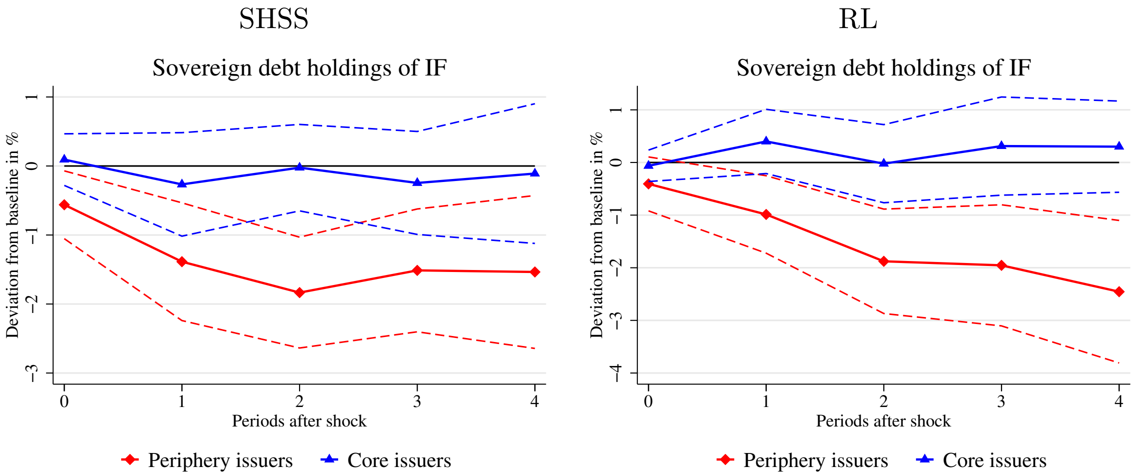
Note: The left-hand side panel shows periphery sovereign debt holdings by holder-sector across holder-country-groups. The right-hand side panel shows domestic and non-domestic periphery-domiciled holdings of periphery sovereign debt by holder-sector.

Figure D.11: Evolution of holdings of periphery sovereign debt by holder-country group and holder-sector



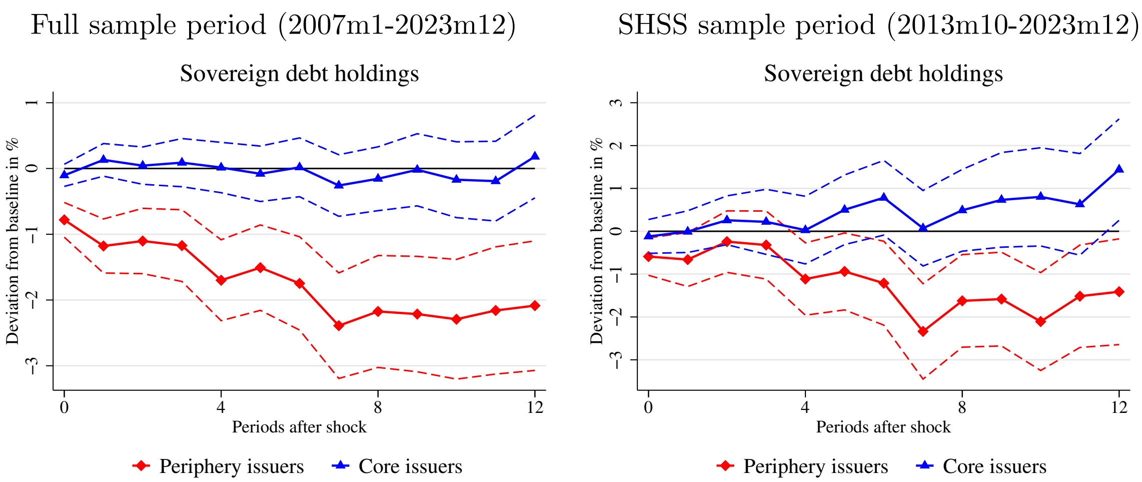
Note: The panels show the evolution of holdings of periphery sovereign debt by core (left-hand side) and periphery (right-hand side) holder-sectors—banks (B), households (HH), insurance corporations (IC), investment funds (IF), other-sectors-composite (OTH), and pension funds (PF)—over time in the SHSS data.

Figure D.12: Effects of euro disaster risk shocks on investment-fund holdings of euro area sovereign debt from holder-country × ISIN panel local projections in SHSS data and domicile-country × ISIN panel local projections in RL data



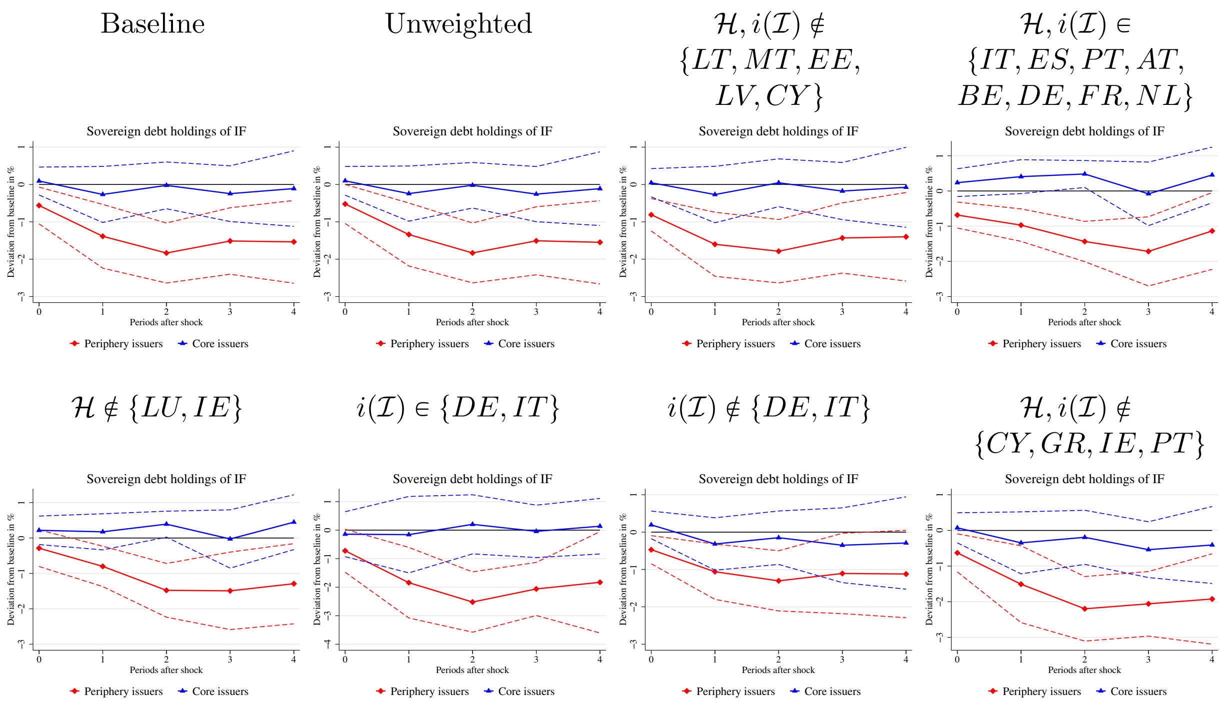
Note: The panels show the impulse response of investment-fund holdings of core (blue triangle line) and periphery (red diamond line) sovereign debt to a euro disaster risk shock that raises the periphery-core 10-year sovereign bond yield spread by one standard deviation for SHSS (left-hand side) and RL (right-hand side) data. The responses are obtained from weighted holder-country (domicile-country) × ISIN panel local projections in Equation (19). Weights are given by the logarithm of the average holder/domicile-country holdings over the sample period. In the regressions using the RL data we consider all individual euro area countries as domicile-countries, and only funds that we also include in the fund-level analysis in Section 4. Standard errors are clustered at the holder/domicile-country level and issuer-country × time level. Dashed lines indicate 90% confidence bands. Periods refer to quarters.

Figure D.13: Effects of euro disaster risk shocks on investment-fund holdings of euro area sovereign debt in RL data estimated for the full RL sample period and the SHSS sample period from 2013q4



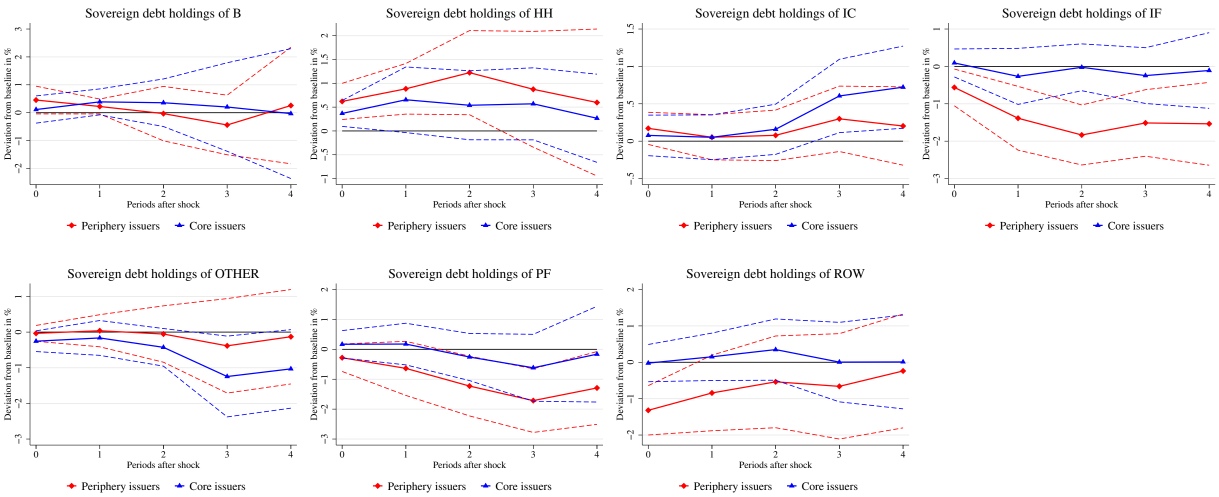
Note: The panels show the impulse response of investment-fund holdings of core (blue triangle line) and periphery (red diamond line) sovereign debt to a euro disaster risk shock that raises the periphery-core 10-year sovereign bond yield spread by one standard deviation for RL data. The left-hand side panel reproduces the baseline results estimated from the full RL sample period from 2007m1-2023m12 as shown in Figure 7. The right-hand side panel shows results for the same estimation using RL data, but for the sample period from 2013m10-2023m12 available in SHSS. Dashed lines indicate 90% confidence bands. Standard errors are clustered at the fund level and issuer × time level. Periods refer to months.

Figure D.14: Effects of euro disaster risk shocks on euro area investment-fund holdings of euro area sovereign debt from different specifications



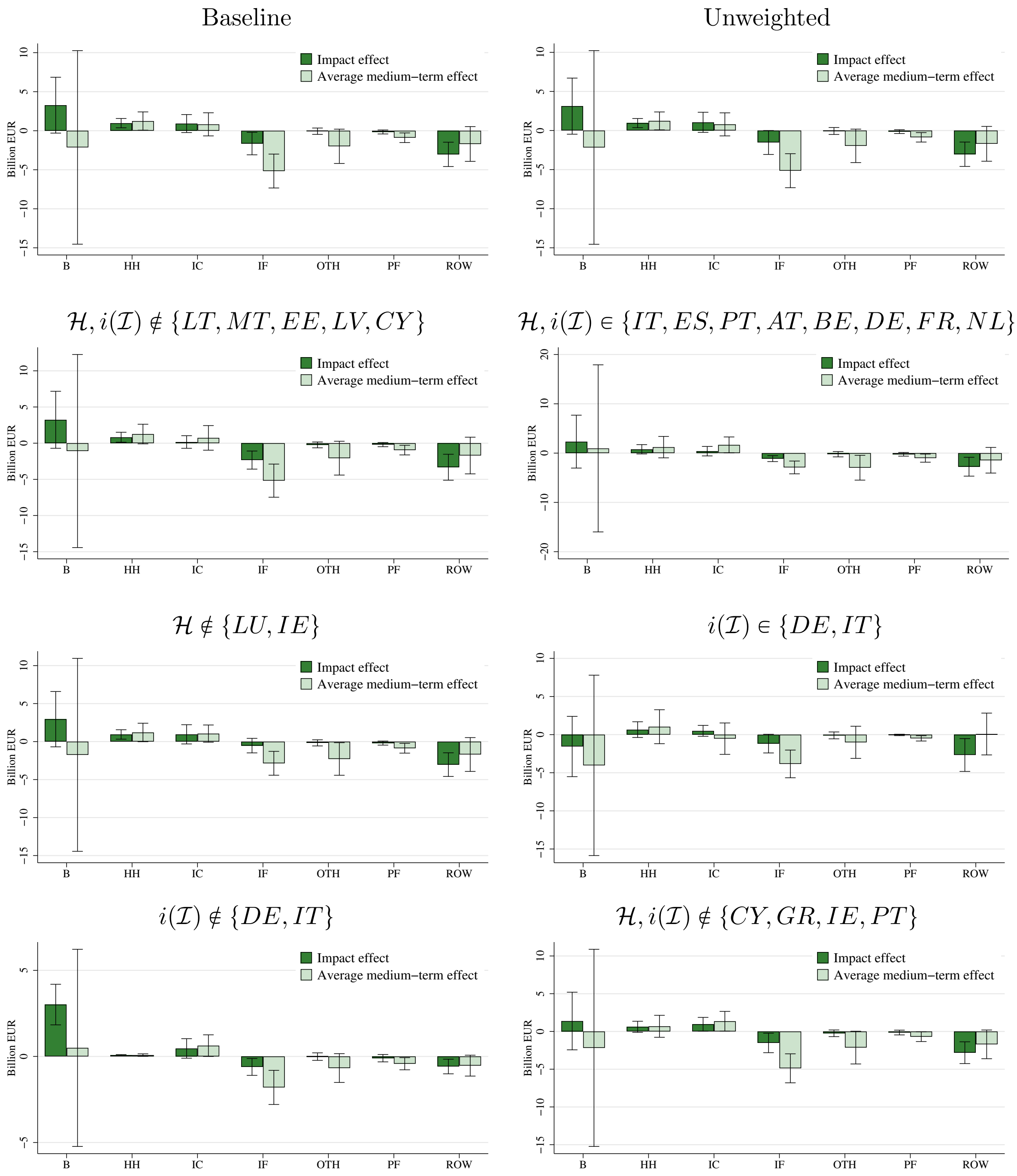
Note: The panels show the response of investment-fund holdings of euro area core (blue triangle line) and periphery sovereign debt (red diamond line) in SHSS data to a euro disaster risk that raises the periphery-core 10-year sovereign bond yield differential by one standard deviation. The baseline panel shows the results from Figure 12. "$\mathcal{H}, i(\mathcal{I}) \notin \{LT, MT, EE, LV, CY\}$": Drop observations for which Lithuania, Malta, Estonia, Latvia and Cyprus are the issuer or holder country. "$\mathcal{H}, i(\mathcal{I}) \in \{IT, ES, PT, AT, BE, DE, FR, NL\}$": Use only observations for which Italy, Spain, Portugal, Austria, Belgium, Germany, France, or the Netherlands are issuer-countries or holder-countries. "$\mathcal{H} \notin \{LU, IE\}$": Drop observations for which Luxembourg or Ireland are holder-countries. "$i(\mathcal{I}) \in (\notin)\{DE, IT\}$": Use only (no) observations for which Italy and Germany are issuer-countries. "$\mathcal{H}, i(\mathcal{I}) \notin \{CY, GR, IE, PT\}$": Drop observations for which Cyprus, Greece, Ireland, or Portugal are the issuer or holder country. Dashed lines indicate 90% confidence bands. Periods refer to quarters.

Figure D.15: Effects of euro disaster risk shocks on core and periphery debt holdings across holder-sectors



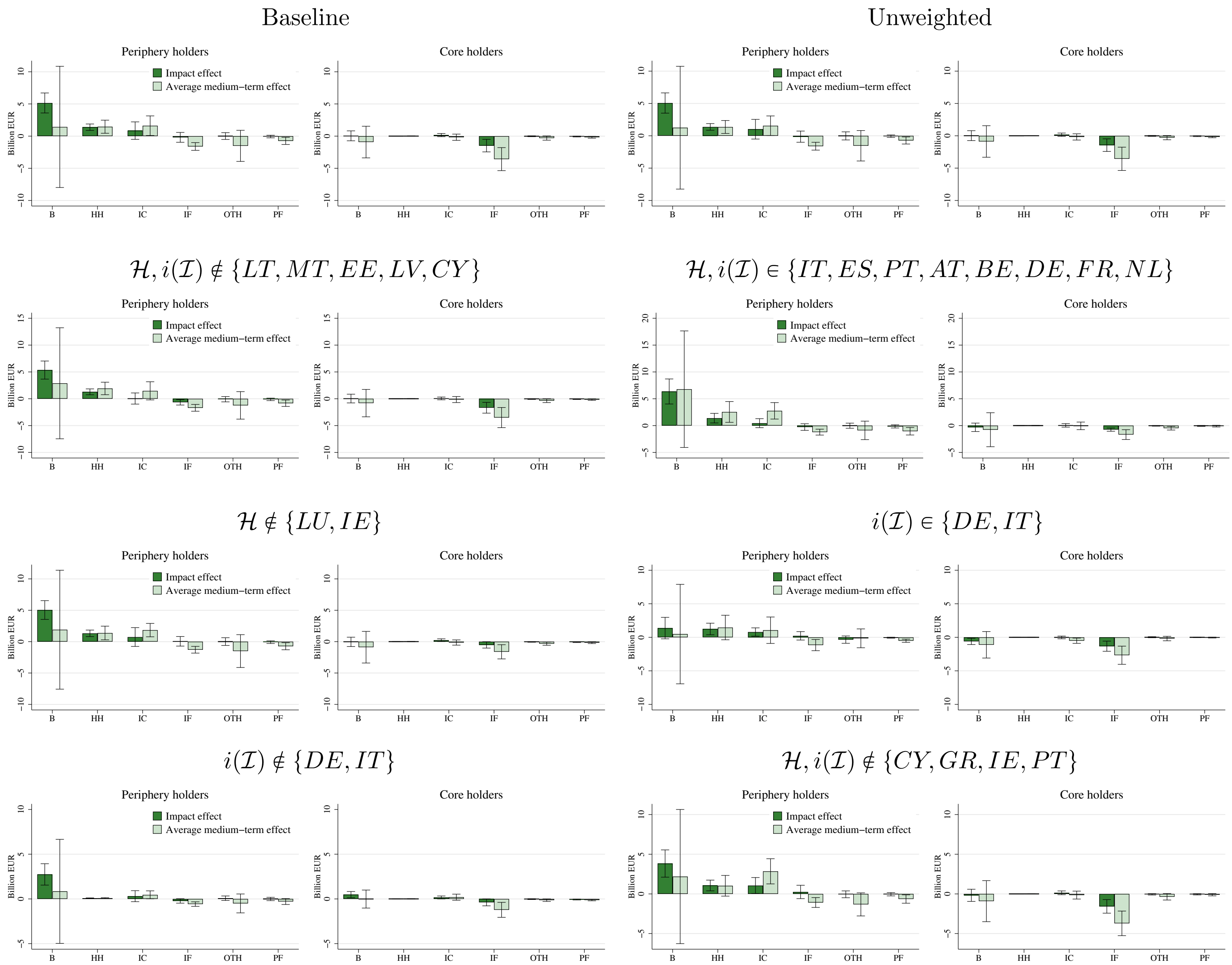
Note: The figure shows the effects of a euro disaster risk shock that raises the periphery-core 10-year sovereign bond yield differential by one standard deviation on euro area core (blue triangle line) and periphery (red diamond line) sovereign debt holdings across holder-sectors, namely banks (B), households (HH), insurance corporations (IC), investment funds (IF), an other-sectors-composite (OTH), pension funds (PF), and the rest of the world (ROW). The estimates are obtained from weighted holder-country × ISIN panel local-projection regressions of Equation (20) run separately for each holder-sector. Dashed lines indicate 90% confidence bands. Periods refer to quarters.

Figure D.16: Effects of euro disaster risk shocks on periphery debt holdings across euro area holder-sectors for different specifications



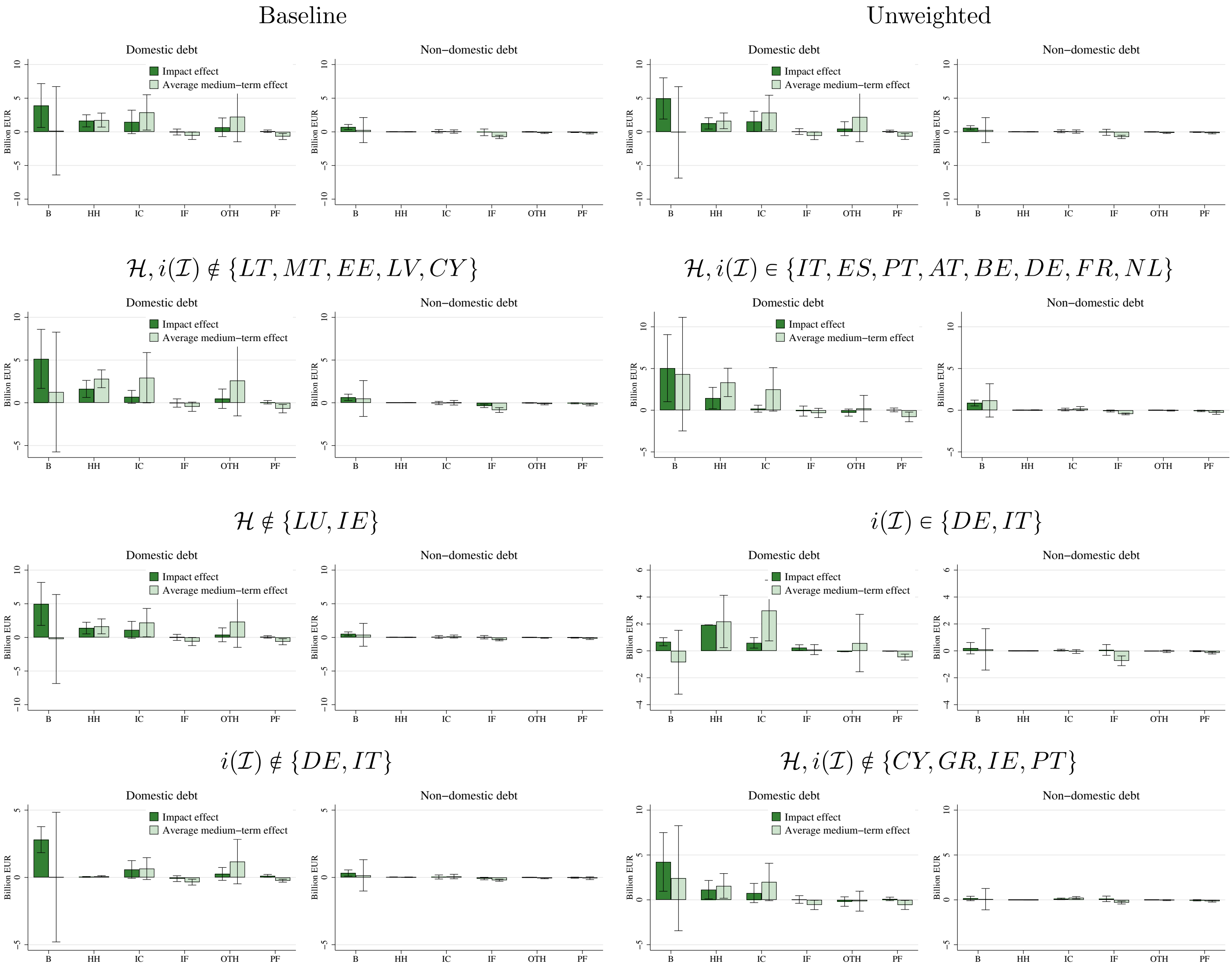
Note: The panels show the response of holdings of periphery sovereign debt to a euro disaster risk shock across holder-sectors on impact (dark-shaded green bars) and the average effect over the impact and the three following periods (light-shaded green bars) for variations of the baseline specification. "Unweighted": No weighting of observations. "$\mathcal{H}, i(\mathcal{I}) \notin \{LT, MT, EE, LV, CY\}$": Drop observations for which Lithuania, Malta, Estonia, Latvia and Cyprus are the issuer or holder country. "$\mathcal{H}, i(\mathcal{I}) \in \{IT, ES, PT, AT, BE, DE, FR, NL\}$": Use only observations for which Italy, Spain, Portugal, Austria, Belgium, Germany, France, or the Netherlands are issuer-countries or holder-countries. "$\mathcal{H} \notin \{LU, IE\}$": Drop observations for which Luxembourg or Ireland are holder-countries. "$i(\mathcal{I}) \in (\notin)\{DE, IT\}$": Use only (no) observations for which Italy and Germany are issuer-countries. "$\mathcal{H}, i(\mathcal{I}) \notin \{CY, GR, IE, PT\}$": Drop observations for which Cyprus, Greece, Ireland, or Portugal are the issuer or holder country. See also the notes to Figure 13.

Figure D.17: Effects of euro disaster risk shocks on periphery debt holdings across core and periphery-domiciled holder-sectors for different specifications



Note: The panels show the response of holdings of euro area periphery sovereign debt to a euro disaster risk shock across core and periphery-domiciled holder-sectors on impact (dark-shaded green bars) and the average effect over the impact and the three following periods (light-shaded green bars) for variations of the baseline specification. "Unweighted": No weighting of observations. "$\mathcal{H}, i(\mathcal{I}) \notin \{LT, MT, EE, LV, CY\}$": Drop observations for which Lithuania, Malta, Estonia, Latvia and Cyprus are the issuer or holder country. "$\mathcal{H}, i(\mathcal{I}) \in \{IT, ES, PT, AT, BE, DE, FR, NL\}$": Use only observations for which Italy, Spain, Portugal, Austria, Belgium, Germany, France, or the Netherlands are issuer-countries or holder-countries. "$\mathcal{H} \notin \{LU, IE\}$": Drop observations for which Luxembourg or Ireland are holder-countries. "$i(\mathcal{I}) \in (\notin)\{DE, IT\}$": Use only (no) observations for which Italy and Germany are issuer-countries. "$\mathcal{H}, i(\mathcal{I}) \notin \{CY, GR, IE, PT\}$": Drop observations for which Cyprus, Greece, Ireland, or Portugal are the issuer or holder country. "Holder-country × issuer-country": Estimate the local projections on holdings data aggregated from the individual ISIN-level to the issuer-country level. See also the notes to Figure 15.

Figure D.18: Effects of euro disaster risk shocks on periphery debt holdings across domestic and non-domestic periphery sovereign debt



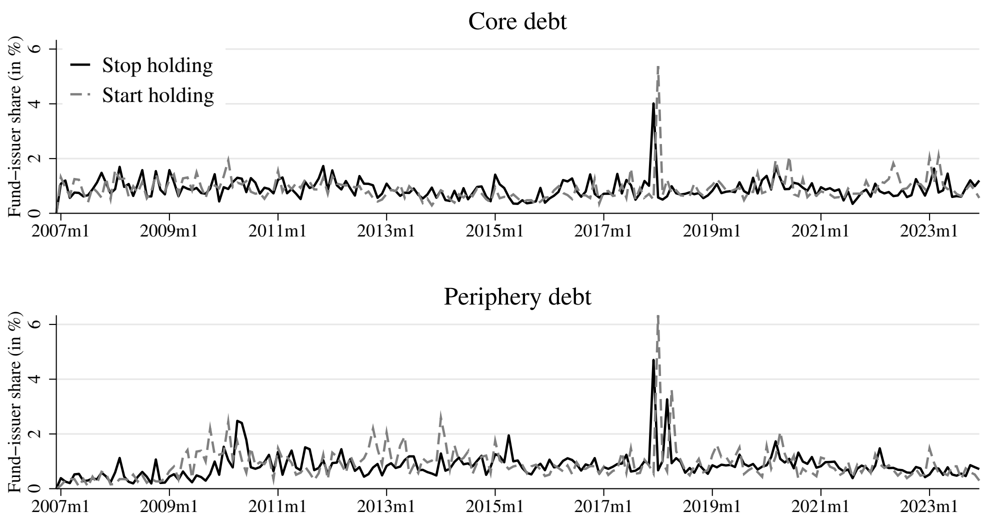
Note: The panels show the response of holdings of euro area periphery sovereign debt to a euro disaster risk shock for periphery holder-sectors across domestic and non-domestic debt on impact (dark-shaded green bars) and the average effect over the impact and the three following periods (light-shaded green bars) for variations of the baseline specification. "Unweighted": No weighting of observations. "$\mathcal{H}, i(\mathcal{I}) \notin \{LT, MT, EE, LV, CY\}$": Drop observations for which Lithuania, Malta, Estonia, Latvia and Cyprus are the issuer or holder country. "$\mathcal{H}, i(\mathcal{I}) \in \{IT, ES, PT, AT, BE, DE, FR, NL\}$": Use only observations for which Italy, Spain, Portugal, Austria, Belgium, Germany, France, or the Netherlands are issuer-countries or holder-countries. "$\mathcal{H} \notin \{LU, IE\}$": Drop observations for which Luxembourg or Ireland are holder-countries. "$i(\mathcal{I}) \in (\notin)\{DE, IT\}$": Use only (no) observations for which Italy and Germany are issuer-countries. See also the notes to Figure 16.

E Extensive vs. intensive-margin adjustments

In this appendix we document that the adjustments of fund holdings of periphery debt arise almost exclusively at the intensive margin.

Figure E.1 displays the evolution of the share of fund-issuer pairs that changes status from holding to non-holding and vice versa, that is $\sum_{i,f} \mathbb{1}(h_{fit} = 0 | h_{fi,t-1} > 0) / \sum_{i,f} \mathbb{1}(h_{fi,t-1} > 0)$ and $\sum_{i,f} \mathbb{1}(h_{fit} > 0 | h_{fi,t-1} = 0) / \sum_{i,f} \mathbb{1}(h_{fi,t-1} = 0)$, respectively.[27] With about 1% on average, the share of fund-issuer pairs that changes status is rather small. An exception is May 2018, when about 4% of fund-issuer pairs transition to non-holding status, only to switch back to holding status shortly thereafter.

Figure E.1: Evolution of the share of fund-issuer pairs changing holding status



Note: The panels show for every period the share of fund-issuer pairs that changes from holding to non-holding status (solid line, $\sum_{i,f} \mathbb{1}(h_{fit} = 0 | h_{fi,t-1} > 0) / \sum_{i,f} \mathbb{1}(h_{fi,t-1} > 0)$, "Stop holding") and from non-holding to holding status (dashed line, $\sum_{i,f} \mathbb{1}(h_{fit} > 0 | h_{fi,t-1} = 0) / \sum_{i,f} \mathbb{1}(h_{fi,t-1} = 0)$, "Start holding"). The top panel shows holding status changes for holdings of core debt and the bottom panel for periphery debt.

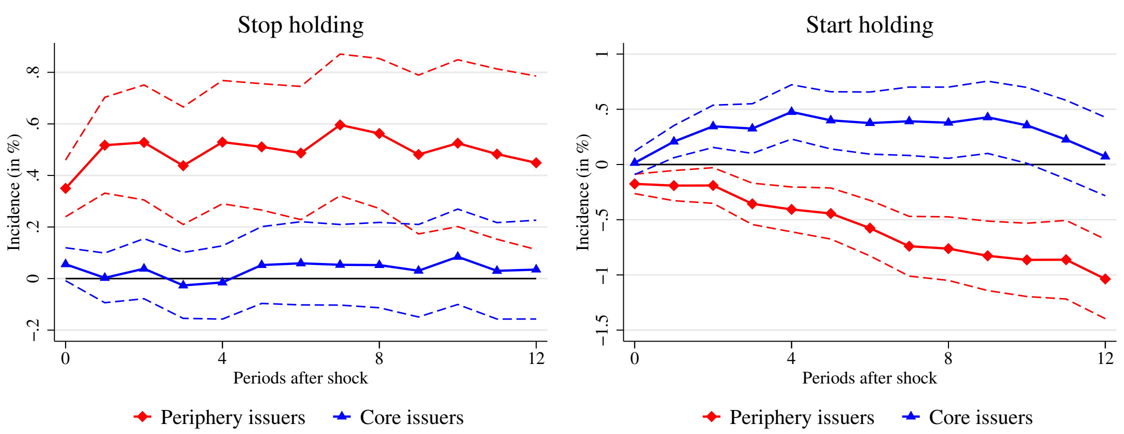
We explore the role of extensive-margin adjustments more systematically using local projections. In particular, for each local-projection horizon ℓ we consider two different alternative dependent variables $\mathbb{1}(\cdot)$ in Equations (17) and (18) without lagged holdings: $\mathbb{1}(h_{fi,t+s} = 0 \text{ for some } 0 \leqslant s \leqslant \ell | h_{fi,t-1} > 0)$, which equals unity if a fund did not hold any debt of issuer i in some period $t+s$ with $\ell \geqslant s \geqslant 0$ after it did in period $t-1$; and $\mathbb{1}(h_{fi,t+s} > 0 \text{ for some } 0 \leqslant$

[27] For the analysis of extensive-margin adjustments we insert zero entries for h_{fit} in every period in which RL reports a fund holds some other asset but information on holdings of euro area sovereign debt is originally missing.

$s \leqslant \ell | h_{fi,t-1} = 0)$, which equals unity if fund f held debt of issuer i in some period $t + s$ with $\ell \geqslant s \geqslant 0$ after it did not in $t-1$. Note that due to the survivorship bias in RL (see Section 3.2), we know that a fund for which $\mathbb{1}(h_{fit} = 0 | h_{fi,t-1} > 0) = 1$ does not drop out of the sample but only stops holding debt of sovereign issuer i, and analogously for $\mathbb{1}(h_{fit} > 0 | h_{fi,t-1} = 0) = 1$. This is because we only have funds in the full sample period that were still in the sample in December 2023.

Figure E.2 shows that a euro disaster risk shock increases the incidence that the average fund which holds the corresponding debt stops holding periphery but not core debt, respectively (left-hand side panel). The effect is immediate and reaches up to about 0.6%. In turn, a euro disaster risk shock reduces the incidence that the average fund which does not hold the corresponding debt starts holding periphery debt by up to about 1%, but also increases the incidence of starting holding core debt by up to about 0.5% (right-hand side panel). Table E.1 provides more information on the regression results at horizon $\ell = s = 0$, including the total number of observations, the number of funds, and the number of holding-status changes.

Figure E.2: Extensive-margin effects of euro disaster risk shocks on investment-fund holdings of euro area sovereign debt



Note: The left-hand side panel shows the impulse response of the incidence of the average fund that holds the corresponding debt stopping holding core debt (blue line with triangles) and periphery (red line with diamonds) sovereign debt. The right-hand side panel shows analogous results for the incidence of the average fund that does not hold the corresponding debt starting holding core debt (blue line with triangles) and periphery (red line with diamonds) sovereign debt. The responses for horizon ℓ are obtained from regressions of Equations (17) and (18) without lagged holdings as control and using as dependent variables $\mathbb{1}(h_{fi,t+s} = 0 \, for \, some \, 0 \leqslant s \leqslant \ell | h_{fi,t-1} > 0)$ and $\mathbb{1}(h_{fi,t+s} > 0 \, for \, some \, 0 \leqslant s \leqslant \ell | h_{fi,t-1} = 0)$, $\ell = 0, 1, 2, \ldots, 12$. Dashed lines indicate 90% confidence bands. Standard errors are clustered at the fund level and issuer × time level. Periods refer to months.

We next explore how much of the change in fund holdings in response to euro disaster risk shocks in Figure 7 is due to adjustments at the intensive margin. To so so, we re-run the local projections in Equation (17) but drop all observations for which $\mathbb{1}(h_{fit} = 0 | h_{fi,t-1} > 0) = 1$, that is when a fund sheds all its holdings of issuer i debt.

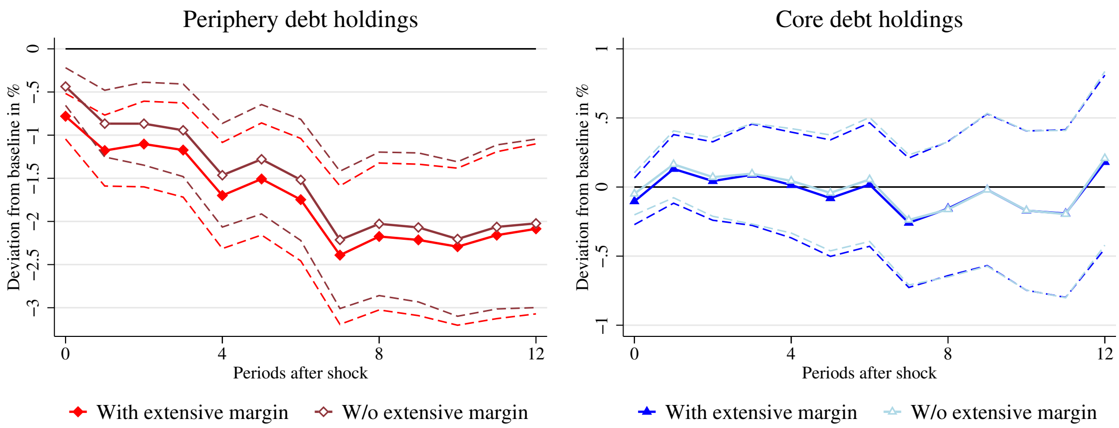
Table E.1: Regressions for extensive-margin effects

	$\mathbb{1}$ (Stop holding)		$\mathbb{1}$ (Start holding)	
	(1)	(2)	(3)	(4)
$\Delta(cds_t^p - cds_t^c)$	0.350***		-0.175***	
	(0.00)		(0.00)	
$\Delta(cds_t^p - cds_t^c) \times \mathbb{1}(i \in core)$	-0.294***	-0.257***	0.191**	0.170***
	(0.00)	(0.00)	(0.02)	(0.01)
Proxy controls $\boldsymbol{d}_{t-1}$	Yes	No	Yes	No
Common controls $\boldsymbol{\eta}_{t-1}$	Yes	No	Yes	No
Issuer controls $\boldsymbol{w}_{i,t-1}$	Yes	Yes	Yes	Yes
Fund controls $\boldsymbol{x}_{f,t-1}$	Yes	No	Yes	No
Fund-issuer FEs	Yes	Yes	Yes	Yes
Fund-time FEs	No	Yes	No	Yes
Total observations	800,624	933,729	707,757	841,333
Number of funds	4,679	3,917	3,437	3,143
Within R-squared	0.11	0.40	0.09	0.32
$\mathbb{1}(\cdot) = 1$	18,807	20,961	17,091	20,083
$\psi + \chi$	0.056		0.015	
	(0.15)		(0.81)	

Note: The table reports results for the linear probability regressions based on Equations (17) and (18). The dependent variable in the regressions underlying the results in Columns (1) and (2) is given by $\mathbb{1}(h_{fit} = 0 | h_{fi,t-1} > 0)$, which equals unity if a fund did not hold any debt of issuer i in t after it did in the previous period $t-1$. The dependent variable in the regressions underlying the results in Columns (3) and (4) is given by $\mathbb{1}(h_{fit} > 0 | h_{fi,t-1} = 0)$, which equals unity if a fund held debt of issuer i in t after it did not do so in the previous period $t-1$. The last two rows report the number of non-zero observations on the dependent variable $\mathbb{1}(\cdot)$ and the estimate and associated p-value of the test of H_0 $\psi + \chi = 0$, respectively. p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). See also the notes to Table 2.

Figure E.3 presents the results. The lines with filled markers reproduce the baseline results from Figure 7, while the lines with hollow markers represent the results excluding the extensive margin. We find that almost the entire shedding of periphery debt in response to euro disaster risk shocks in Figure 7 is due to adjustments at the intensive margin. The difference between the responses of core holdings with and without extensive-margin adjustment in Figure E.3 is hardly visible.

Figure E.3: Effects of euro disaster risk shocks on investment-fund holdings of euro area sovereign debt without extensive-margin adjustment



Note: The left-hand side panel shows the impulse response of a fund's holdings of euro area periphery sovereign debt for the baseline specification which does not distinguish between extensive and intensive-margin adjustments (solid red line with filled diamonds) and for the specification in which the extensive-margin adjustment is excluded (solid maroon line with hollow diamonds). The right-hand side panel shows analogous results for core debt holdings. The responses for the intensive margin at horizon ℓ are obtained from regressions of Equations (17) and (18) excluding observations with $\mathbb{1}(h_{fit} = 0 | h_{fi,t-1} > 0) = 1$. Standard errors are clustered at the fund level and issuer $\times$ time level. Dashed lines indicate 90% confidence bands. Periods refer to months.

F The role of currency denomination

In this appendix, we explore whether funds adjust their euro area sovereign debt holdings differently across currency denominations. We find that funds shed in particular EUR-denominated periphery debt and accumulate non-EUR denominated core and periphery debt.

Overall, the share of non-EUR denominated holdings in total holdings is very small (left-hand side panels in Figure F.1). At the same time, a non-trivial share of funds holds euro area sovereign debt denominated in multiple currencies, at least since the euro area sovereign debt crisis (right-hand side panels in Figure F.1).[28] Non-EUR denominated holdings are larger for periphery than for core sovereign debt.

We next explore whether currency denomination plays a role in funds' response to euro disaster risk shocks. Indexing the denomination currency by c, we estimate at the fund-issuer-currency level:

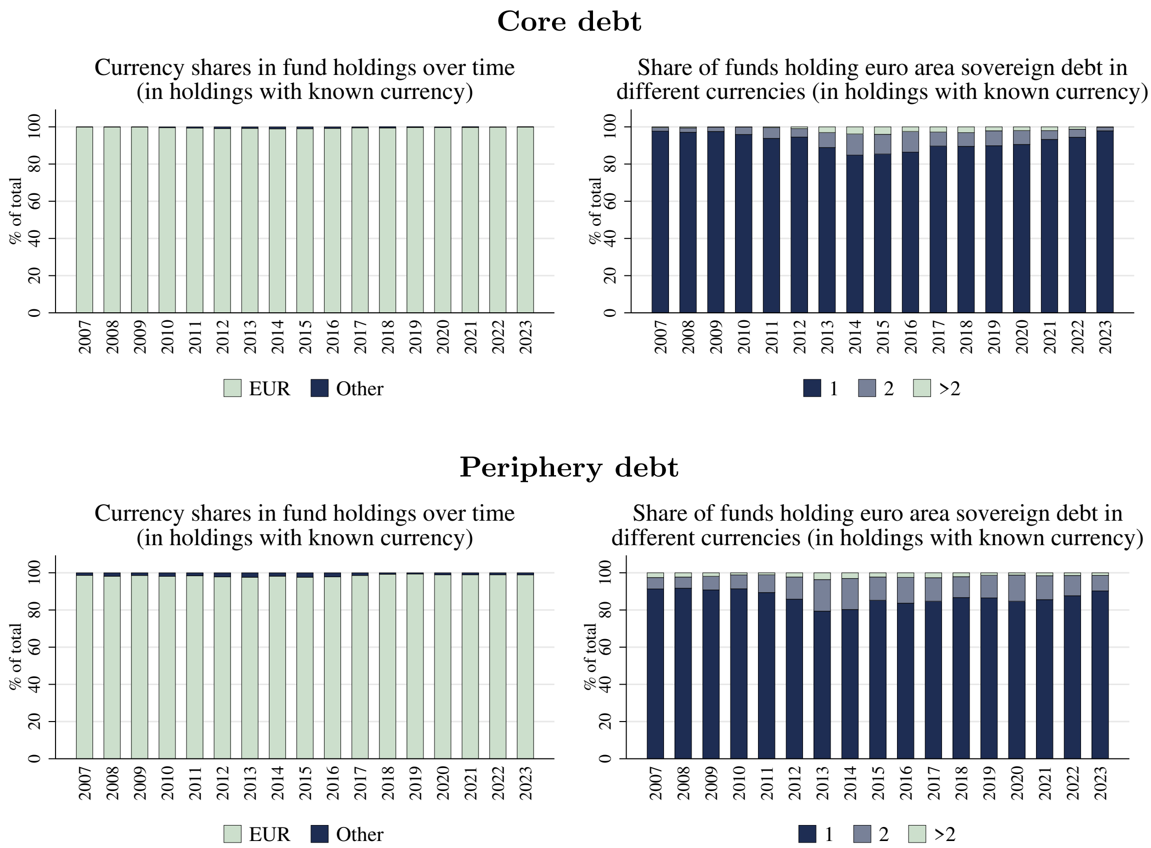
$$\begin{aligned} h_{fic,t+\ell} - h_{fic,t-1} = \gamma_{fi}^{(\ell)} + \varrho^{(\ell)} h_{fic,t-1} + \boldsymbol{\beta}^{(\ell)} \boldsymbol{x}_{ft} + \boldsymbol{\delta}^{(\ell)} \boldsymbol{w}_{it} + \boldsymbol{\kappa}^{(\ell)} \boldsymbol{\eta}_t + \boldsymbol{\mu}^{(\ell)} \boldsymbol{d}_t \\ + \left[\psi^{(\ell)} + \chi^{(\ell)} \mathbb{1}(i \in core) \right] \Delta(cds_t^p - cds_t^c) + u_{fict}^{(\ell)}. \end{aligned} \tag{F.1}$$

Table F.1 reports results for regressions of Equation (F.1) estimated separately for different currency sets. The number of observations included in the regressions is larger than in the baseline as for each fund-issuer observation there is at least one currency denomination. Column (1) reports results for regressions using holdings regardless of their currency of denomination. In Column (2) we only use holdings for which we have information on the currency of denomination. Here we primarily lose observations from prior to October 2013 when the ECB's CSDB is not available.[29] In Column (3) we only use EUR-denominated holdings, in Column (4) only non-EUR-denominated holdings, and in Column (5) only denominations in non-EUR advanced-economy currencies. The findings in Columns (3) to (5) suggest that a euro disaster risk shock induces the average fund to shed only EUR-denominated periphery debt. At the same time, the fund builds up non-EUR denominated core debt in response to euro disaster risk shocks.

[28] We draw on CSDB for information on the currency denomination of funds' euro area sovereign debt holdings. CSDB provides data from October 2013 onward. For ISINs held by funds both after and prior to October 2013, we fill missing information using CSDB. For ISINs held exclusively before this date, we use Bloomberg.

[29] We always have information on the currency in which the market value of a fund's holdings of a security is reported, which is different from the information on the currency of denomination of that security. For this reason we do not need to drop the holdings for which we do not have information on the currency of denomination from our baseline regressions in Section 4.

Figure F.1: Currency composition of fund holdings of euro area core and periphery sovereign debt



Note: The left-hand side panels show the evolution of the currency composition of fund holdings of euro area sovereign debt. The right-hand side panels show the evolution of the share of funds with different numbers of currency denominations in their euro area debt holdings. The top (bottom) row shows the evolution of the currency composition of fund holdings of euro area core (periphery) debt over time.

Next we estimate local projections

$$\begin{aligned} h_{fic,t+h} - h_{fic,t-1} = \gamma_{fi}^{(\ell)} + &\varrho^{(\ell)} h_{fic,t-1} + \boldsymbol{\beta}^{(\ell)} \boldsymbol{x}_{ft} + \boldsymbol{\delta}^{(\ell)} \boldsymbol{w}_{it} + \boldsymbol{\kappa}^{(\ell)} \boldsymbol{\eta}_t + \boldsymbol{\mu}^{(\ell)} \boldsymbol{d}_t \\ &+ \chi_1^{(\ell)} \phi_t + \chi_2^{(\ell)} \left[\phi_t \times \mathbb{1}(c = \text{EUR})\right] + \chi_3^{(\ell)} \left[\phi_t \times \mathbb{1}(i \in core)\right] \\ &+ \chi_4^{(\ell)} \cdot \left[\phi_t \times \mathbb{1}(i \in core) \times \mathbb{1}(c = \text{EUR})\right] + u_{fict}^{(\ell)}, \qquad \text{(F.2)} \end{aligned}$$

for $h = 0, 1, \ldots, 12$ to explore the dynamic effects of euro disaster risk shocks on fund holdings for different combinations of core/periphery and EUR/non-EUR-denominated debt holdings. The left-hand side panels in Figure F.2 depict the dynamic effects on the level of holdings and the right-hand side panels for the corresponding core-periphery differentials.

The left-hand side panel in the first row presents the dynamic effects on fund holdings of non-

Table F.1: Effects of euro disaster risk shocks on fund holdings of euro area sovereign debt at fund-issuer-currency level at horizon $\ell = 9$

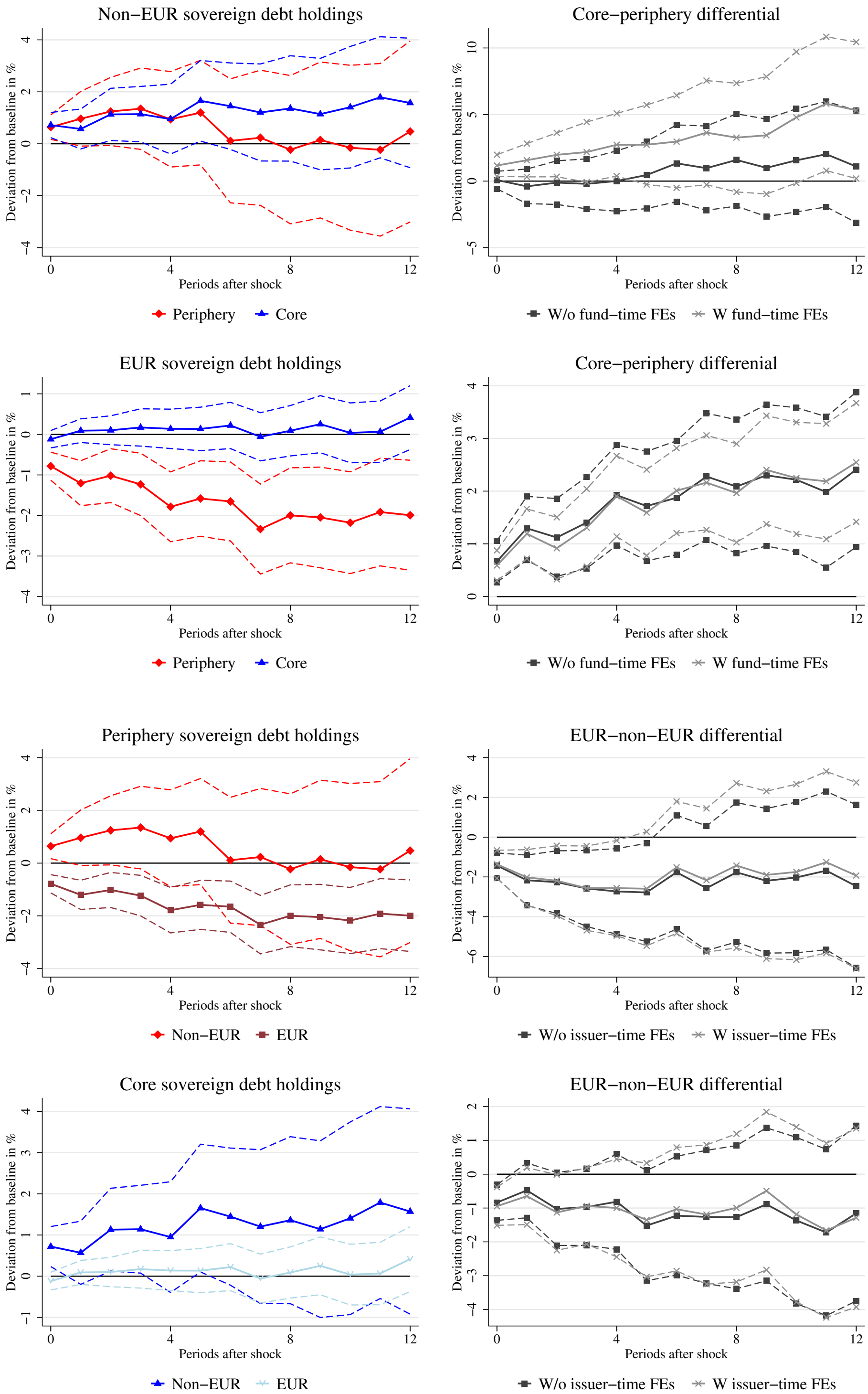
	(1) Baseline	(2) Known c	(3) EUR	(4) Non-EUR	(5) Non-EUR AE c
$\Delta(cds_t^p - cds_t^c)$	-2.450***	-1.863***	-1.992***	-0.916	-0.894
	(0.00)	(0.00)	(0.00)	(0.21)	(0.22)
$\Delta(cds_t^p - cds_t^c) \times \mathbb{1}(i \in core)$	1.764***	2.135***	2.260***	1.993*	1.961*
	(0.00)	(0.00)	(0.00)	(0.06)	(0.06)
Lagged holdings $h_{fi,t-1}$	Yes	Yes	Yes	Yes	Yes
Proxy controls $\boldsymbol{d}_{t-1}$	Yes	Yes	Yes	Yes	Yes
Common controls $\boldsymbol{\eta}_{t-1}$	Yes	Yes	Yes	Yes	Yes
Issuer controls $\boldsymbol{w}_{i,t-1}$	Yes	Yes	Yes	Yes	Yes
Fund controls $\boldsymbol{x}_{f,t-1}$	Yes	Yes	Yes	Yes	Yes
Fund-issuer FEs	Yes	Yes	Yes	Yes	Yes
Total observations	621,737	585,127	558,633	26,333	26,262
Number of funds	3,880	3,817	3,666	778	778
Within R-squared	0.24	0.28	0.30	0.37	0.37
p-value $\psi + \chi$	-0.686**	0.273	0.268	1.077	1.066
	(0.05)	(0.44)	(0.45)	(0.18)	(0.19)

Note: The table reports results for the regression of Equation (F.1) for samples of fund euro area sovereign debt holdings with different currency denominations at horizon $\ell = 9$. p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). See also the notes to Table 2.

EUR-denominated core (blue triangle lines) and periphery (red diamond line) sovereign debt. The results suggest that for non-EUR-denominated debt a euro disaster risk shock induces the average fund to *increase* its holdings of both core and periphery debt. The effect is quantitatively stronger and more precisely estimated for core debt. Nonetheless, the right-hand side panel in the first row suggests that for non-EUR-denominated debt, the core-periphery differential is mostly not statistically significant. The second row in Figure F.2 presents results for EUR-denominated debt, which are very similar to those from the baseline in Figure 7. This is not surprising, as EUR-denominated debt is the lion's share of total euro area sovereign debt.

The left-hand side panels in the third and fourth row in Figure F.2 show the same impulse responses as in the first two rows, but organize them differently. In particular, the left-hand side panel in the third (fourth) row shows the effects on fund holdings of EUR and non-EUR-denominated periphery (core) debt. Rearranging the impulse responses allows us to present the estimates of different differentials in the right-hand side panels. For example, in the third (fourth) row we show the EUR-non-EUR differential for fund holdings of periphery (core) debt. The results suggest that the EUR-non-EUR differential is fairly similar for fund holdings of periphery and core debt. Notice though that in case of periphery debt the differential arises both because of a flight-from-EUR and a flight-to-non-EUR, while in case of core debt the differential arises only because of a flight-to-EUR.

Figure F.2: Dynamic effects of fund holdings of euro area sovereign debt to euro disaster risk shock across core and periphery issuers as well as EUR and non-EUR denomination



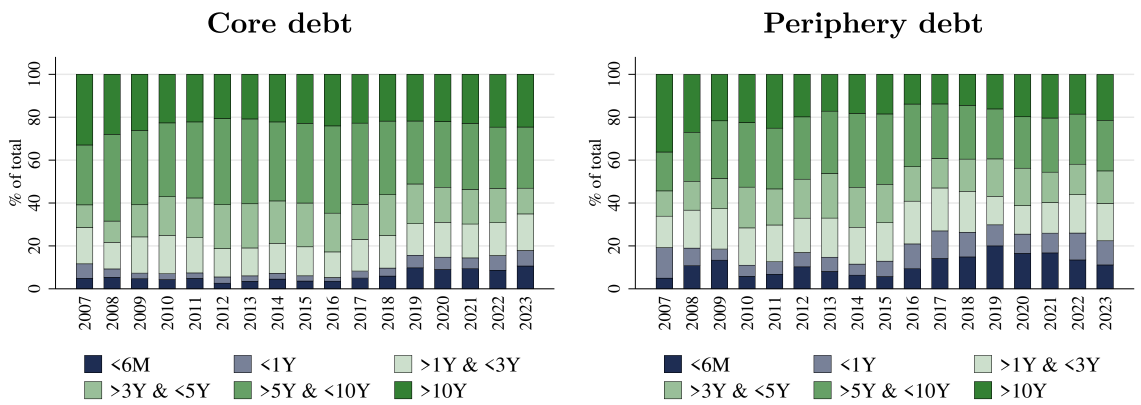
Note: The left-hand side panels show the dynamic response of a fund's holdings of euro area core (blue lines) and periphery sovereign debt (red lines) for either EUR or non-EUR denominated debt to a euro disaster risk shock. The right-hand side panels show the estimated difference between the response of a fund's holdings of core and periphery debt (first two rows) and of EUR and non-EUR denominated debt (last two rows) to a euro disaster risk shock. The black solid squared line depicts the estimates without fund-time FEs, and the grey solid crossed line the estimates without fund-time FEs. Dashed lines indicate 90% confidence bands. Periods refer to months.

G The role of residual maturity

In this appendix, we explore whether bonds' residual maturity plays a role in fund responses to euro disaster risk shocks. We find that funds shed in particular periphery sovereign debt with a rather long residual maturity.

Figure G.1 shows the residual maturity of fund holdings of euro area core and periphery sovereign debt for different maturity buckets over time. As no source provides comprehensive information, we combine information from Refinitiv Lipper and CSDB to obtain the residual maturity.[30] The following observations stand out. First, most debt holdings have a residual maturity of more than one year. Second, typically, more than 75% (65%) of core (periphery) debt holdings have a maturity of more than five years. Third, the share of funds' debt holdings with a residual maturity of less than one year is higher for periphery than for core issuers. Fourth, the residual maturity of the euro area sovereign debt held by investment funds has become shorter after 2015.

Figure G.1: Residual maturity composition of fund holdings of euro area sovereign debt



Note: The figure shows the evolution of the residual-maturity composition of fund holdings of euro area sovereign debt.

Indexing short, medium or long-term residual maturity by $m \in \{st, mt, lt\}$, we estimate regressions at the fund-issuer-maturity level

$$h_{fim,t+\ell} - h_{fim,t-1} = \gamma_{fi}^{(\ell)} + \varrho^{(\ell)} h_{fim,t-1} + \boldsymbol{\beta}^{(\ell)} \boldsymbol{x}_{ft} + \boldsymbol{\delta}^{(\ell)} \boldsymbol{w}_{it} + \boldsymbol{\kappa}^{(\ell)} \boldsymbol{\eta}_t + \boldsymbol{\mu}^{(\ell)} \boldsymbol{d}_t + \left[\psi^{(\ell)} + \chi^{(\ell)} \mathbb{1}(i \in core)\right] \Delta(cds_t^p - cds_t^c) + u_{fimt}^{(\ell)}. \tag{G.1}$$

[30] We first extract the information on the residual maturity from the fund's holding description in RL. If this information is missing or is ambiguous—e.g. because we do not know whether, say, XX in XX/YY/ZZ refers to the day or the month—we use the information on residual maturity in CSDB. If this is also missing, we use the residual maturity provided explicitly from RL.

Table G.1: Effects of euro disaster risk shocks on fund holdings of euro area sovereign debt at fund-issuer-residual-maturity level at horizon $\ell = 9$

	(1) Baseline	(2) Known m	(3) $m < 1Y$	(4) $1Y < m < 5Y$	(5) $m > 5Y$
$\Delta(cds_t^p - cds_t^c)$	-1.578***	-1.566***	0.405	-0.704	-2.708***
	(0.00)	(0.00)	(0.48)	(0.13)	(0.00)
$\Delta(cds_t^p - cds_t^c) \times \mathbb{1}(i \in core)$	1.383***	1.383***	-1.296*	0.877	2.593***
	(0.00)	(0.00)	(0.07)	(0.10)	(0.00)
Lagged holdings	Yes	Yes	Yes	Yes	Yes
Proxy controls $\boldsymbol{d}_{t-1}$	Yes	Yes	Yes	Yes	Yes
Common controls	Yes	Yes	Yes	Yes	Yes
Issuer controls	Yes	Yes	Yes	Yes	Yes
Fund controls	Yes	Yes	Yes	Yes	Yes
Fund-issuer FEs	Yes	Yes	Yes	Yes	Yes
Total observations	1,204,426	1,203,685	100,571	451,807	649,131
Number of funds	3,932	3,932	2,484	3,138	3,098
Within R-squared	0.16	0.16	0.28	0.25	0.23
p-value $\psi + \chi$	−0.194	−0.183	−0.891*	0.172	−0.115
	(0.47)	(0.50)	(0.10)	(0.63)	(0.77)

Note: The table reports results for the regression of Equation (G.1) for samples of fund euro area sovereign debt holdings with different maturity at horizon $\ell = 9$. p-values are provided in parentheses below the point estimates. Asterisks indicate significance at 10%(*), 5%(**), and 1%(***). See also the notes to Table 2.

Table G.1 reports results for regressions of Equation (G.1), estimated separately for different residual maturity sets at horizon $\ell = 9$. Column (1) reports results for regressions using holdings regardless of their residual maturity. In Column (2) we only use holdings for which we have information on the residual maturity. In Column (3) we only use holdings with a residual maturity of less than one year, in Column (4) with residual maturity between one and five years, and in Column (5) with residual maturity longer than five years.[31]

The findings in Columns (3) to (5) suggest that a euro disaster risk shock induces a fund to shed only periphery debt with a rather long residual maturity. The negative effect of a euro disaster risk shock on periphery holdings is estimated to be almost twice as large for debt with long residual maturity in Column (5) compared to the average effect across all residual maturities in the baseline in Columns (1) and (2).

Next we estimate local projections

$$\begin{aligned}\Delta h_{fim,t+h} - h_{fim,t-1} = \gamma_{fi}^{(\ell)} &+ \varrho^{(\ell)} h_{fim,t-1} + \boldsymbol{\beta}^{(\ell)} \boldsymbol{x}_{ft} + \boldsymbol{\delta}^{(\ell)} \boldsymbol{w}_{it} + \boldsymbol{\kappa}^{(\ell)} \boldsymbol{\eta}_t + \boldsymbol{\mu}^{(\ell)} \boldsymbol{d}_t \\ &+ \chi_1^{(\ell)} \phi_t + \chi_2^{(\ell)} [\phi_t \times \mathbb{1}(m < 5Y)] + \chi_3^{(\ell)} \left[\phi_t^{(\ell)} \times \mathbb{1}(i \in core)\right] \\ &+ \chi_4^{(\ell)} \cdot \left[\phi_t^{(\ell)} \times \mathbb{1}(i \in core) \times \mathbb{1}(m > 5Y)\right] + u_{fimt}^{(\ell)}, \qquad \text{(G.2)}\end{aligned}$$

for $h = 0, 1, \ldots, 12$ to explore the dynamic effects of euro disaster risk shocks on fund holdings

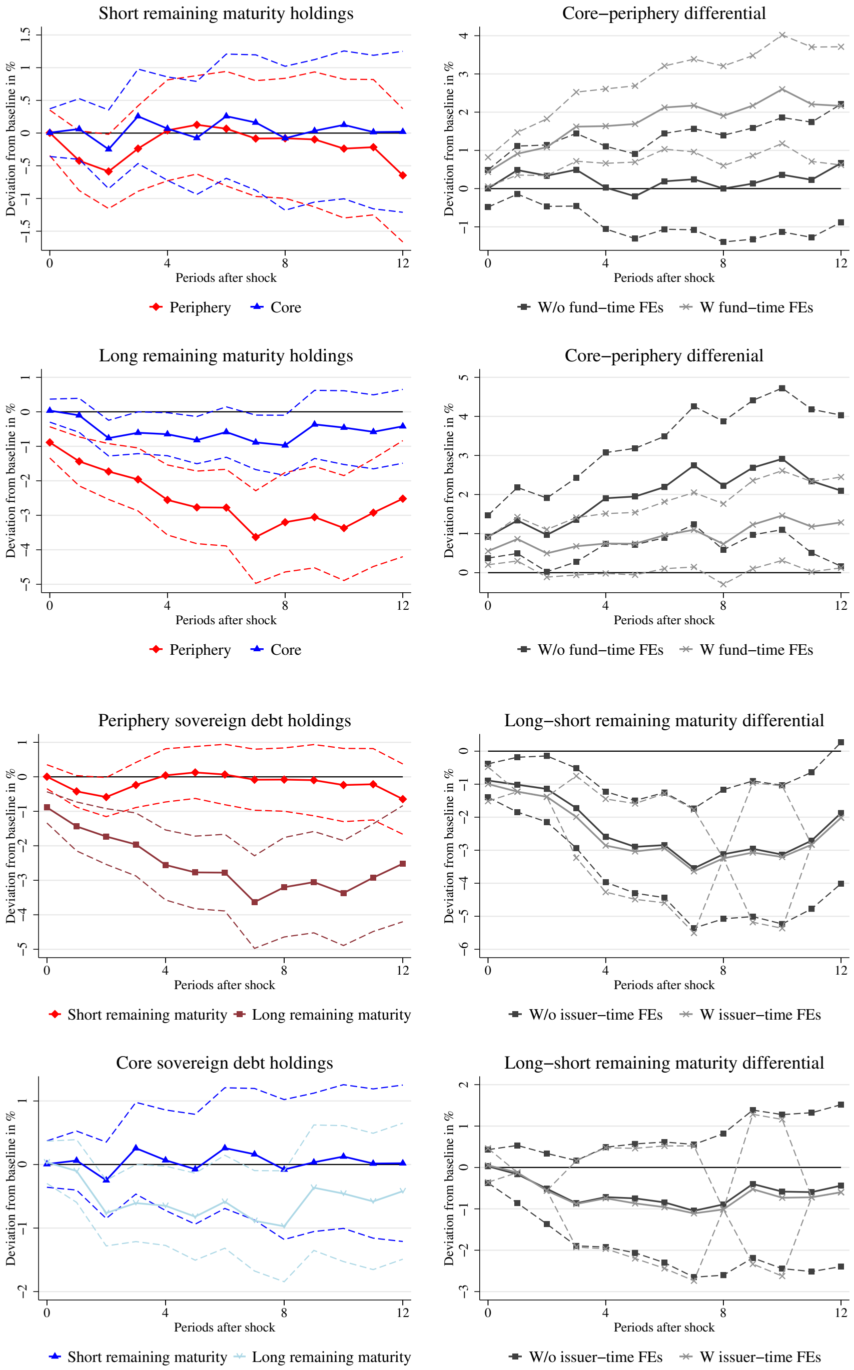
[31] Results for finer residual maturity buckets as in Figure G.1 yield consistent results, which are available on request.

for different combinations of core/periphery and short/long-residual-maturity debt holdings. We combine all maturities longer than five years to limit the number of impulse responses. The left-hand side panels in Figure G.2 depict the dynamic effects on holdings and the right-hand side panels for the corresponding differentials. For example, the left-hand side panel in the first row presents the dynamic effects on fund holdings of short residual-maturity core (blue triangle lines) and periphery (red diamond line) sovereign debt.

The results presented in the second and third rows in Figure G.2 confirm those in Table G.1: In response to a euro disaster risk shock, the average fund sheds periphery sovereign debt with a relatively long residual maturity. The results in Figure G.2 additionally show that this difference is estimated to be statistically significantly different from zero. The effect on holdings with short residual maturities is estimated to be not statistically different from zero.

Our findings for the role of residual maturity could indicate that investors consider euro disaster shocks to have rather persistent effects, which warrant a strategic rebalancing away from periphery debt. The results could also be imply that such shocks make funds less willing to accept higher return volatility due to market and duration risks.

Figure G.2: Dynamic effects of fund holdings of euro area sovereign debt to euro disaster risk shock across core and periphery issuers as well as short and long residual maturity



Note: The left-hand side panels show the dynamic response of a fund's holdings of euro area core (blue lines) and periphery sovereign debt (red lines) for either short or long residual maturities to a euro disaster risk shock. The right-hand side panels show the estimated difference between the response of a fund's holdings of core and periphery debt (first two rows) and between short and long residual maturity (last two rows) to a euro disaster risk shock. The black solid squared line depicts the estimates without fund-time FEs, and the grey solid crossed line the estimates without fund-time FEs. Dashed lines indicate 90% confidence bands. Periods refer to months.

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