# An Anatomy of the 2022 Gilt Market Crisis

Gábor Pintér (BoE)

Bank of England

May 2023

The views expressed are those of the author and not necessarily those of the Bank of England or its committees.

# Introduction

*'It was not quite a Lehman moment. But it got close.'*
*(Sep 2022, Senior London-based banker)*

# Contribution and Data

- Contribution:
  - Detailed account of a liquidity crisis through the joint analysis government bond, repo and swap markets
  - Identify individual clients sharpens the analysis (compared to Falato, Goldstein, and Hortacsu (2021); O'Hara and Zhou (2021); Kargar, Lester, Lindsay, Liu,Weill, and Zuniga (2021); Haddad, Moreira, and Muir (2021); Ma, Xiao, and Zeng (2022) among others)

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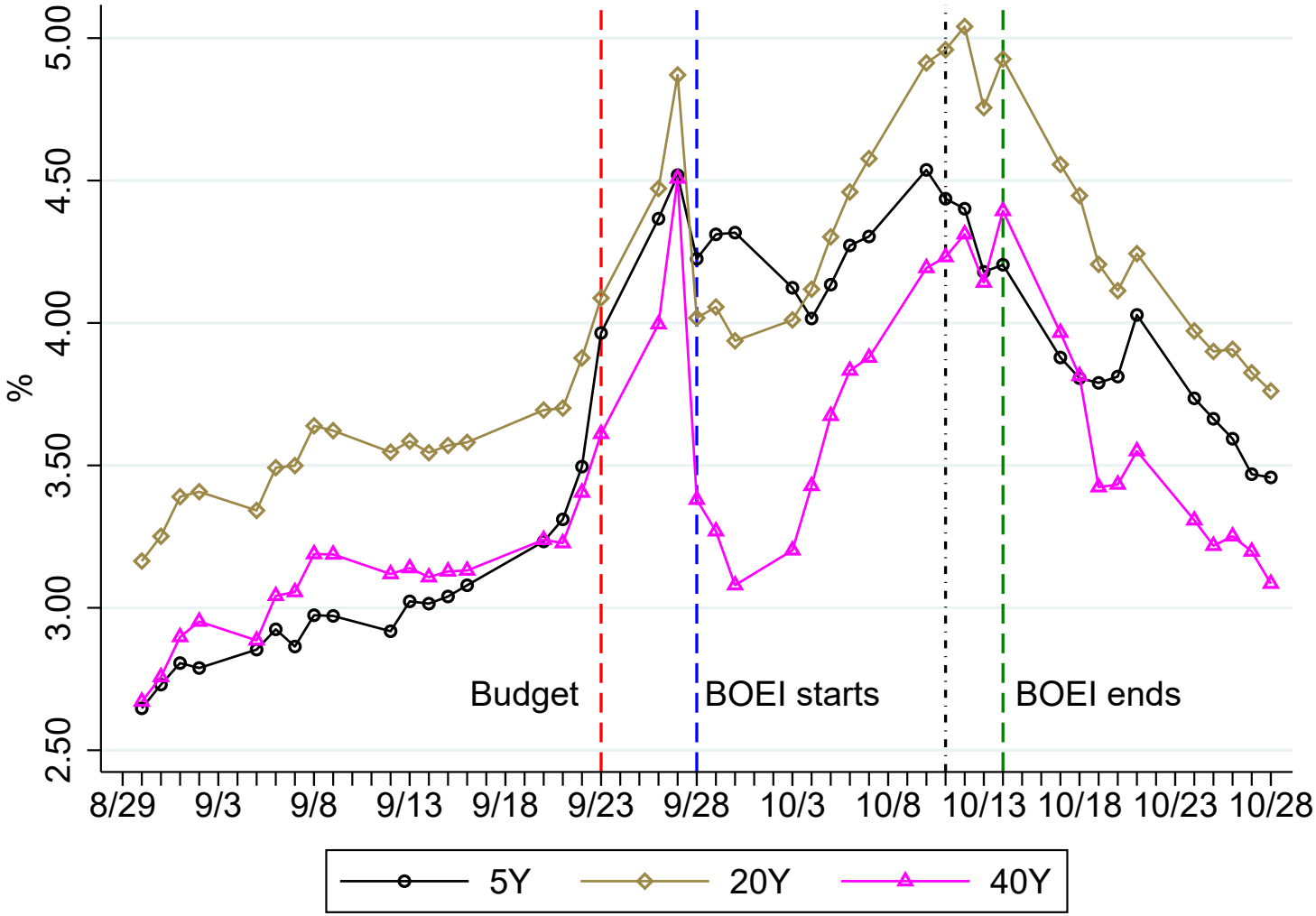
- Datasets:
  - Government Bond Market: all secondary market trades from the MIFID II dataset
  - Repo Market: Sterling Money Market Data (SMMD), a proprietary dataset of the Bank of England
  - Swaps: EMIR TR data
    - Legal Entity Identifiers (LEIs) allows a consistent merge across these markets

# Overview

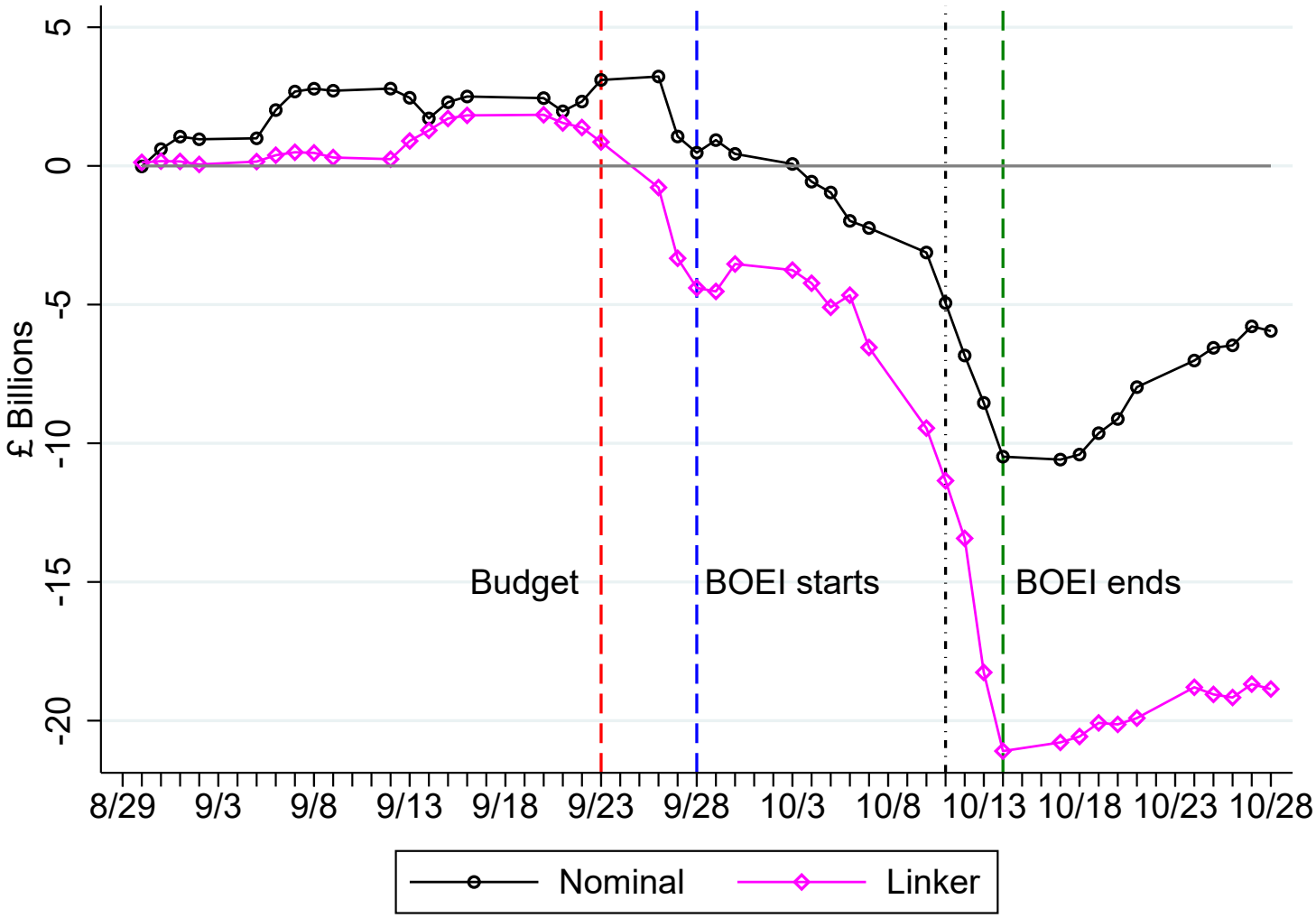
- Extreme stress in gilt markets during 23 Sep – 14 Oct 2022
- At its centre: highly leveraged, liability-driven investment (LDI) strategies of certain pension funds and asset managers
- Sudden worsening of repo and swap positions (collateral and margin calls) forced them to quickly liquidate gilts for cash.
- Selling pressures and market illiquidity $\longrightarrow$ yield spikes and extreme orderflows $\longrightarrow$ Bank of England intervention within days to restore market functioning (Breeden, 2022; Hauser, 2022).

# Nominal Yields

## 5Y, 20Y, 40Y Maturities



# Gilt Sales by the LDI Sector



# Liability-Driven Investment

## Liability Hedging

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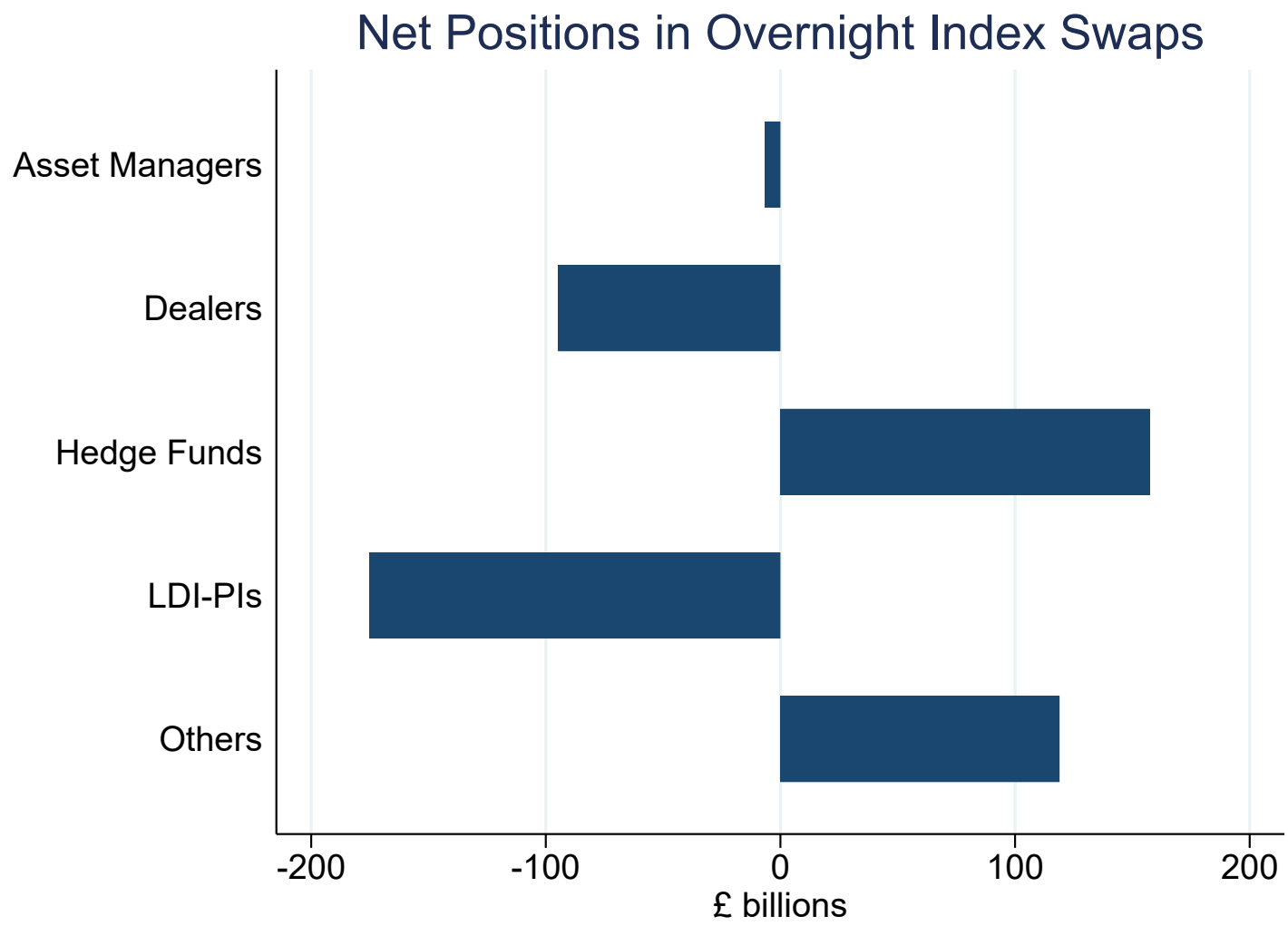
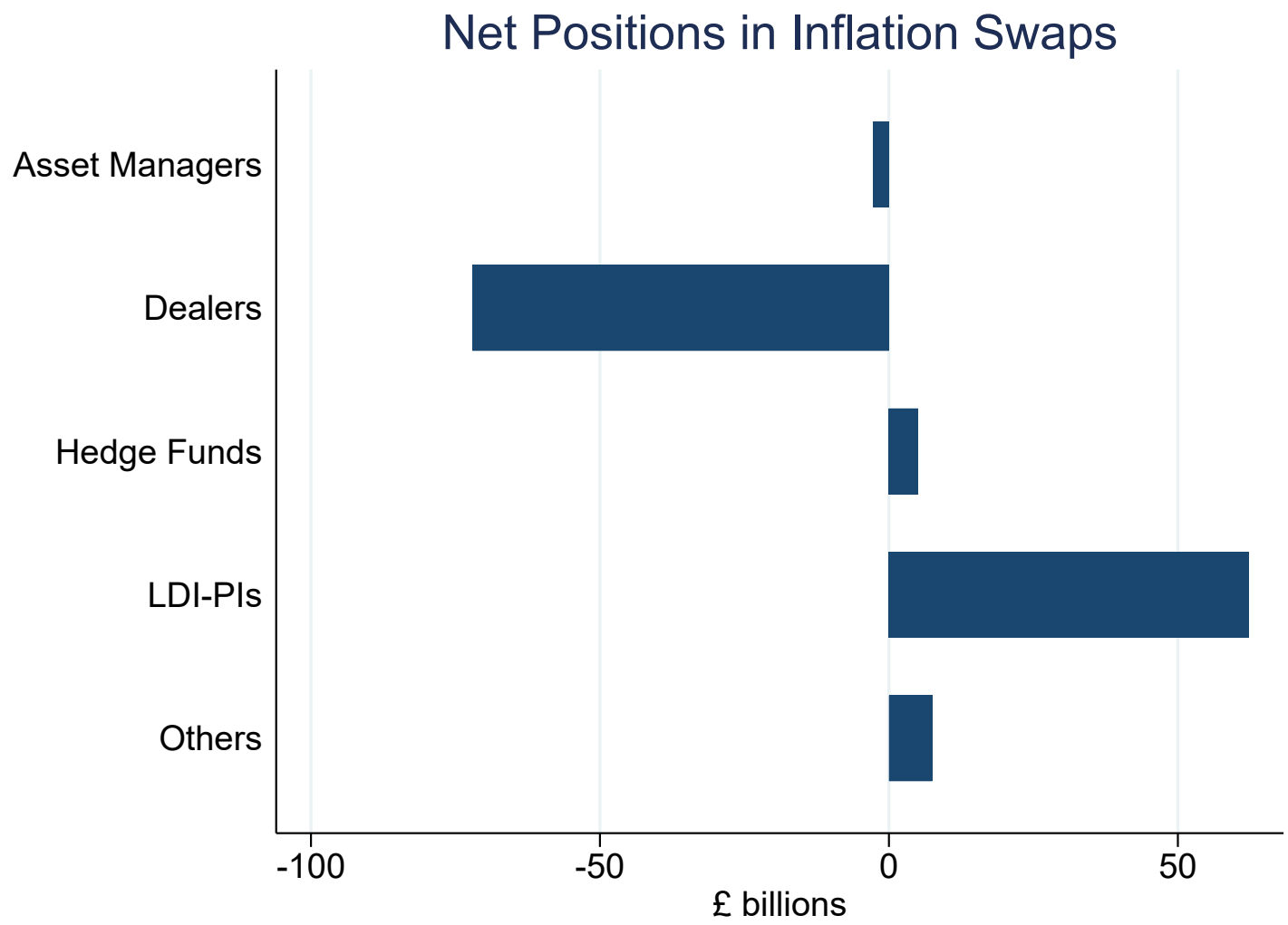
# Net Positions in the OIS Market (22 Sep, 2022)

## LDIs are the largest payer of floaters



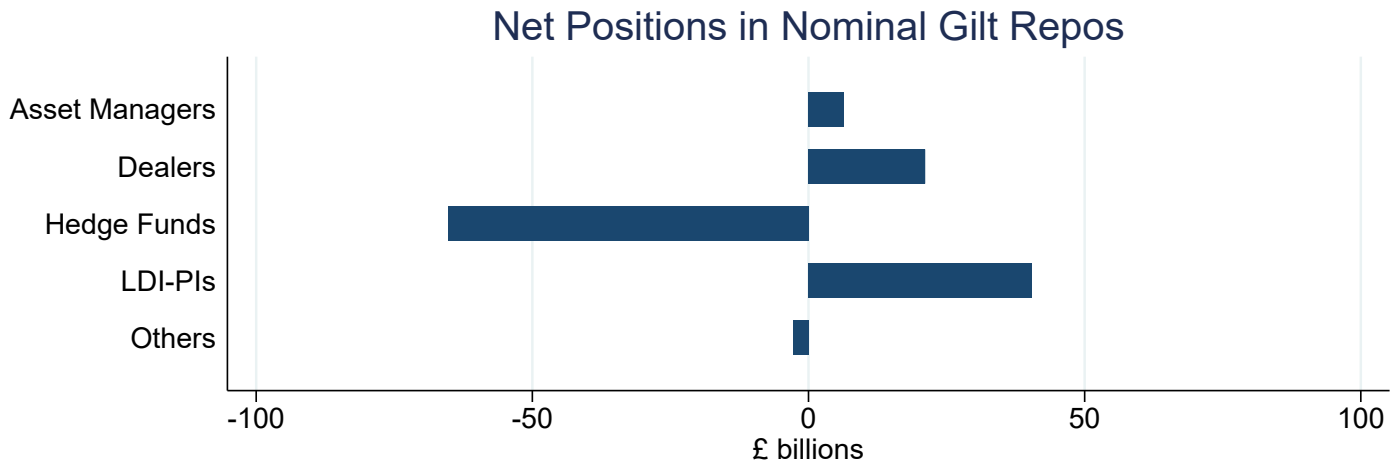
# Net Positions in the Inflation-swap Market (22 Sep, 2022)

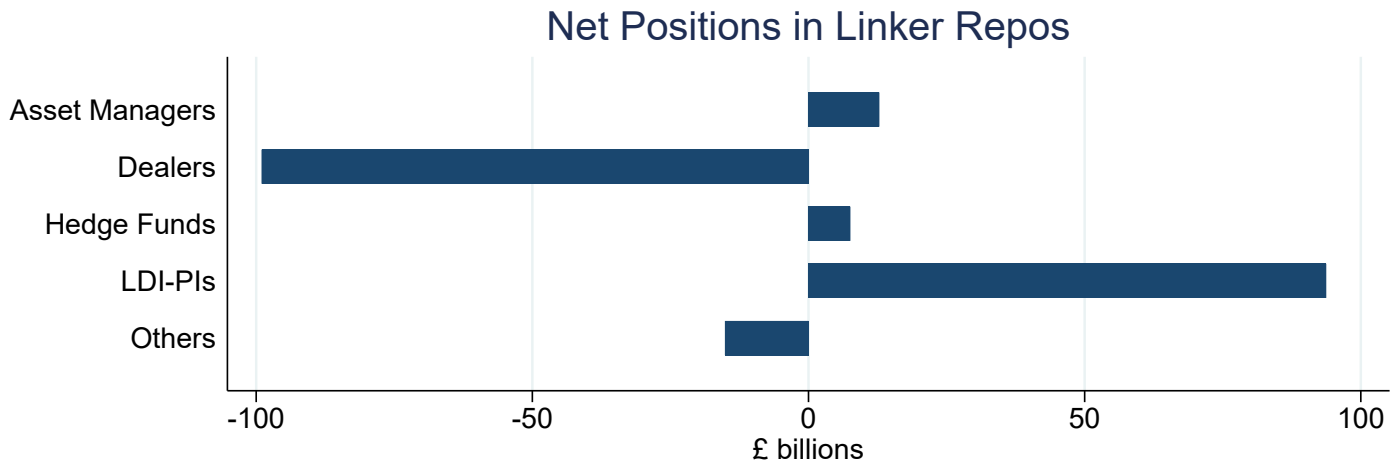
## LDIs are the largest buyer of inflation



# Net Positions in the Repo Market (22 Sep, 2022)

## LDIs are the largest borrowers

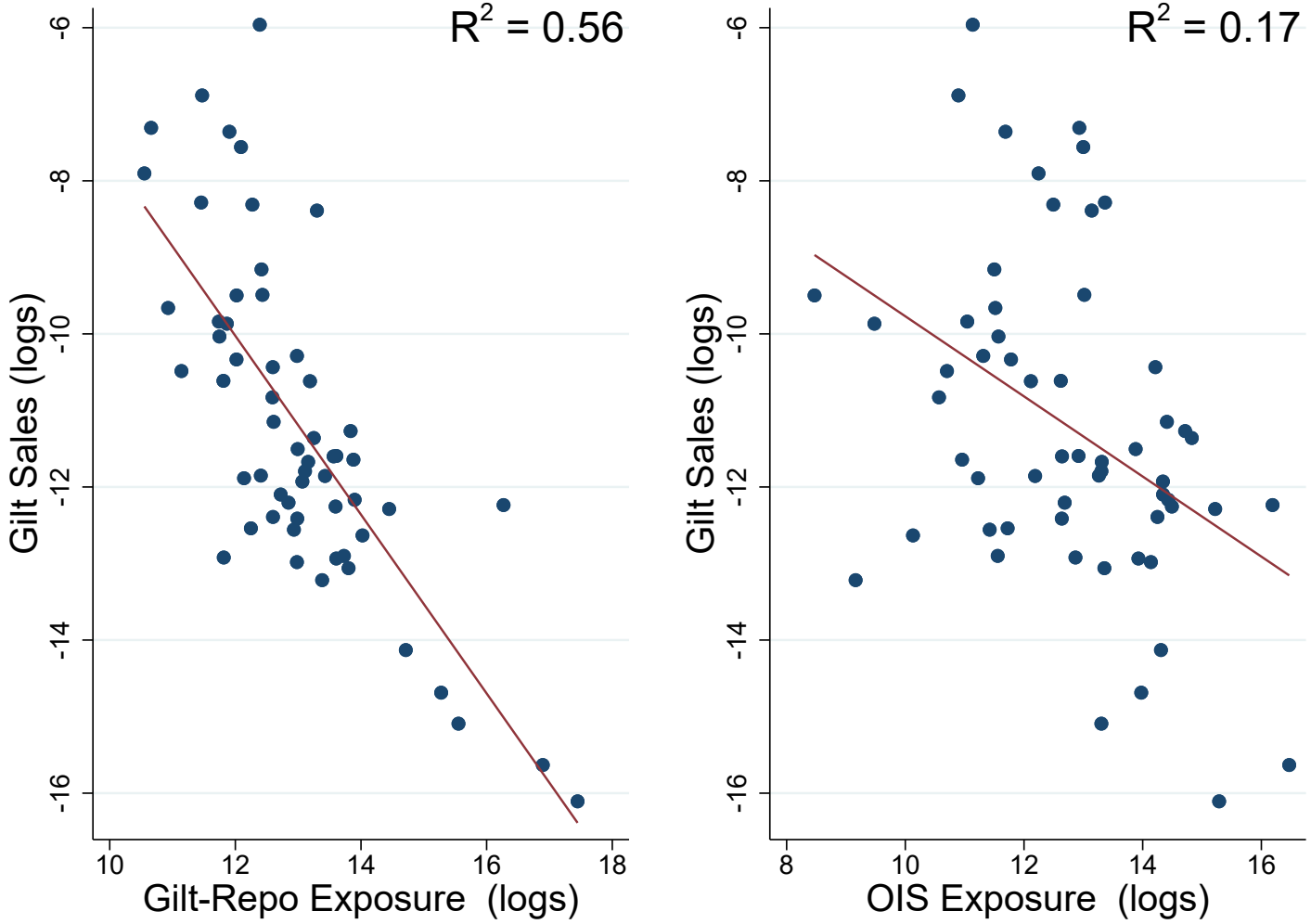


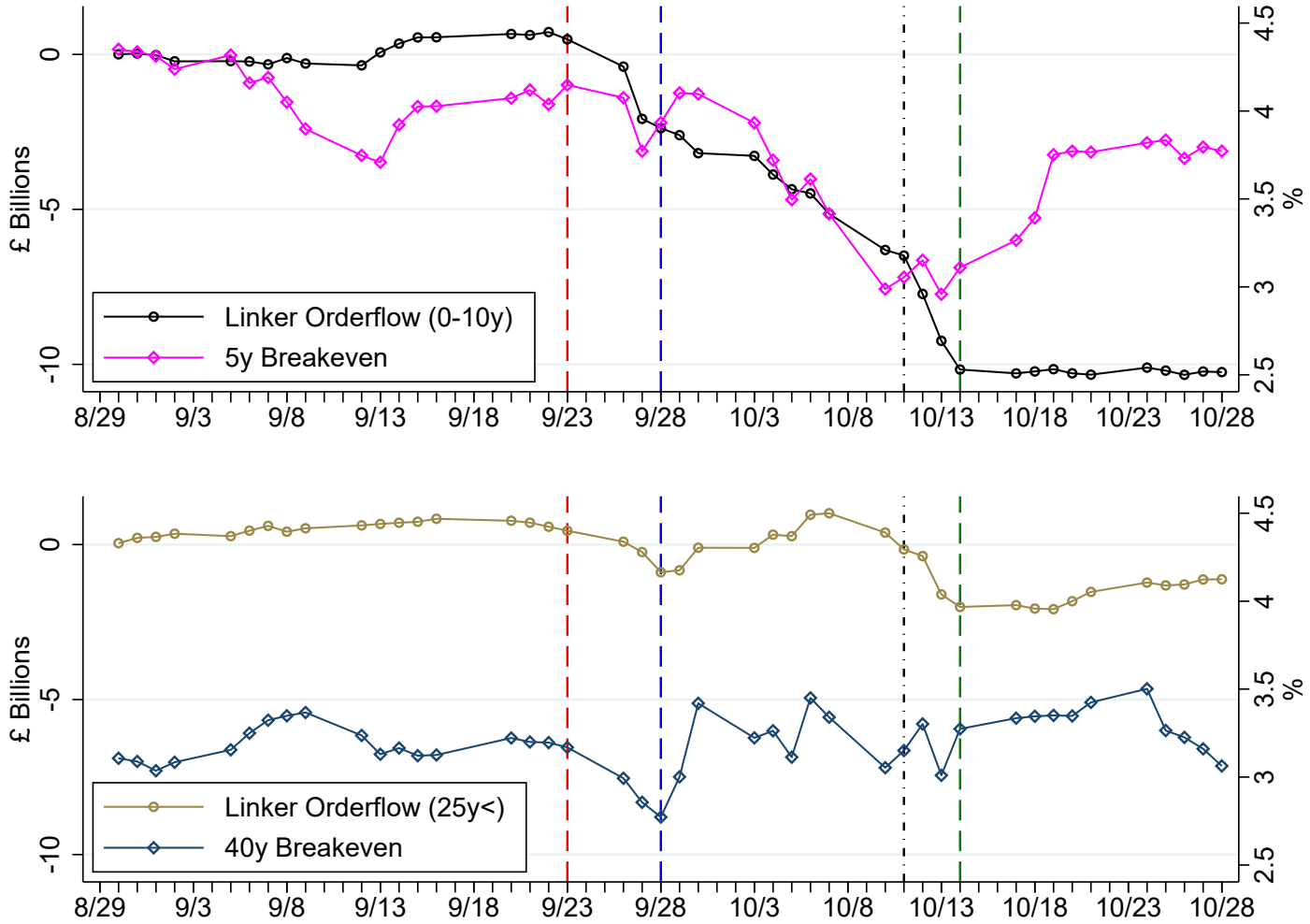
# 6 Main Results

1. Pre-crisis swap and repo positions of LDIs **predictive** of gilts sales
2. Selling pressure started in linkers (across **all** maturities) followed by nominals (**mid** maturities) $\longrightarrow$ consistent **price pressures**
3. **3 firms** generated over 70% of LDI gilt sales to dealers
4. Transaction **costs soared**
   - concentrated in smaller trade sizes, at smaller dealers, at clients other than LDIs ($\rightarrow$ illiquidity **spillovers**)
   - stronger **trading relationships** mitigated these cost hikes
5. Dispersion of transaction prices jumped (large price differentials **across dealers** $\leftrightarrow$ intermediation frictions)
6. Hedge funds **profited** greatly

# Result 1: Role of Pre-crisis Funding Positions



# Result 2: Evidence on Price Pressure



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## Mispricing in UK Inflation Markets (Fleckenstein-Longstaff-Lustig, 2014)

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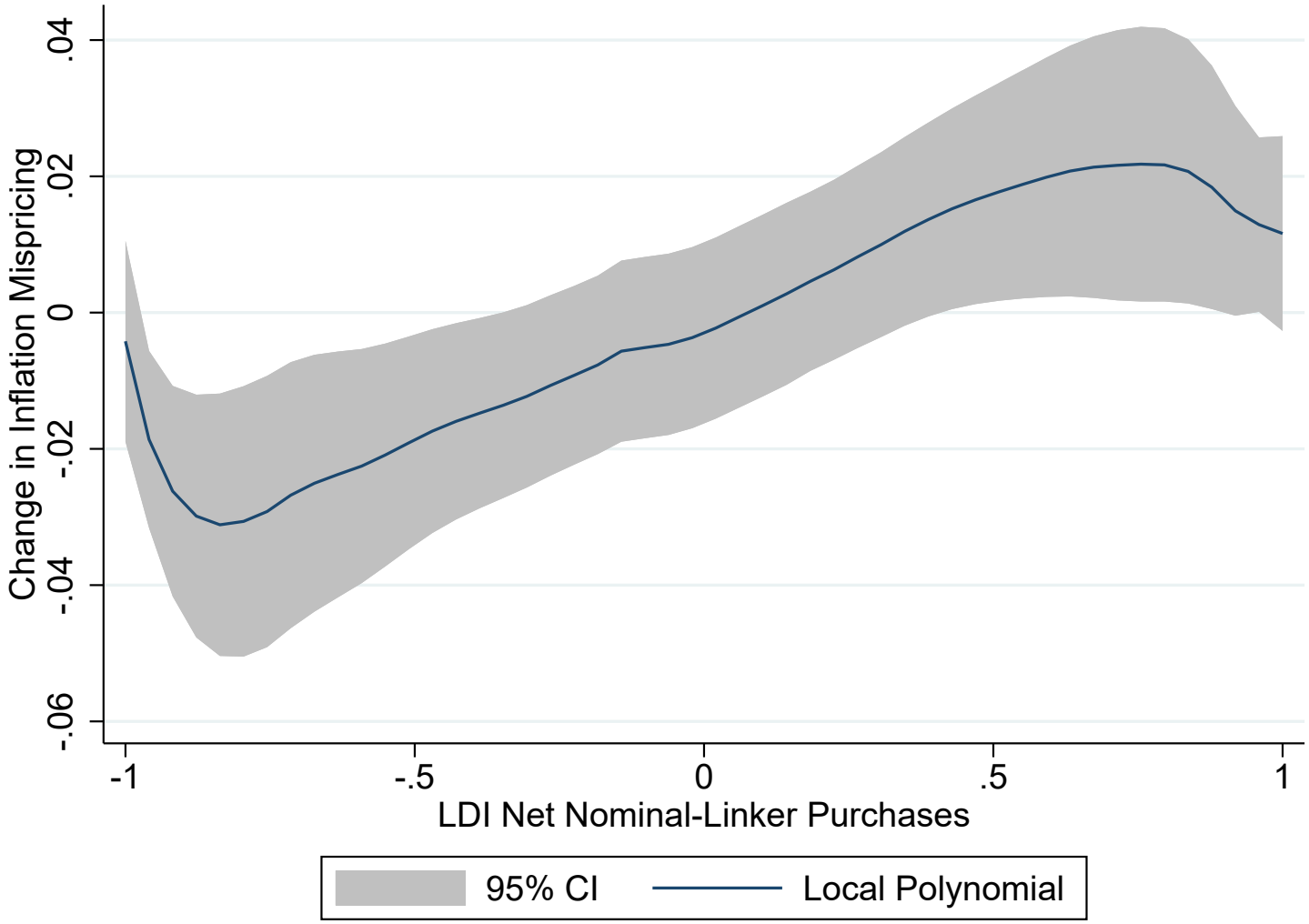
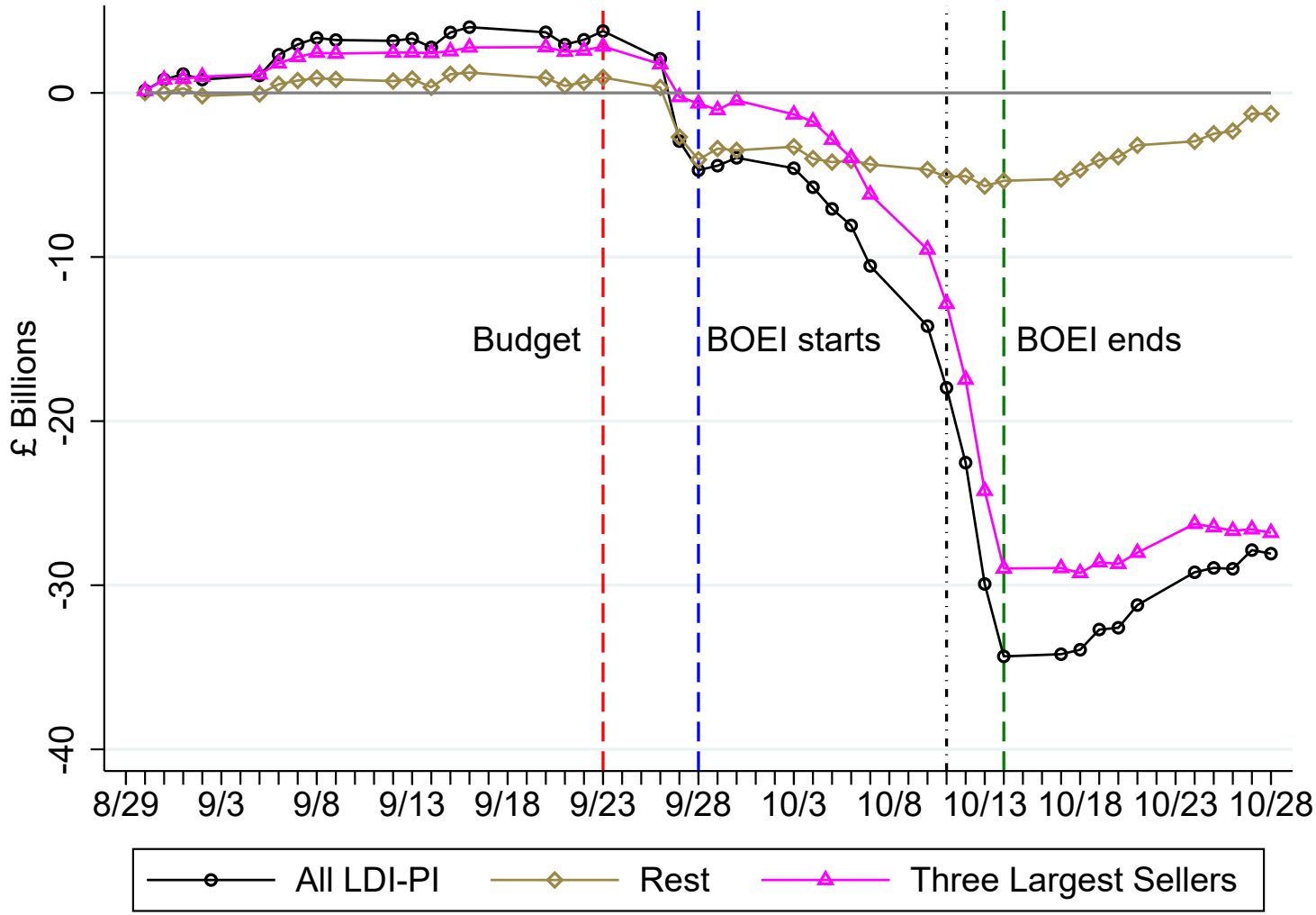
## Mispricing in Inflation Markets (Barria-Pinter, 2023)



# Result 3: A few large sellers



# Result 4: Transaction Cost Heterogeneity

## Measurement

- Measuring transaction costs (O'Hara and Zhou (2021)) for each trade $v$:

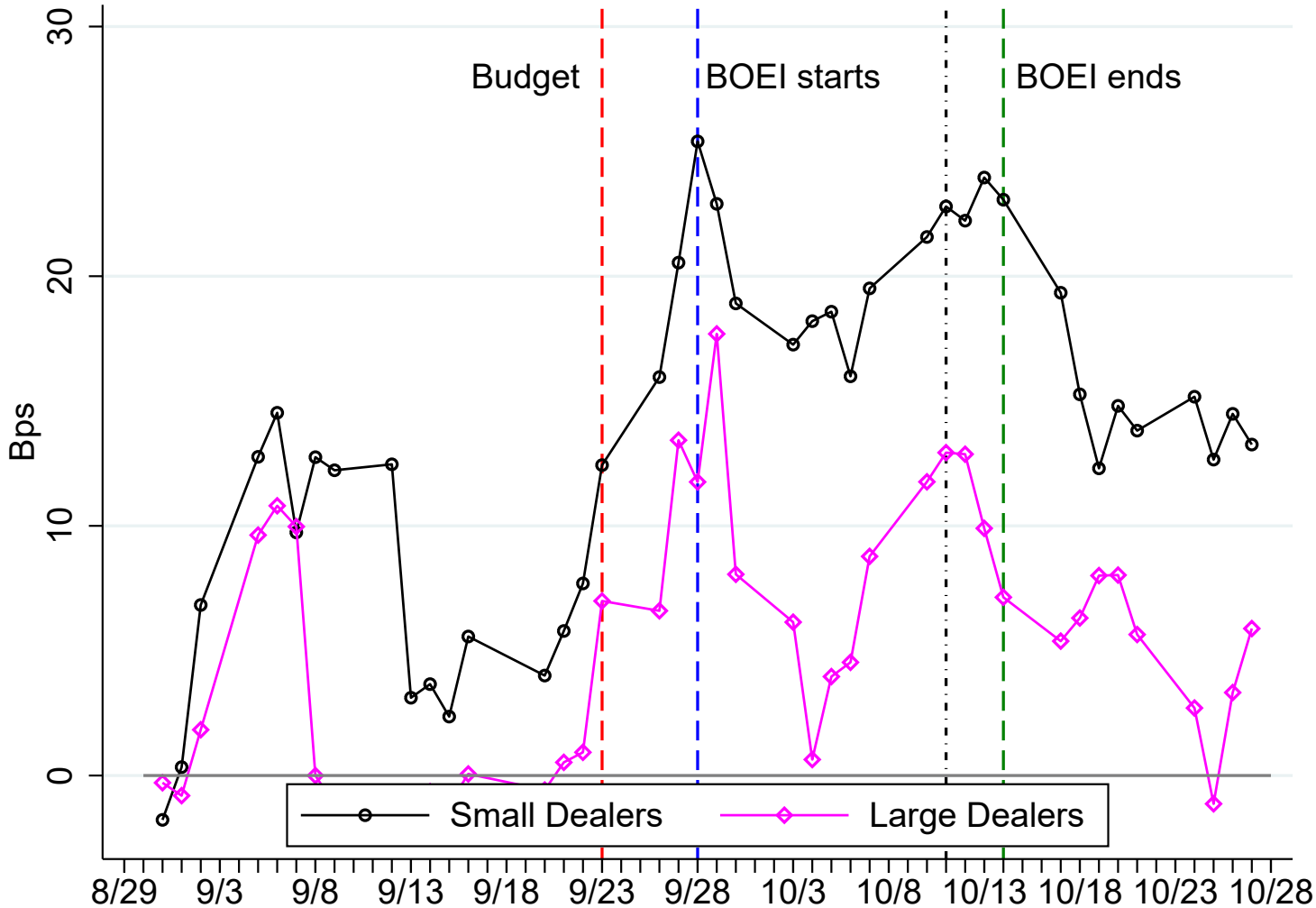
$$Cost_v = \left[\ln\left(P_v^\star\right) - \ln\left(\overline{P}\right)\right] \times \mathbf{1}_{B,S}, \tag{1.1}$$

where:

  - $P_v^\star$ is the transaction price,
  - $\mathbf{1}_{B,S}$ buy-sell indicator
  - $\overline{P}$ is a benchmark price (hourly quoted price from Datastream)

# Result 4: Transaction Cost Heterogeneity

## Small vs Large Dealers



# Result 5: Dispersion of Transaction Prices

- Measuring total dispersion (Jankowitsch, Nashikkar, and Subrahmanyam (2011)) :

$$D_T = \sqrt{\frac{1}{N}\sum_{v}^{N}\left(\ln\left(P_v^{\star}\right) - \ln\left(\overline{P}\right)\right)^2}, \tag{1.2}$$

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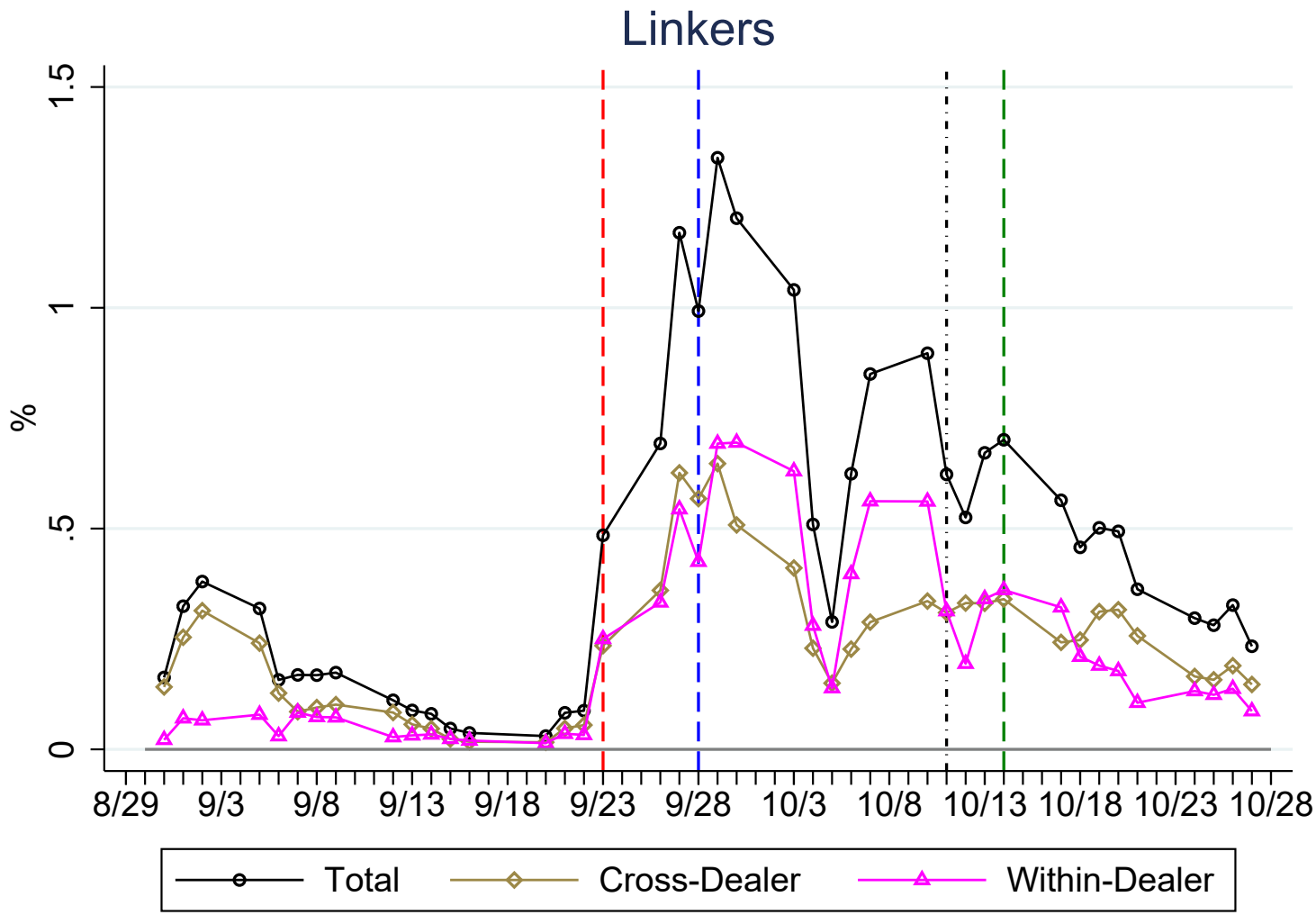
- The decomposition of total dispersion 1.2 is then written as:

$$D_T^2 = \underbrace{\frac{1}{N}\sum_{v}^{N}\left(\ln\left(P_v^{\star}\right) - \ln\left(\ddot{P}\right)\right)^2}_{within-dealer} + \underbrace{\frac{1}{N}\sum_{v}^{N}\left(\ln\left(\ddot{P}\right) - \ln\left(\overline{P}\right)\right)^2}_{cross-dealer}, \tag{1.3}$$

where $\ddot{P}$ is the average hourly transaction price at the dealer where trade $v$ is executed.

# Result 5: Heightened Dispersion of Transaction Prices



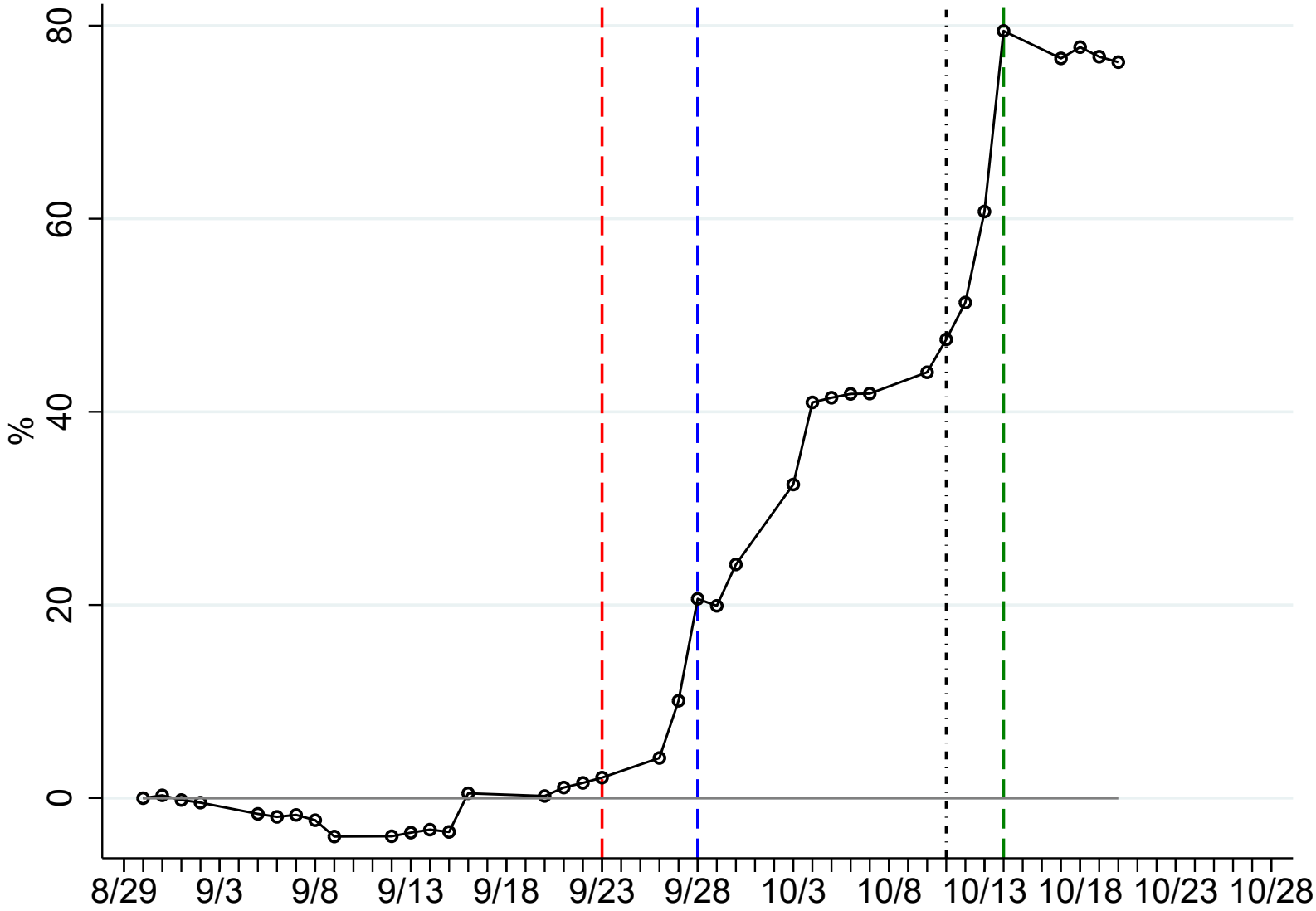
# Result 6: Hedge Fund Returns - Measurement

- $T$-day-horizon return on each hedge fund trade on day $t$ (Di Maggio, Franzoni, Kermani, and Sommavilla (2019)) for each trade $j$:

$$Performance_j^T = \left[\ln\left(P^T\right) - \ln\left(P_j^\star\right)\right] \times \mathbf{1}_{B,S}, \tag{1.4}$$

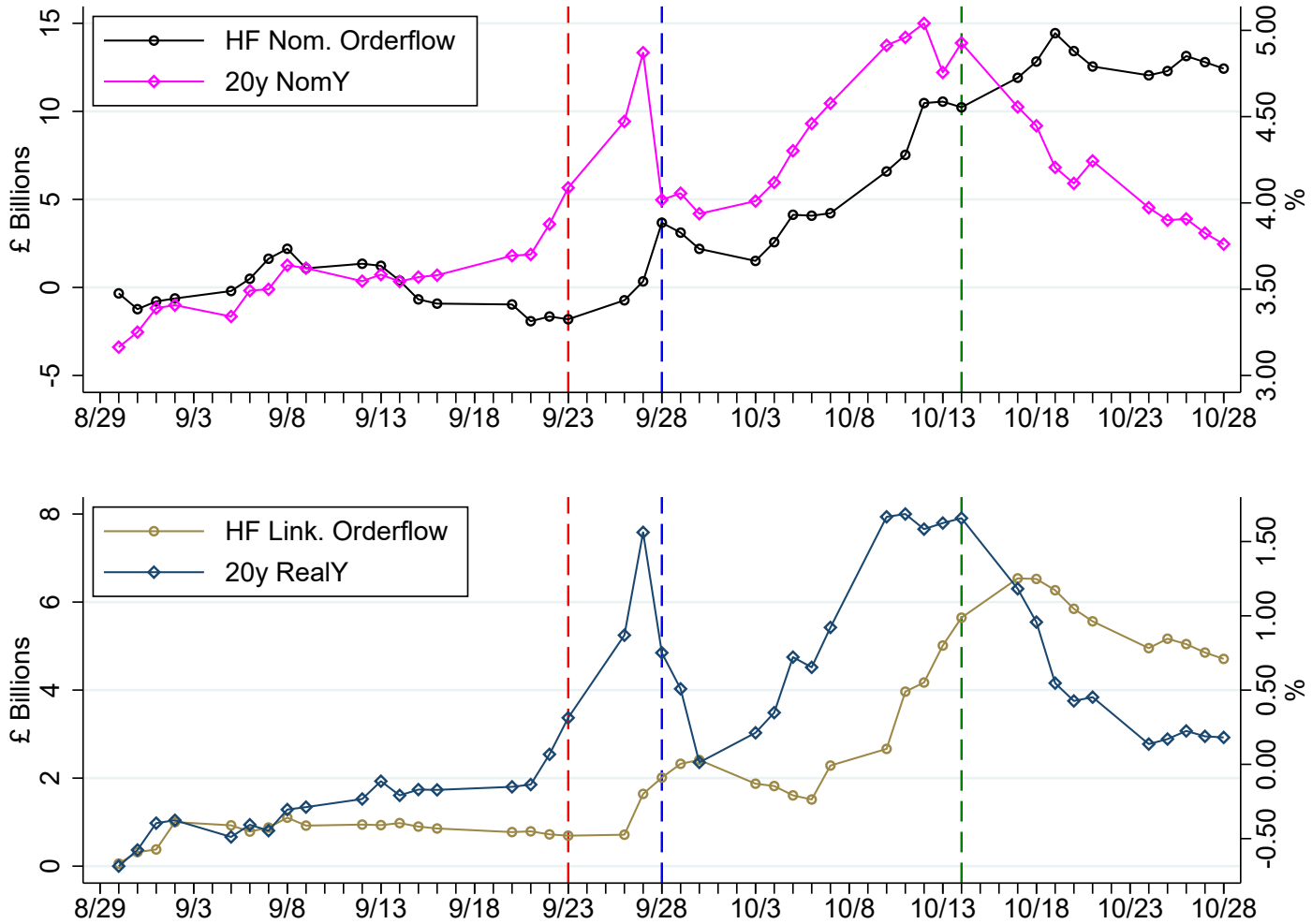
- we then aggregate at the hedge fund sector - day level (using unweighted or size weighted) averages
- we experiment with horizon $T = 1, 3, 6$ days

# Result 6: Cumulative Hedge Fund Returns



# Result 6: Hedge Funds' Timing of Liquidity Provision

## Hedge Fund Orderflow and Yield Dynamics



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5. Will dealers manage to intermediate rapidly increasing government debt ?! (Duffie, 2020)
6. Was the BoE intervention optimal ?
   - beyond reduced-form regressions $\rightarrow$ structural equilibrium model $\rightarrow$ **policy counterfactuals** (Gavazza-Pinter-Uslu (2023))

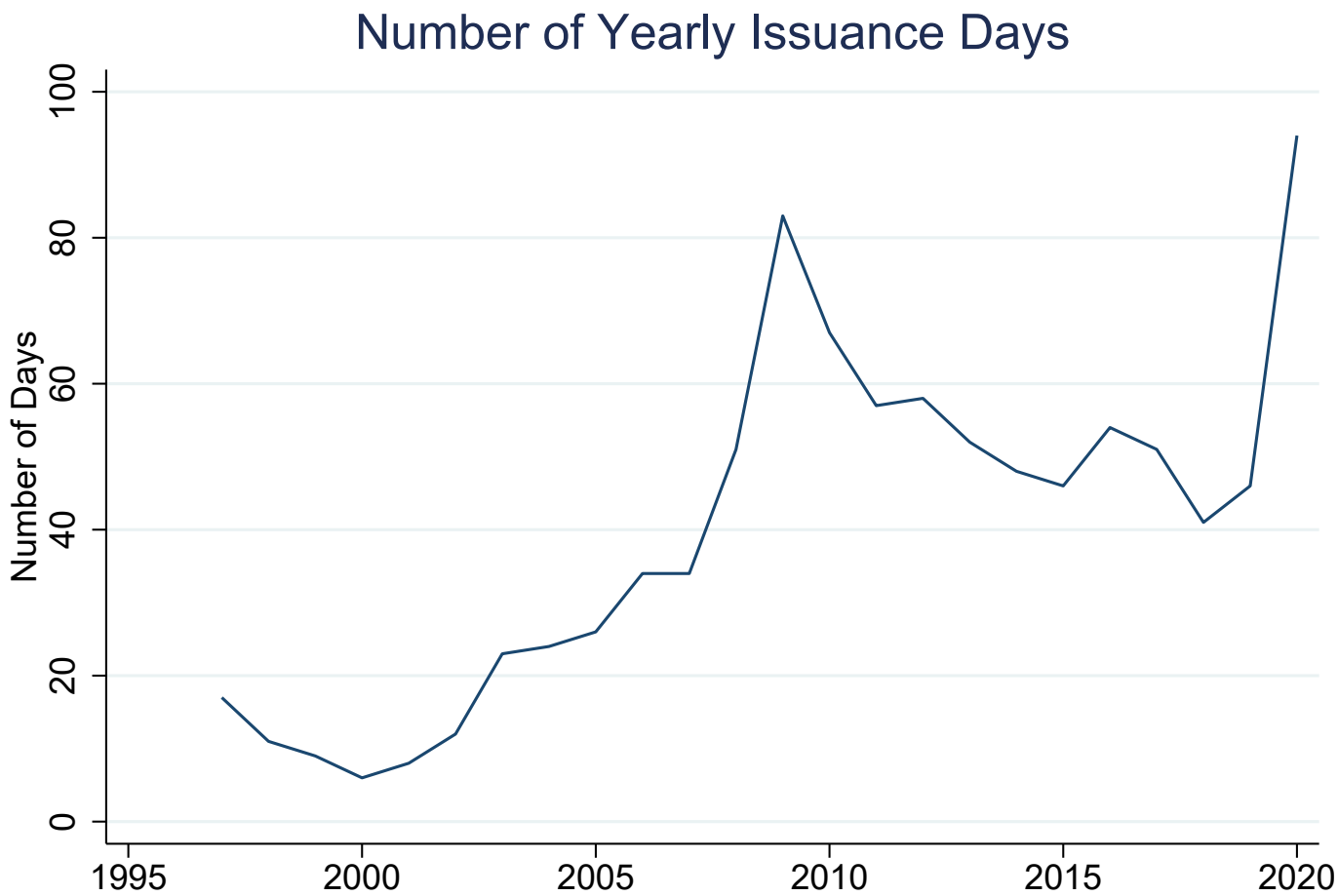
THANK YOU FOR YOUR ATTENTION!

# Sizeable Issuances during the Crisis

| Operation Date | Gilt Name | Nom. Amount | Cash Raised |
|---|---|---|---|
| 27-Sep-2022 | 0 1/8% Index-linked Gilt 2031 | 1,200 | 1,383 |
| 28-Sep-2022 | 1½% Green Gilt 2053 | 4,500 | 2,352 |
| 4-Oct-2022 | 0½% Treasury Gilt 2061 | 2,500 | 948 |
| 5-Oct-2022 | 1% Treasury Gilt 2032 | 3,750 | 2,852 |
| 11-Oct-2022 | 0 1/8% Index-linked Gilt 2051 | 1,106 | 871 |
| 12-Oct-2022 | 4 1/8% Treasury Gilt 2027 | 4,365 | 4,252 |
| | | **17,422** | **12,658** |

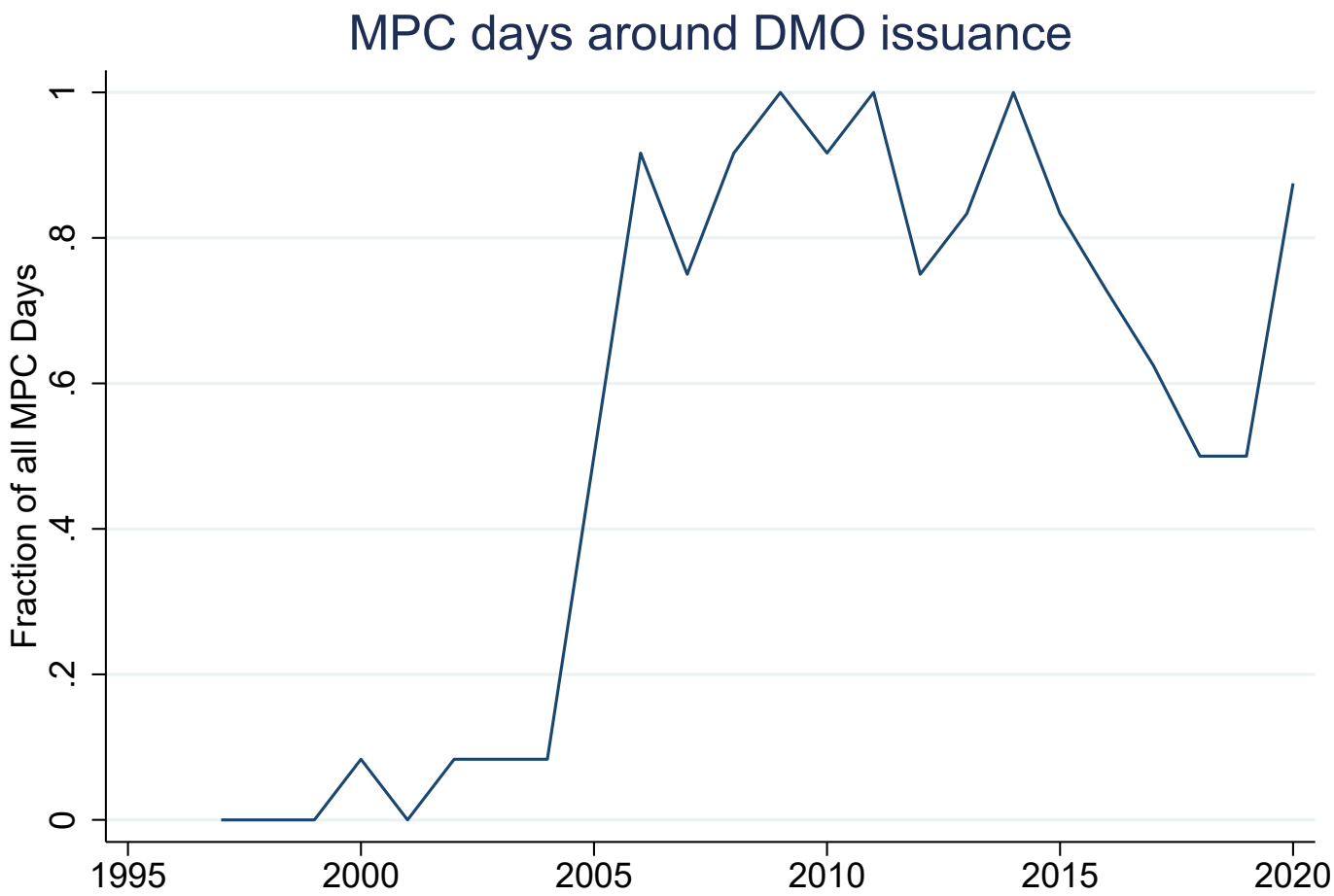
# Increasing Issuance Activity of the Years

Lou-Pinter-Uslu, 2022



# Fiscal-Monetary Interactions?

## Lou-Pinter-Uslu, 2022

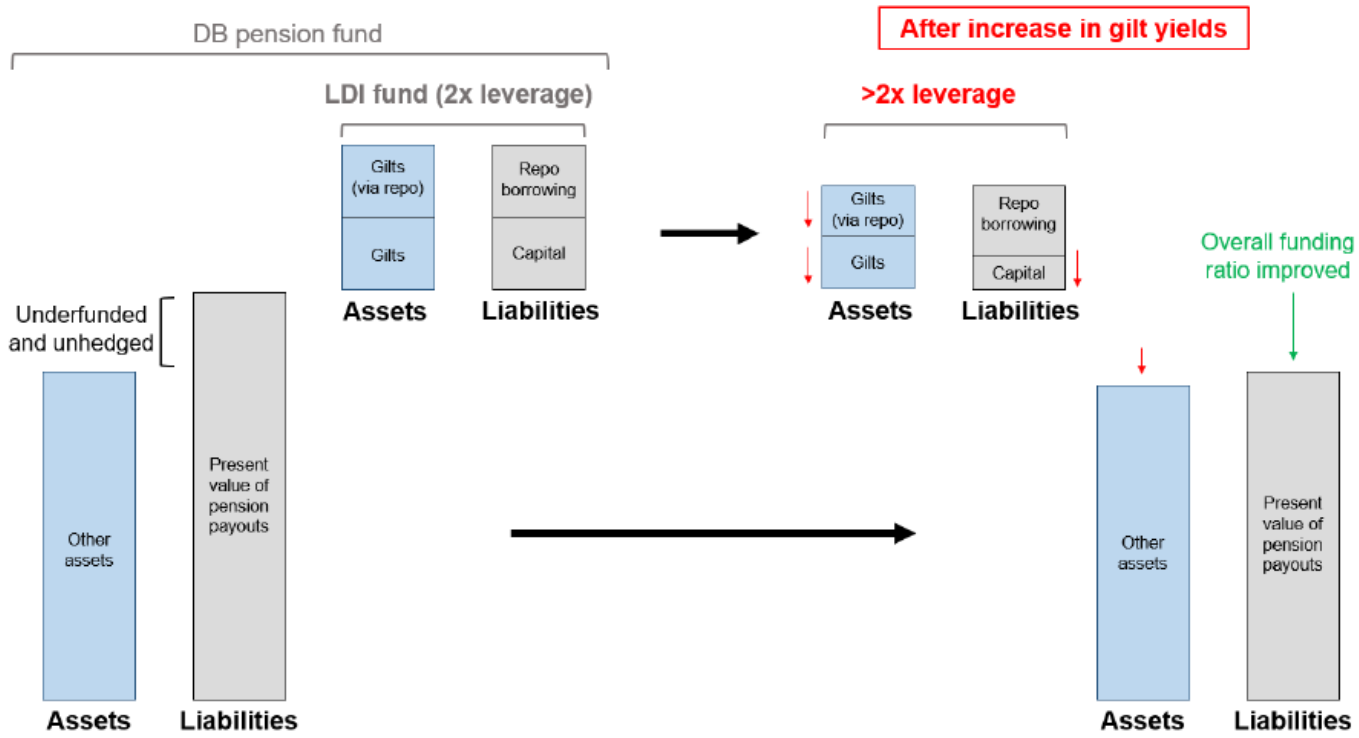



Go Back

# Liability-Driven Investment

## Leverage (Cunliffe, 2022)

**Diagram 1**: Illustrative change in assets and liabilities for a DB pension fund using LDI to hedge its liabilities, with impact of an increase in long-term gilt yields

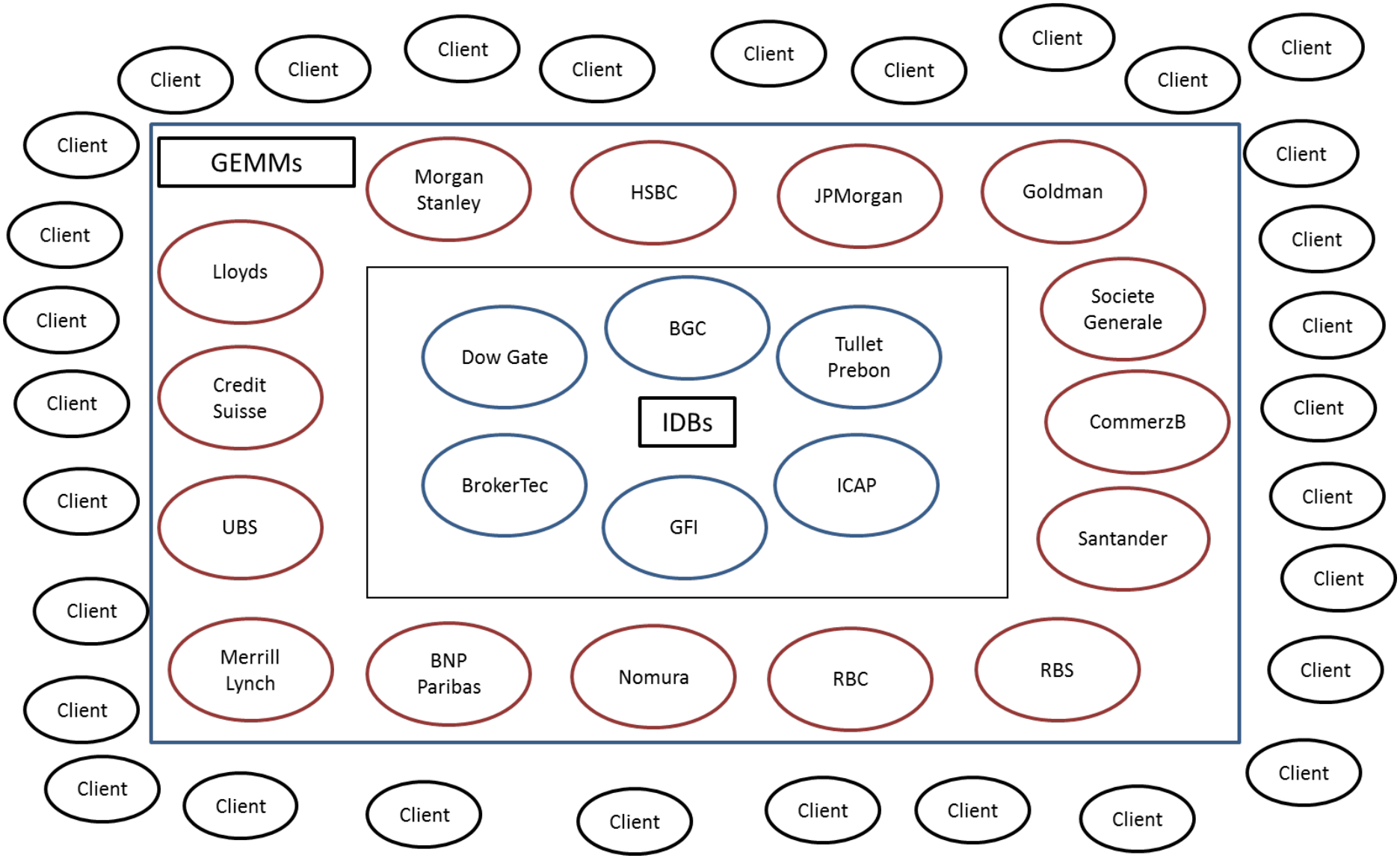



Source: Bank of England

# Outline

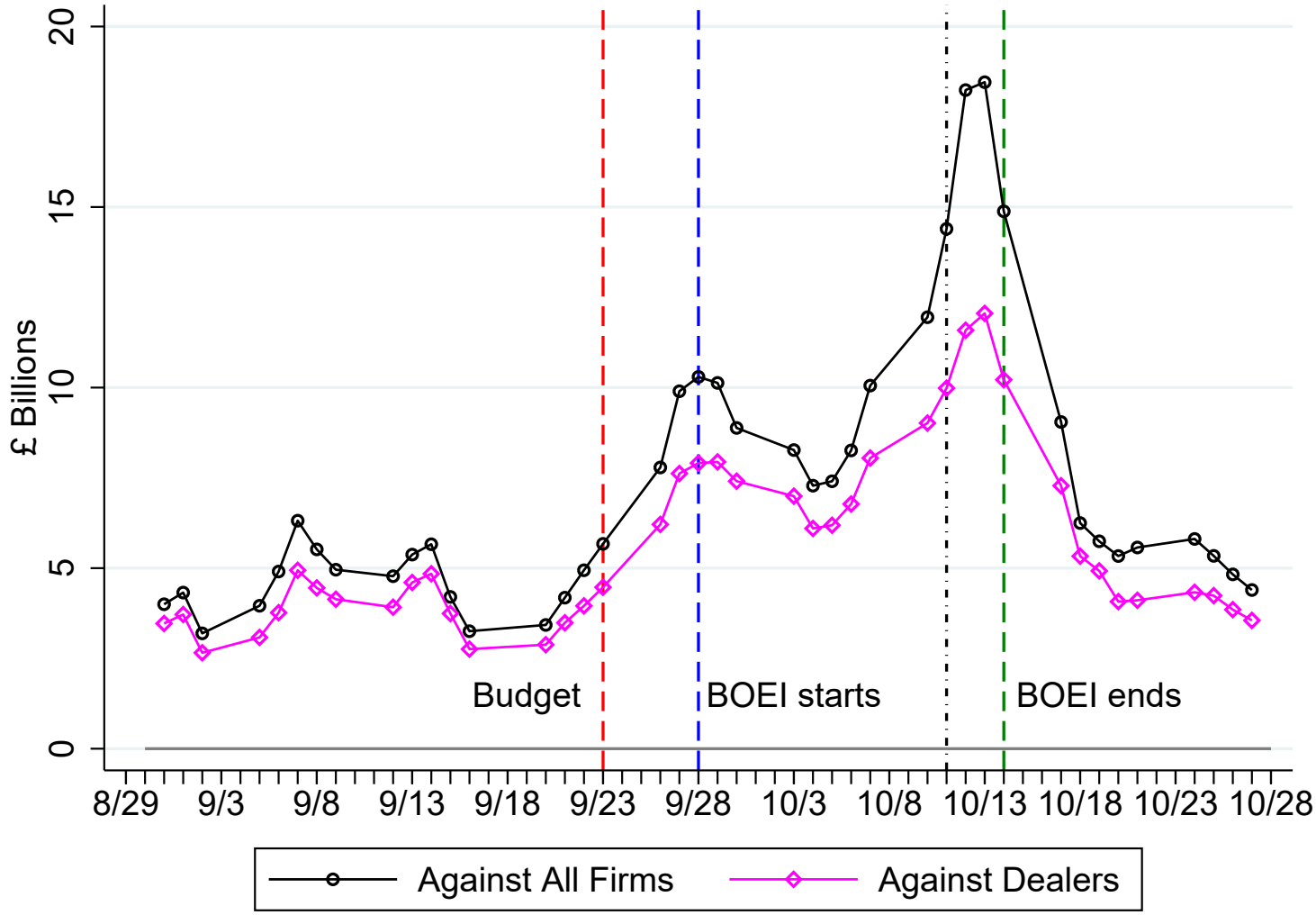
1. Stylised Facts from UK Bond Markets
2. Stylised Facts from UK Swap and Repo Markets
3. Trading Costs around the Crisis
4. Trading Relationships and Trade Networks
5. Aggregate Price Dispersion
6. Hedge Fund Trading
7. Comparisons with COVID-19

# Market Structure of UK Gilt Market



# Elevated LDI Trading Activity

## Turnover of LDI Sector



# Elevated LDI Activity in Linkers and Nominals

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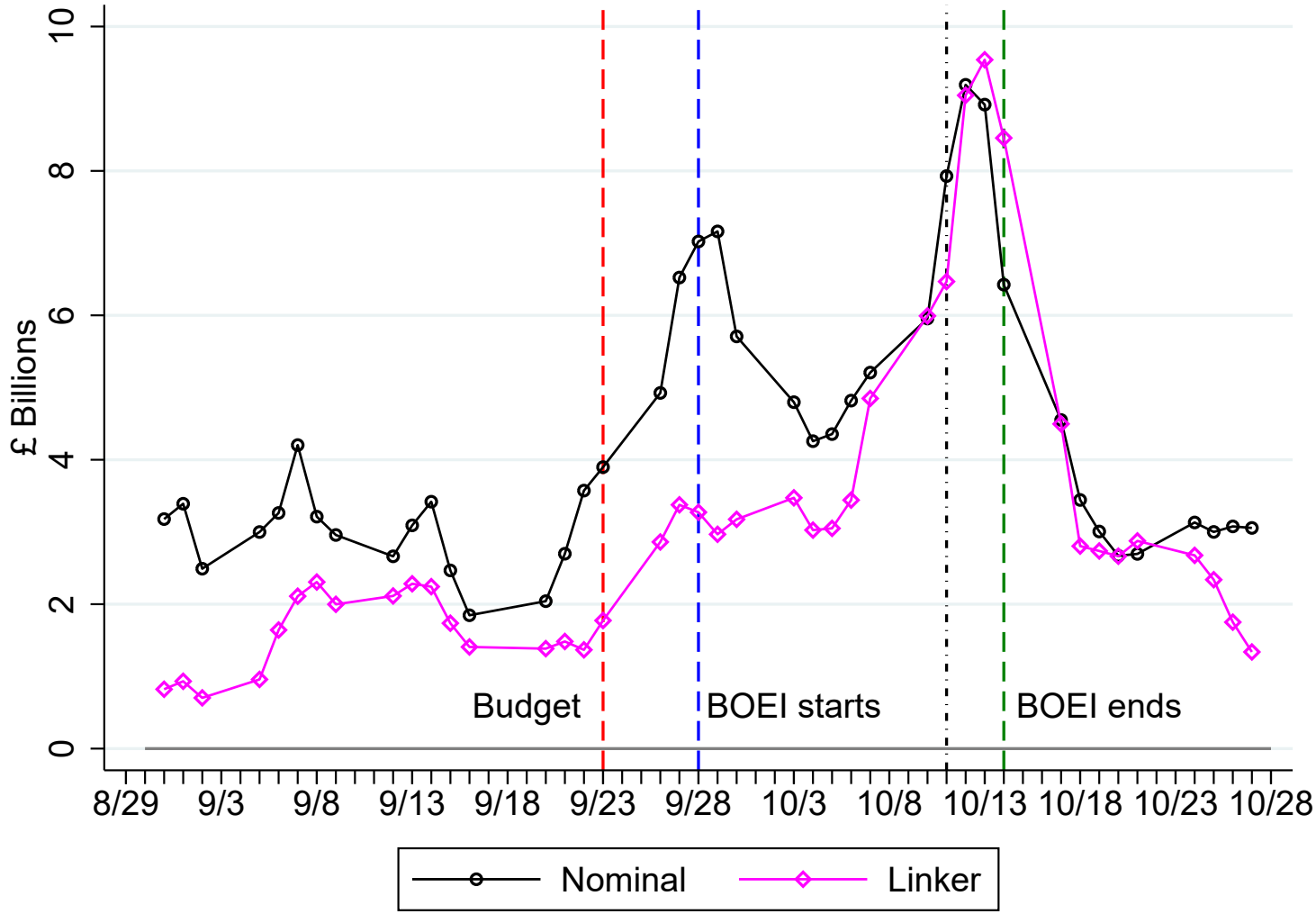
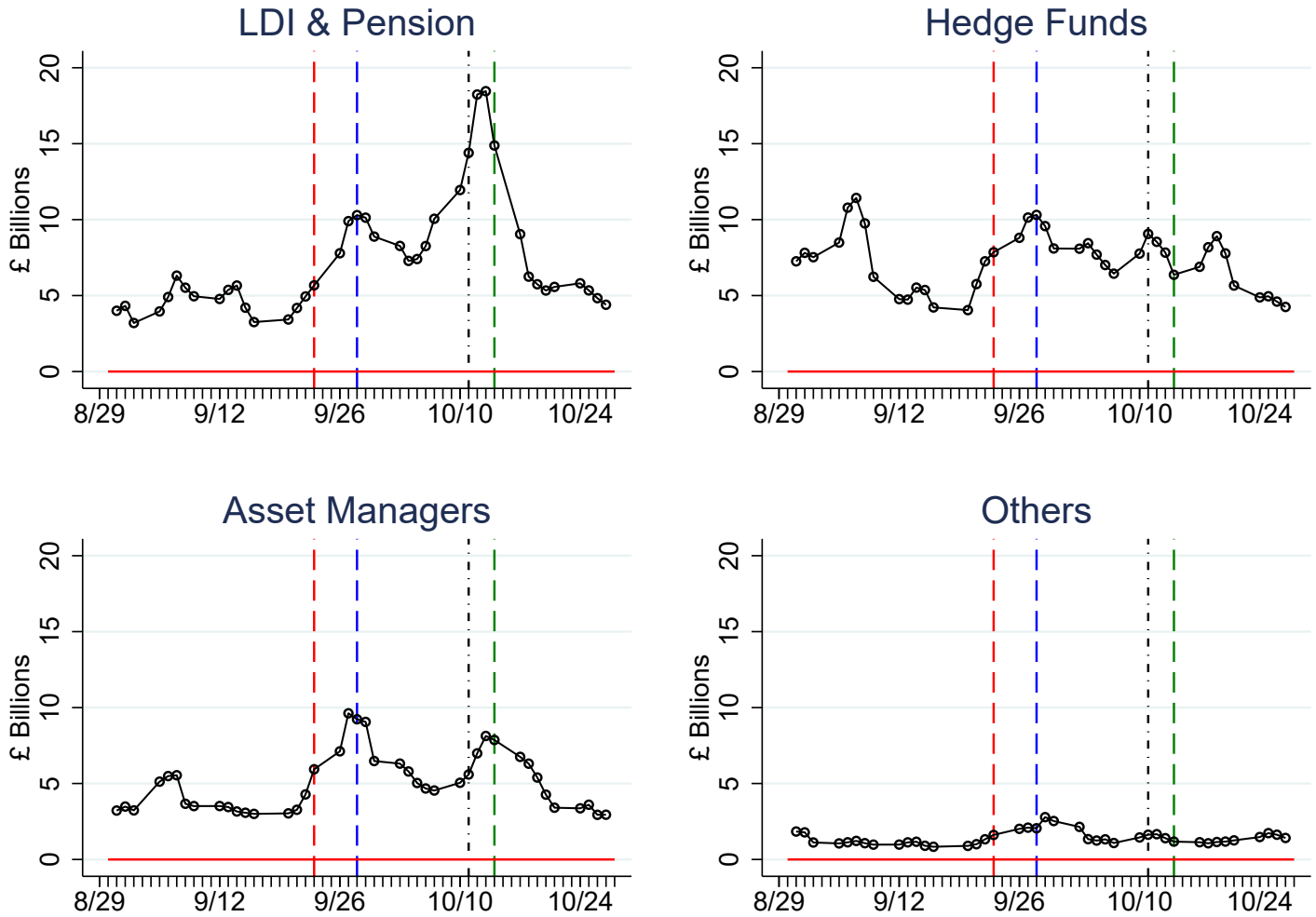


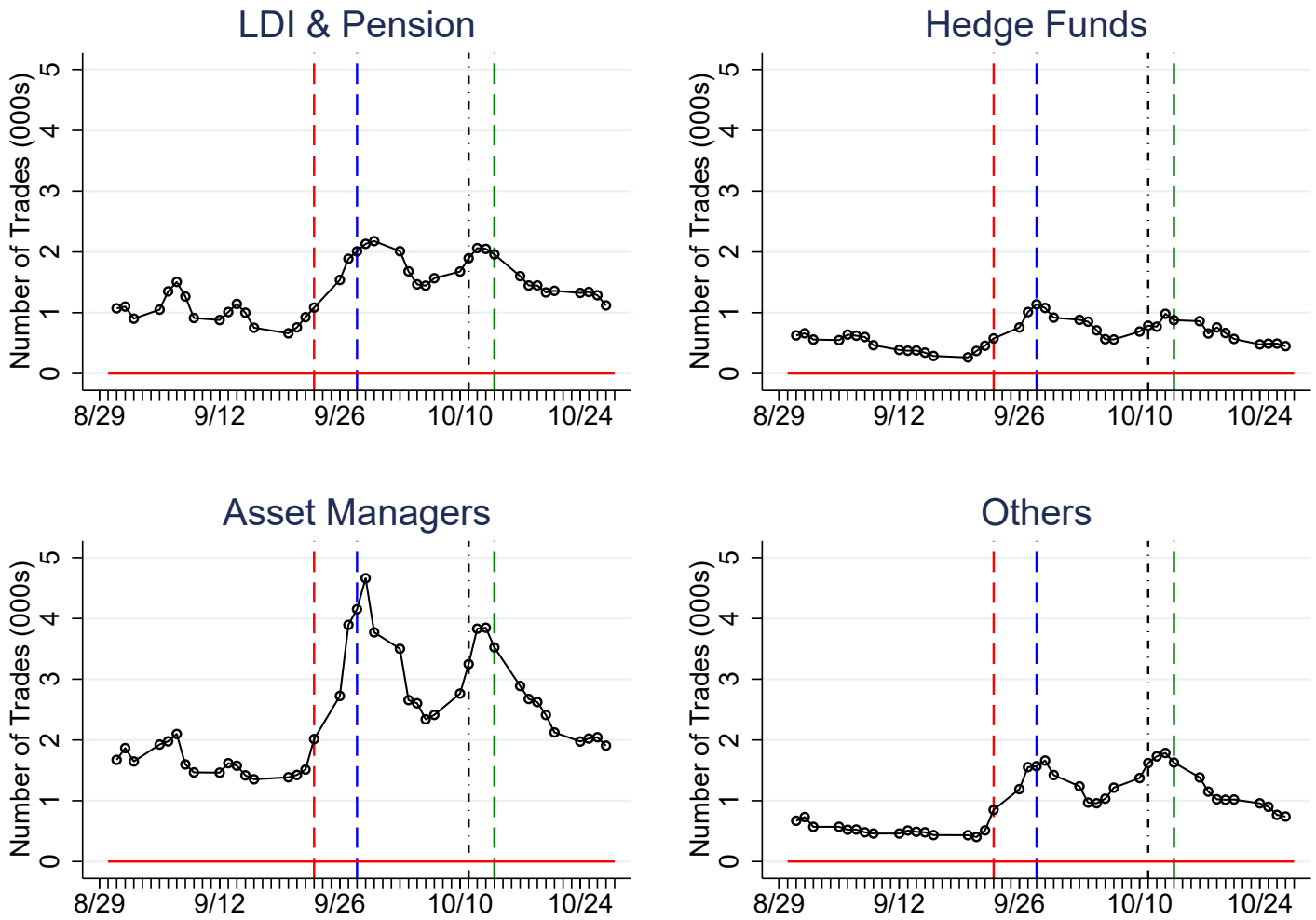
# Elevated Activity in Other Sectors

## Turnover of Different Client Types



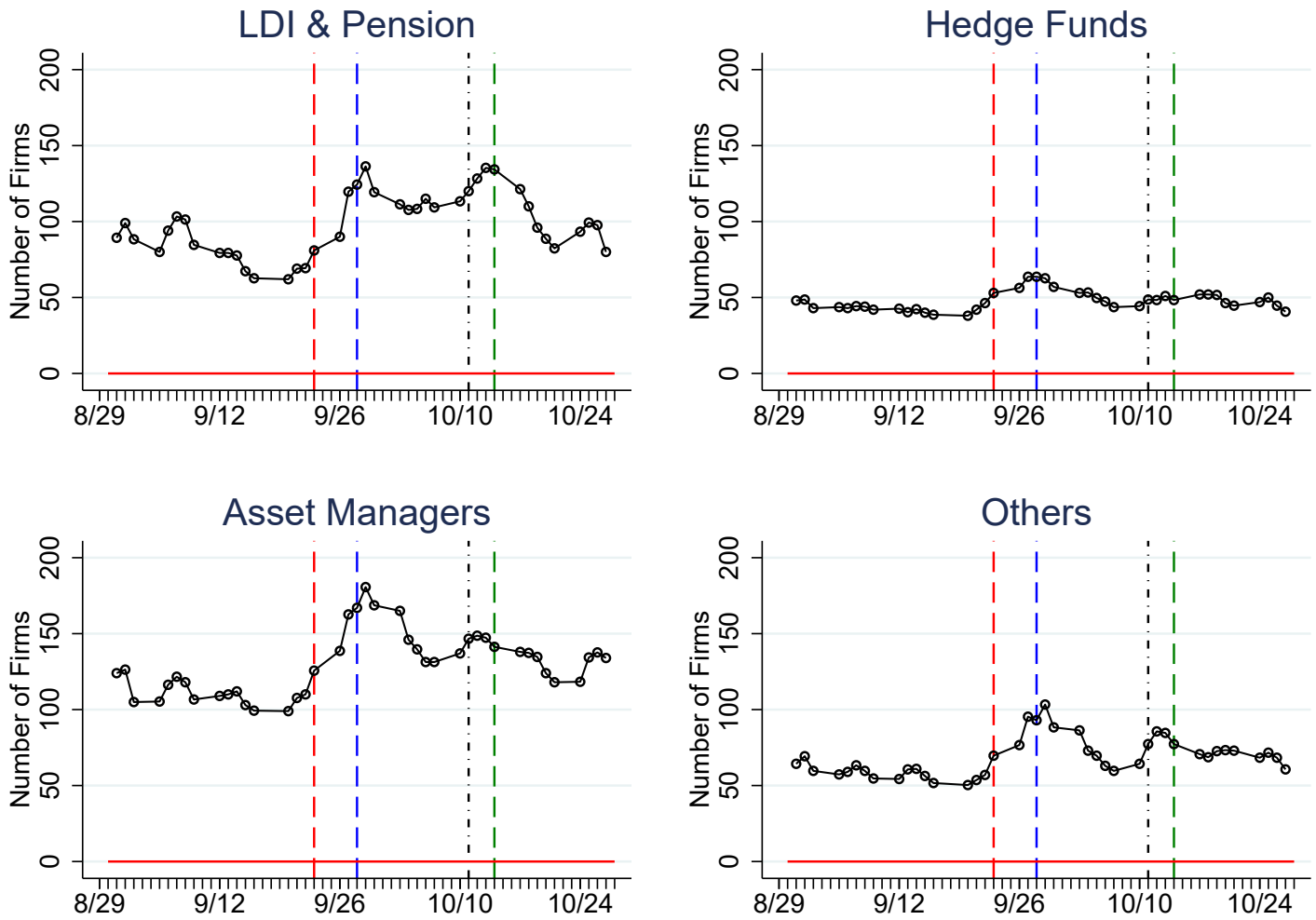
# Elevated Activity in Other Sectors

## Trading Intensity of Different Client Types



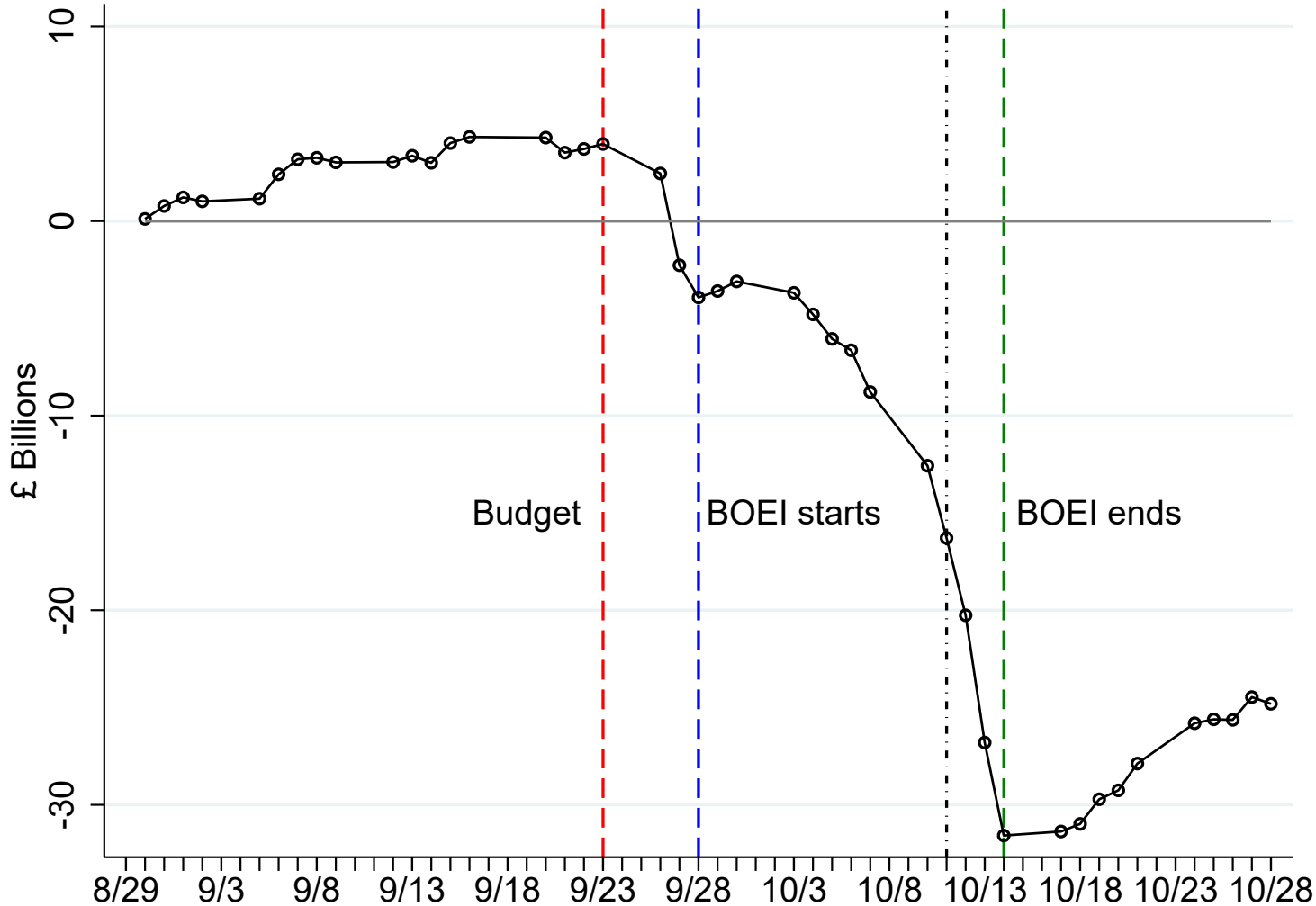
# Elevated Activity in Other Sectors

## Number of Firms of Different Client Types



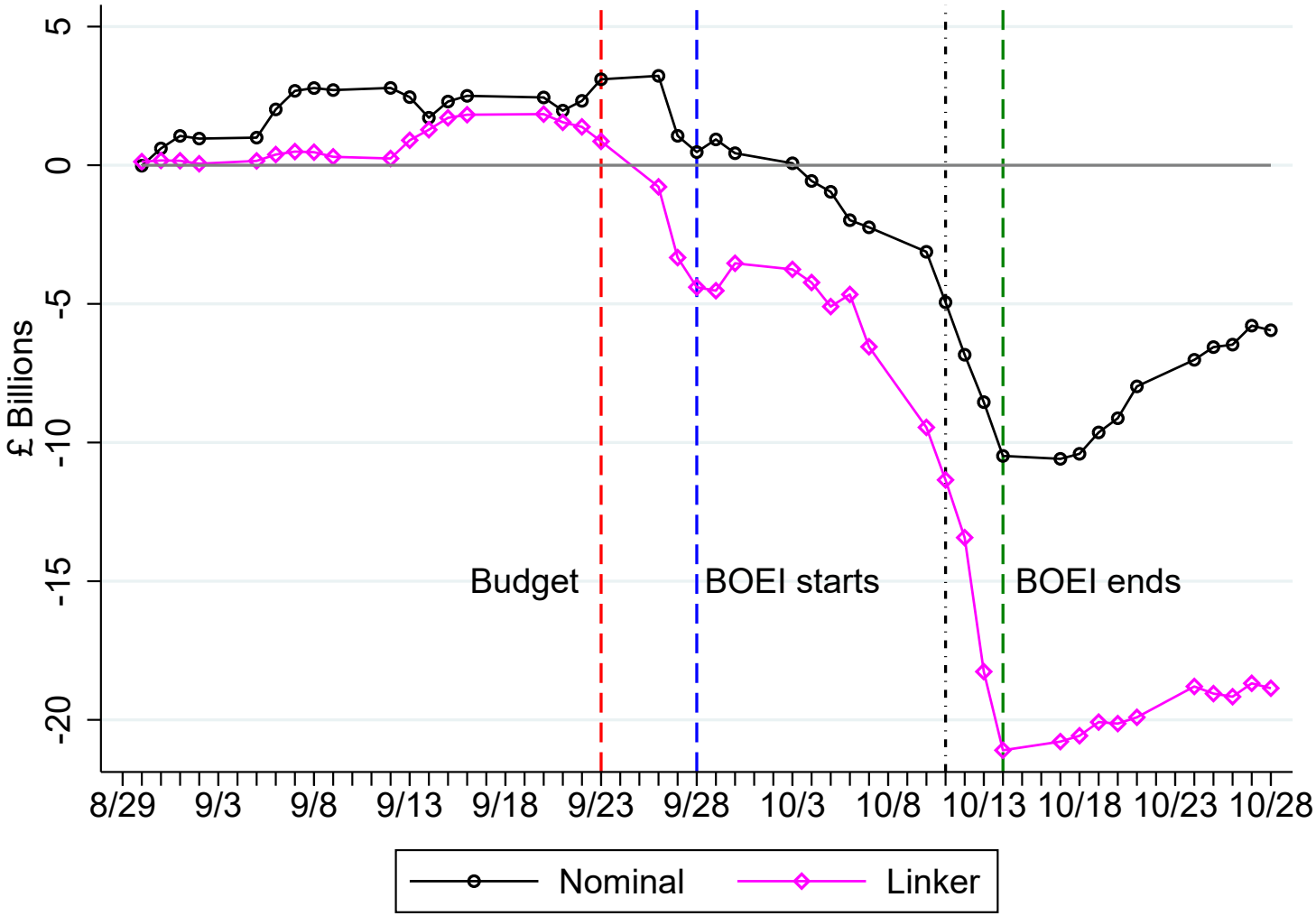
# LDIs Selling

## Total Orderflow of LDI Sector



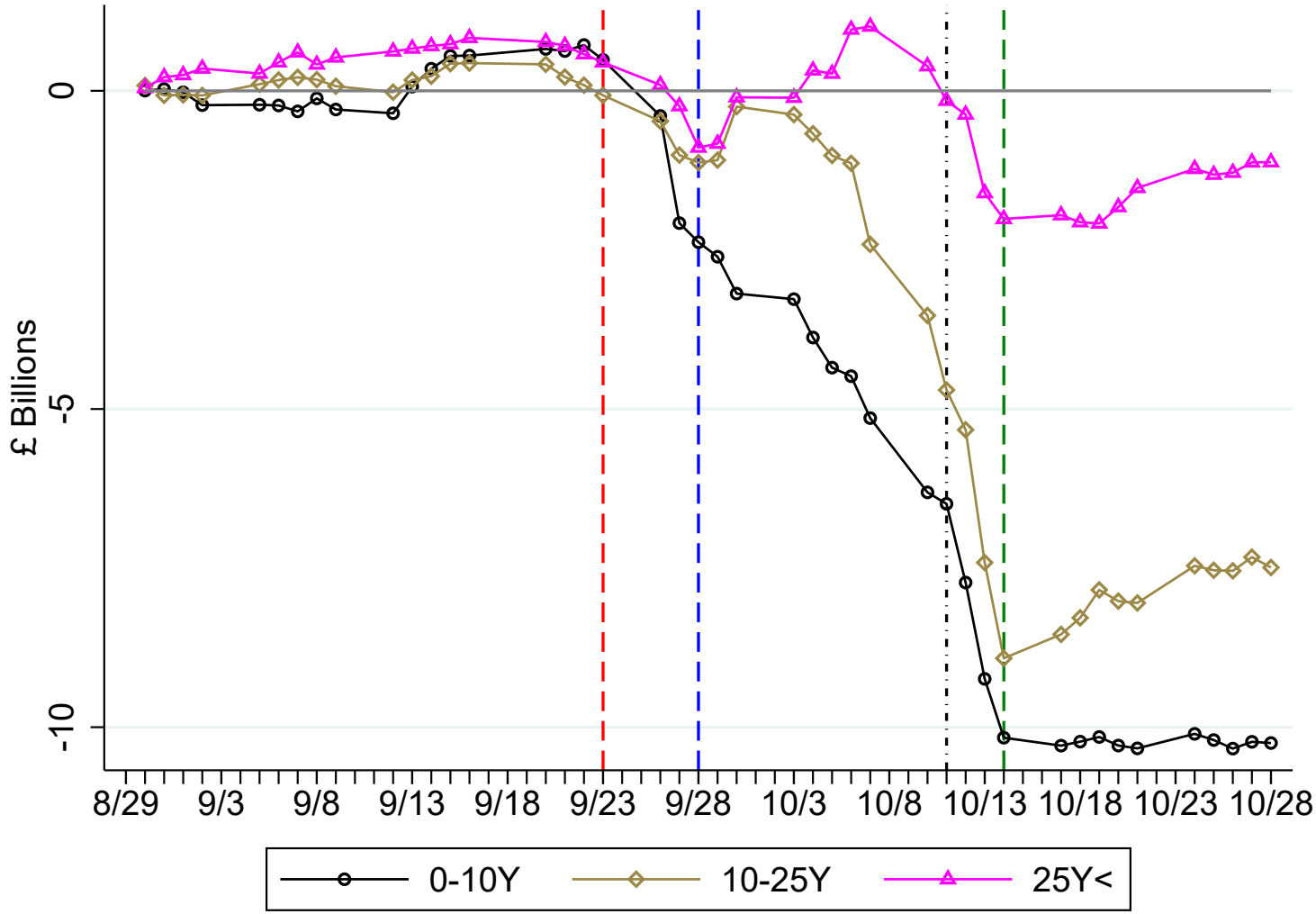
# LDIs Selling: It Started with Linkers

## Orderflow of LDI Sector



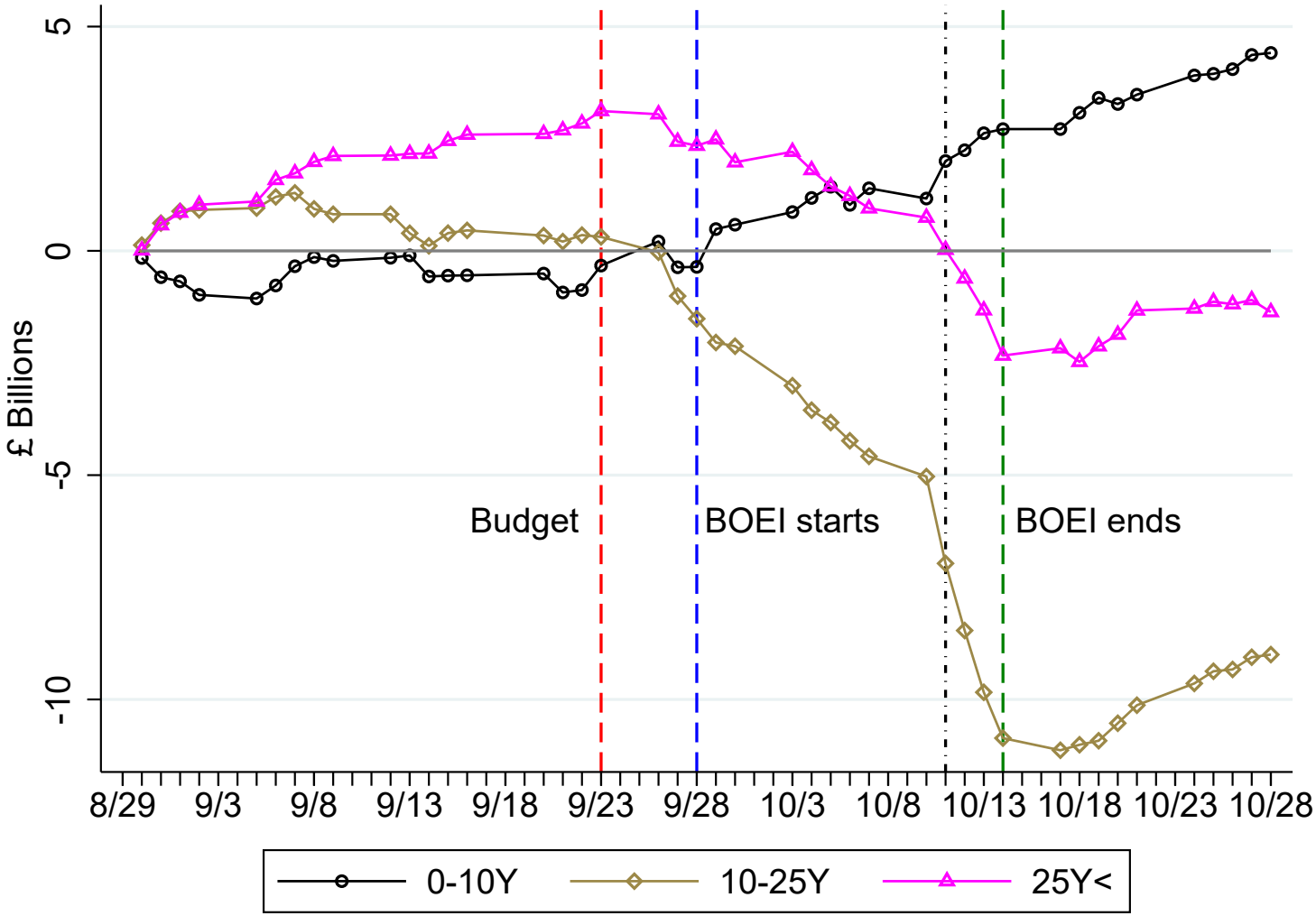
# LDIs Selling: All Maturities in Linkers

## Linker Orderflow of LDI Sector



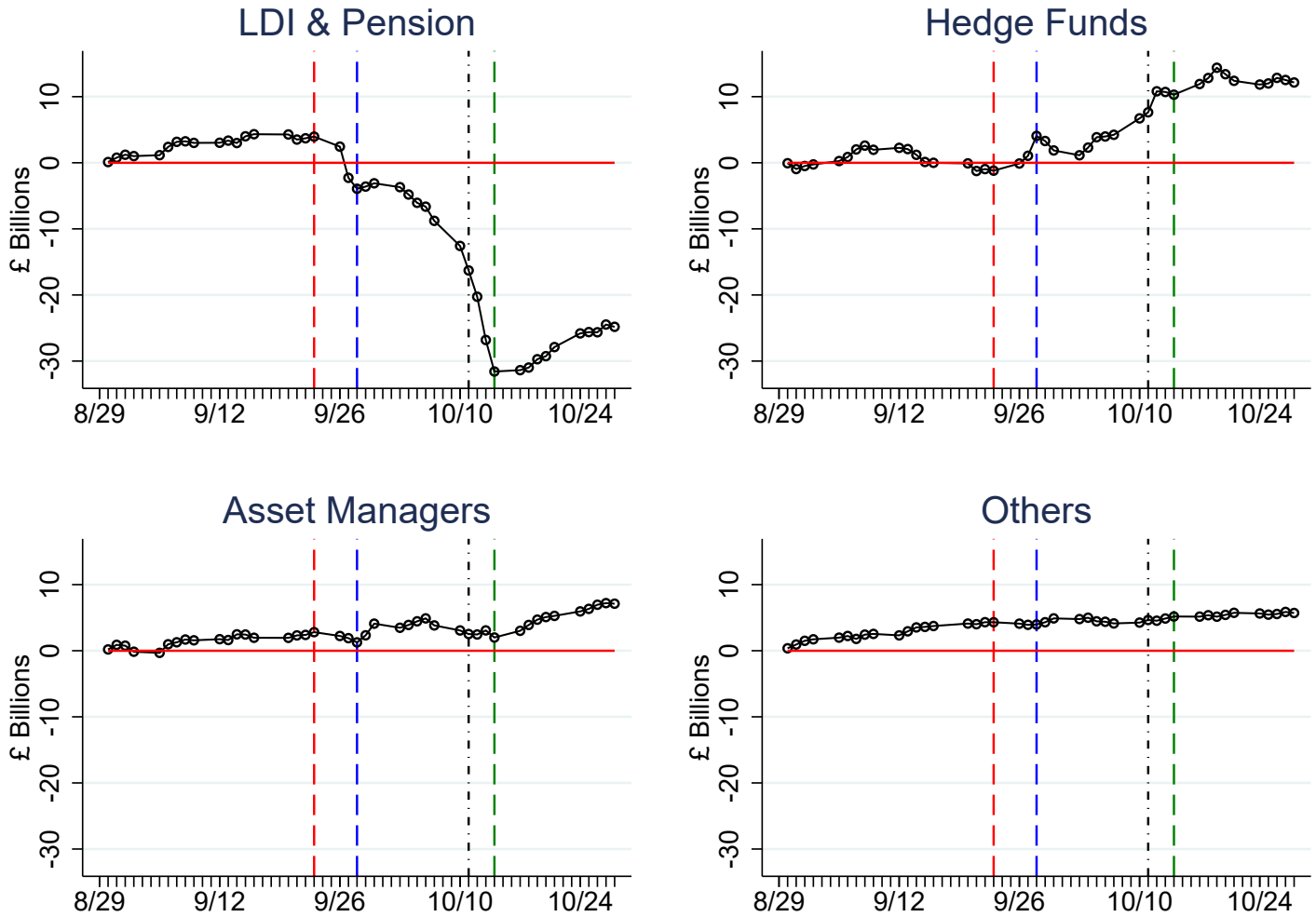
# LDIs Selling: Mainly Medium Maturities in Nominals

## Nominal Orderflow of LDI Sector



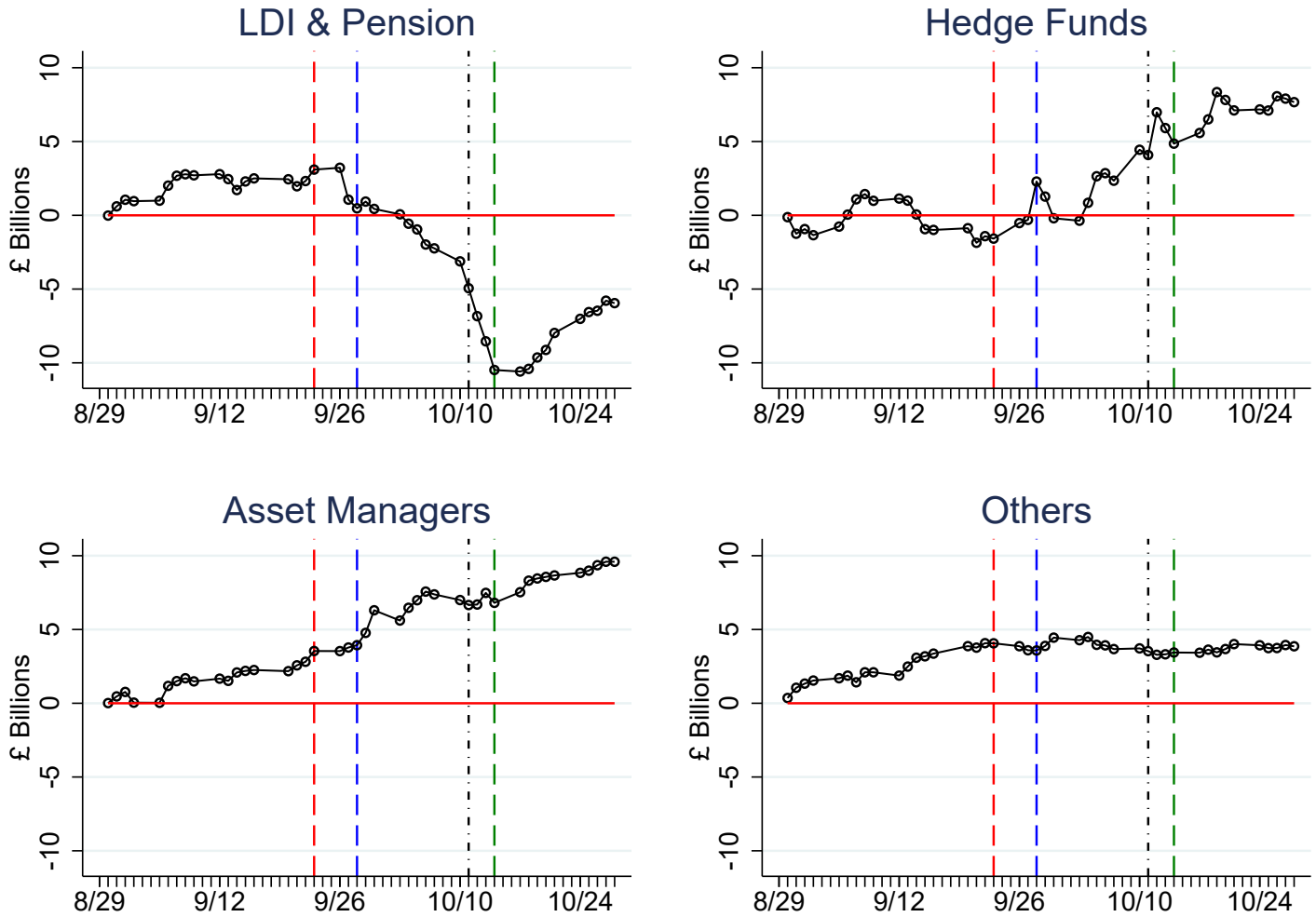
# Limited Liquidity Provision from Other Clients

## Total Orderflow of Different Sectors



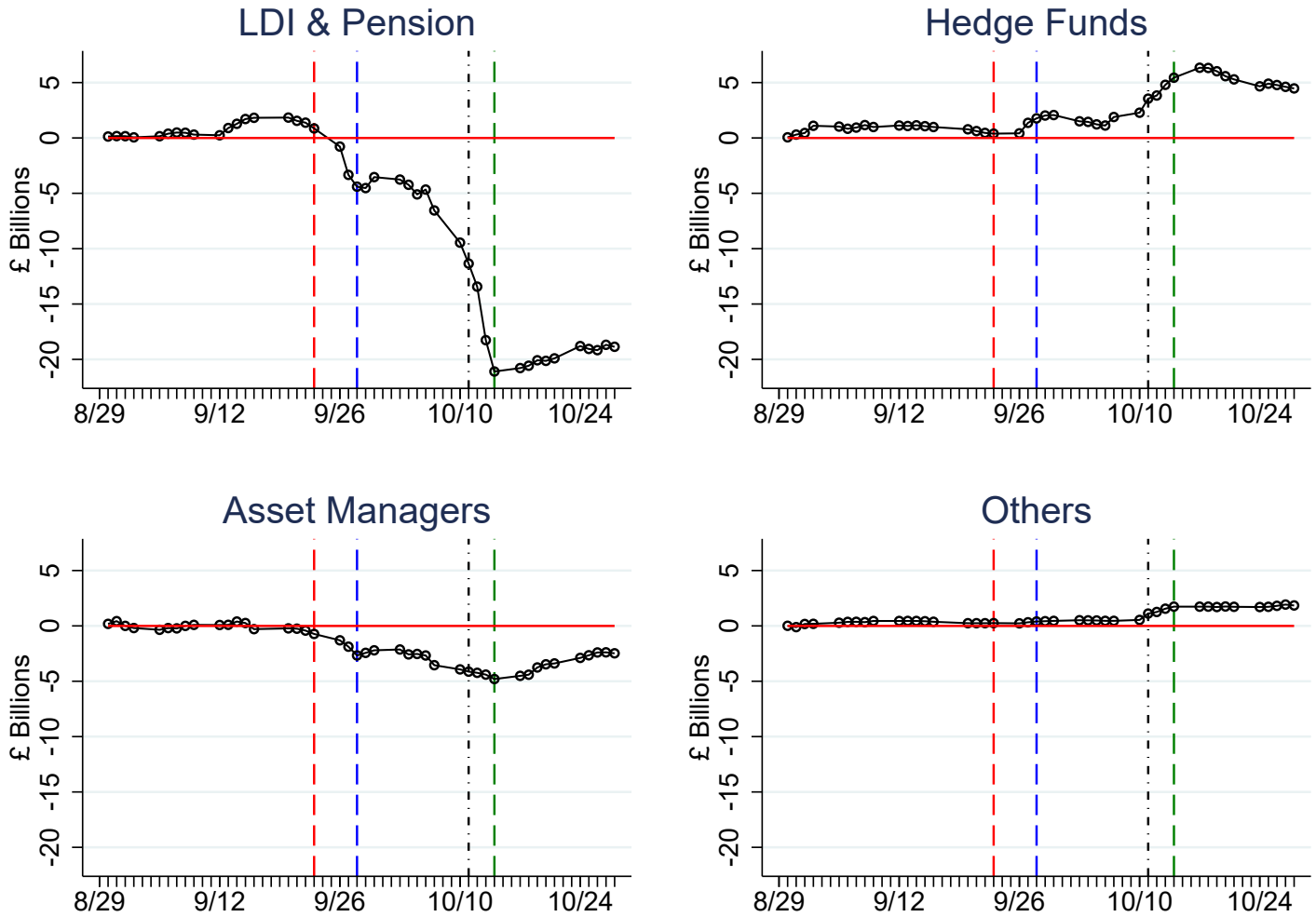
# Some Liquidity Provision in Nominals

## Nominal Orderflow of Different Sectors



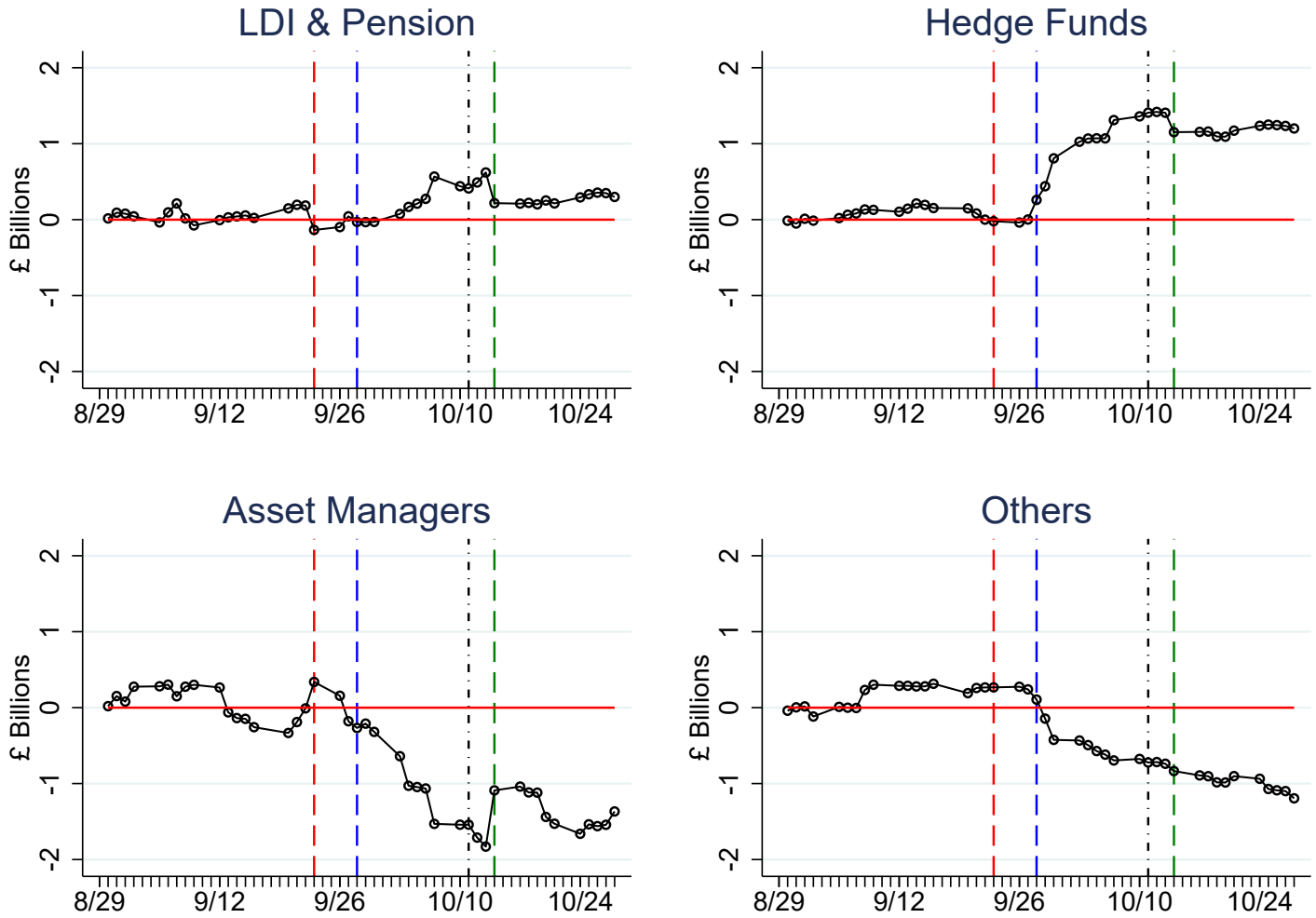
# Little Liquidity Provision in Linkers

## Linker Orderflow of Different Sectors



# Client-to-Client Orderflow Remained Modest

## Orderflow of Different Sectors



# Nominal Yields

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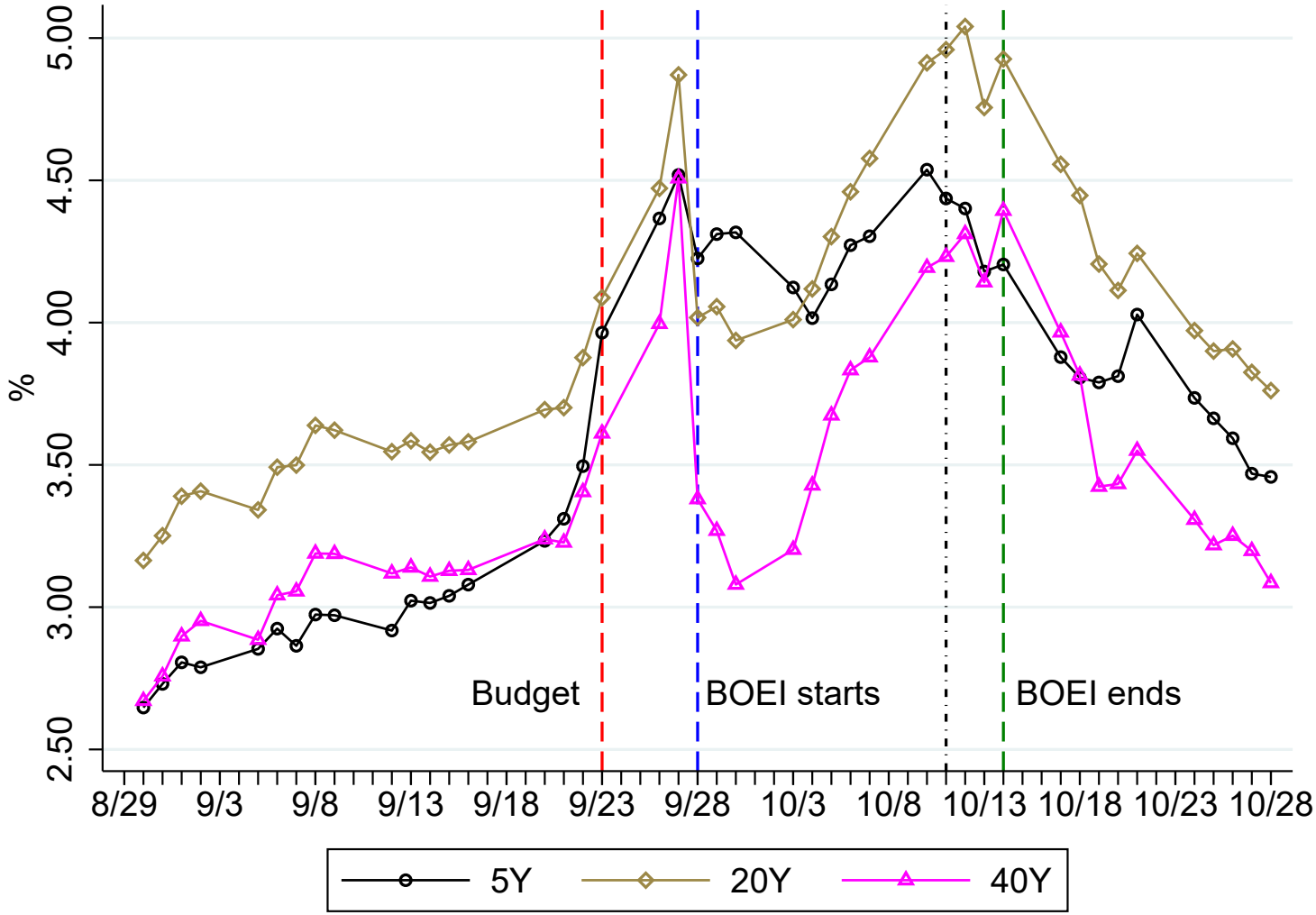
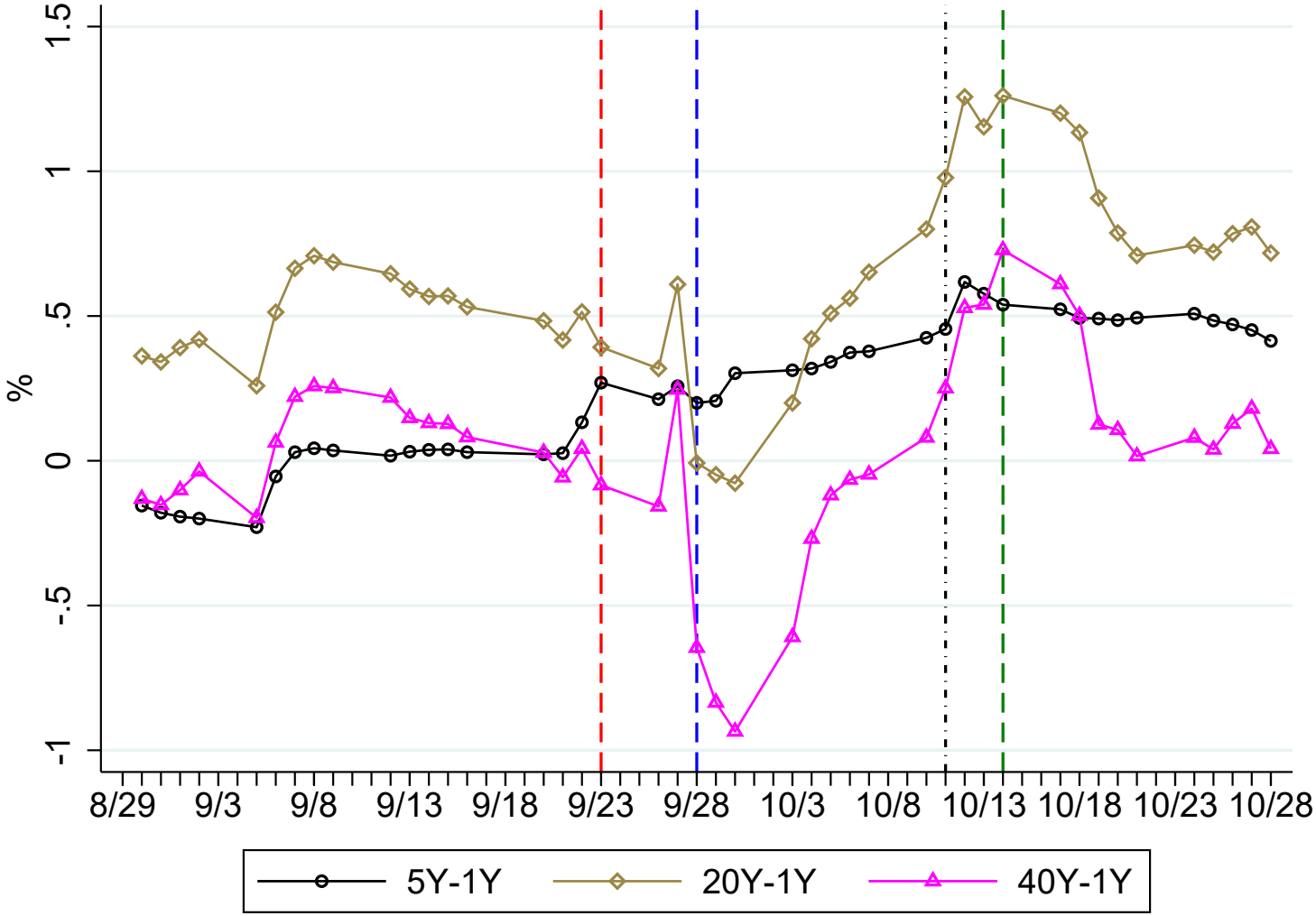


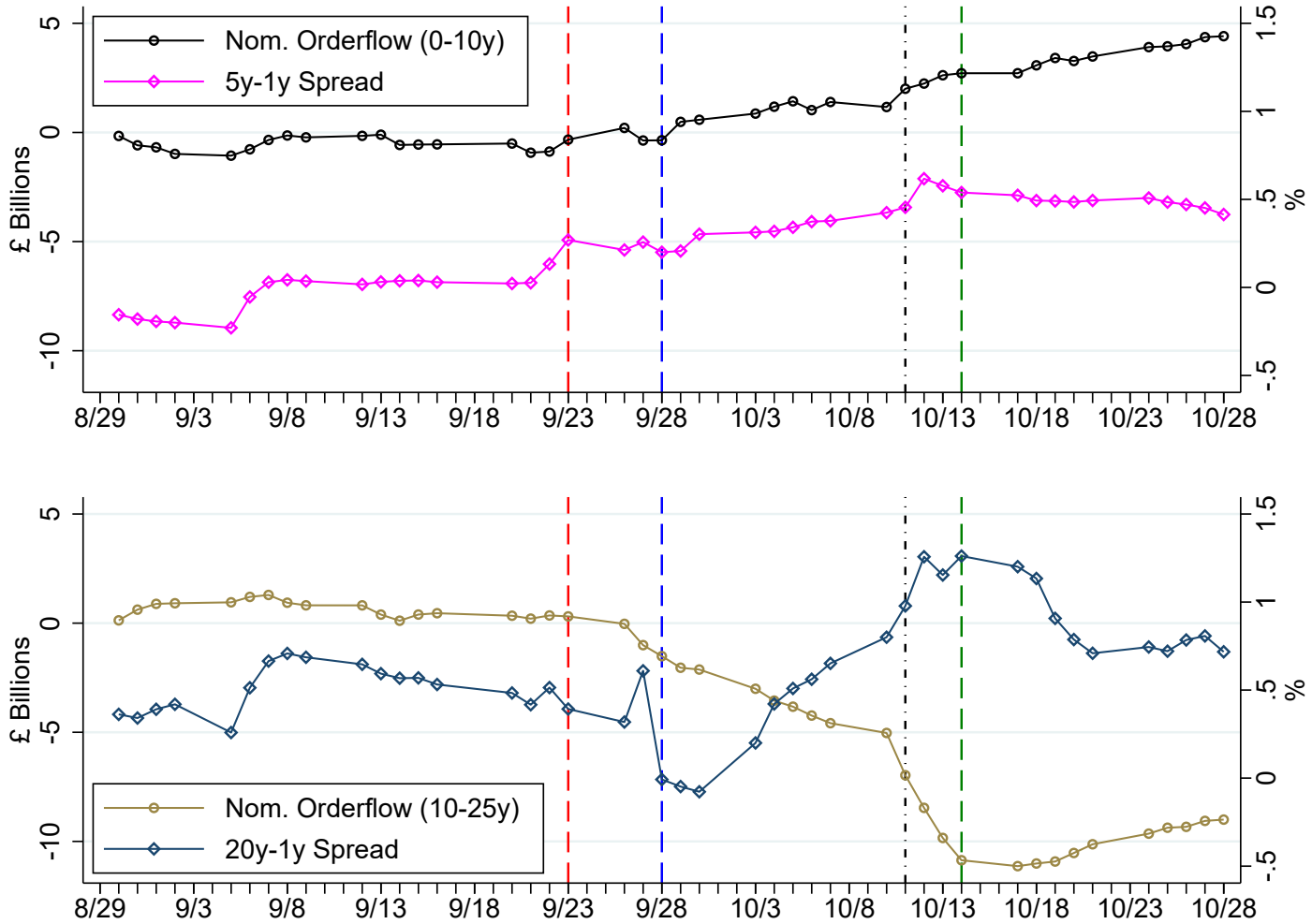
# Nominal Term Spreads

## 5Y, 20Y, 40Y Maturities



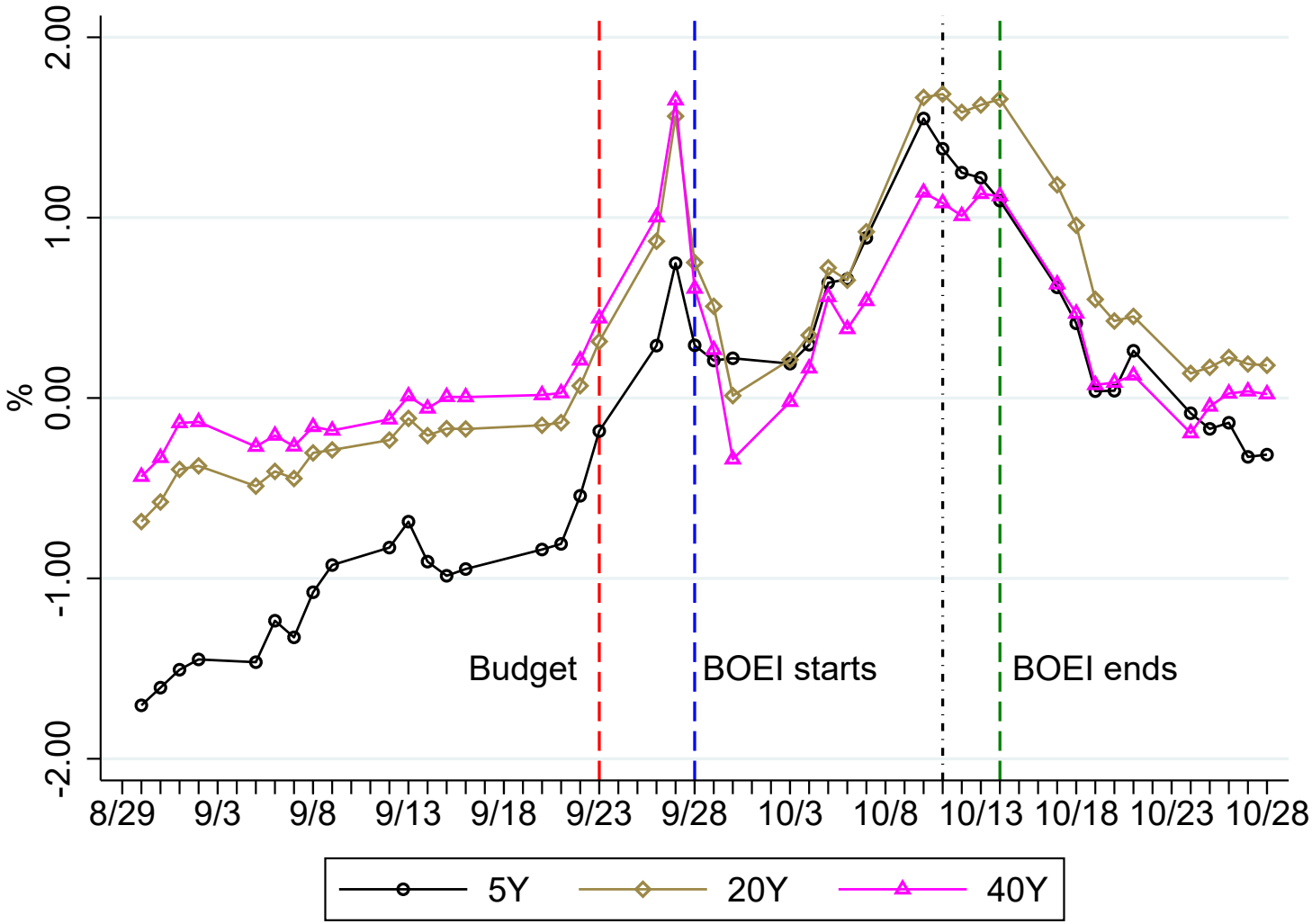
# Nominal Term Spreads and LDI Orderflow

## Evidence on Price Pressure?



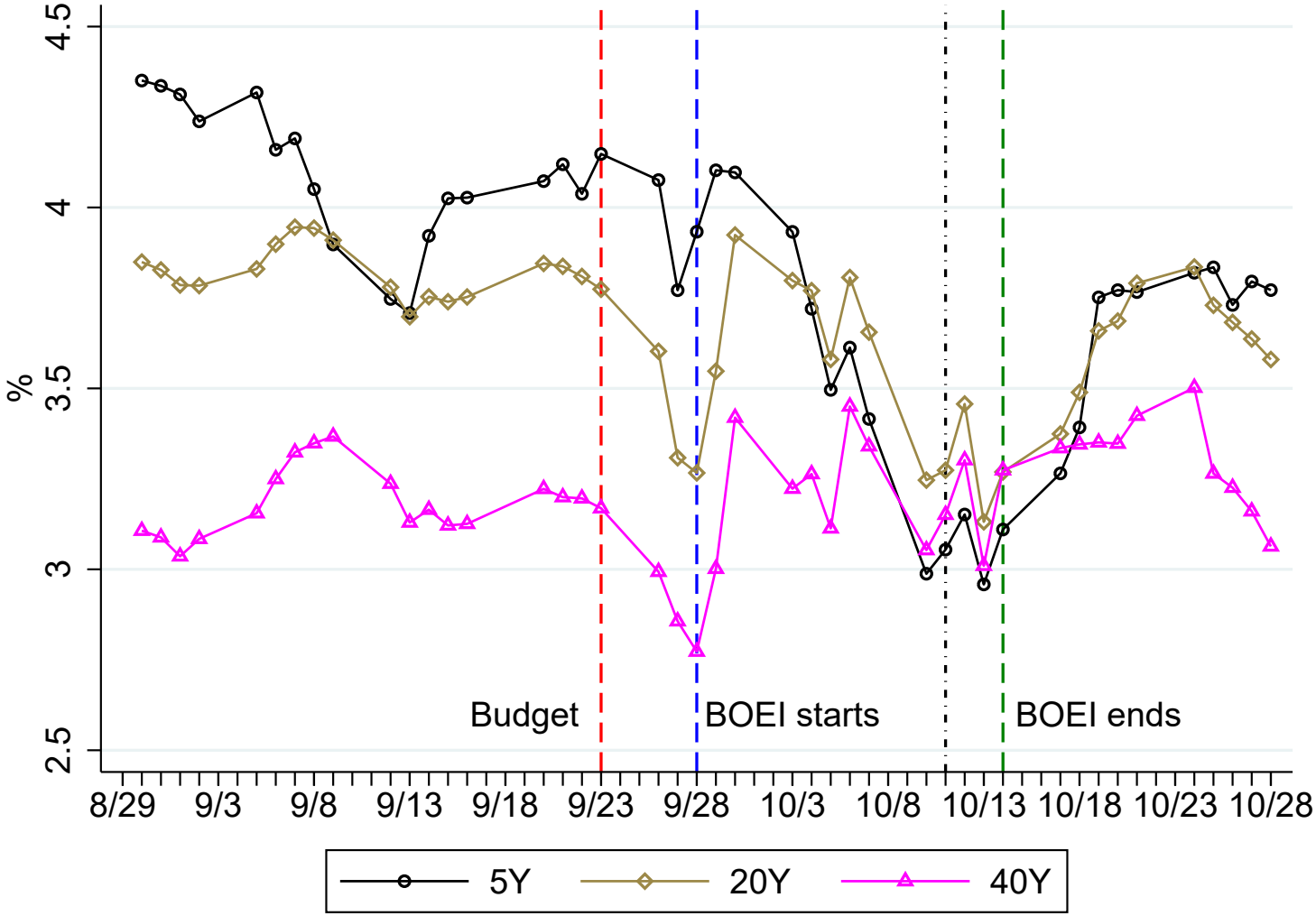
# Real Yields

## 5Y, 20Y, 40Y Maturities



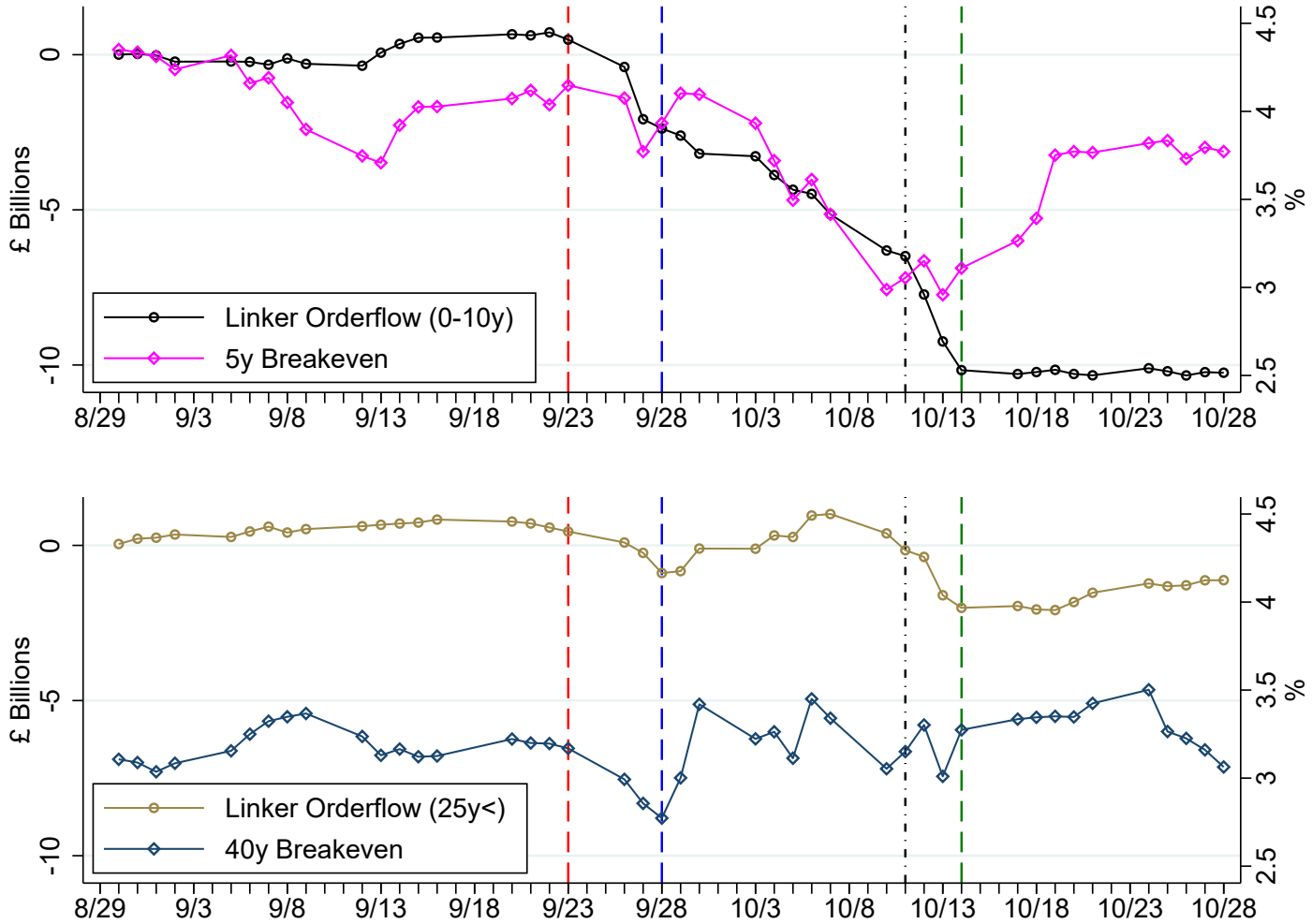
# Breakeven Inflation

## 5Y, 20Y, 40Y Maturities



# Breakeven Inflation and LDI Orderflow

## Evidence on Price Pressure?

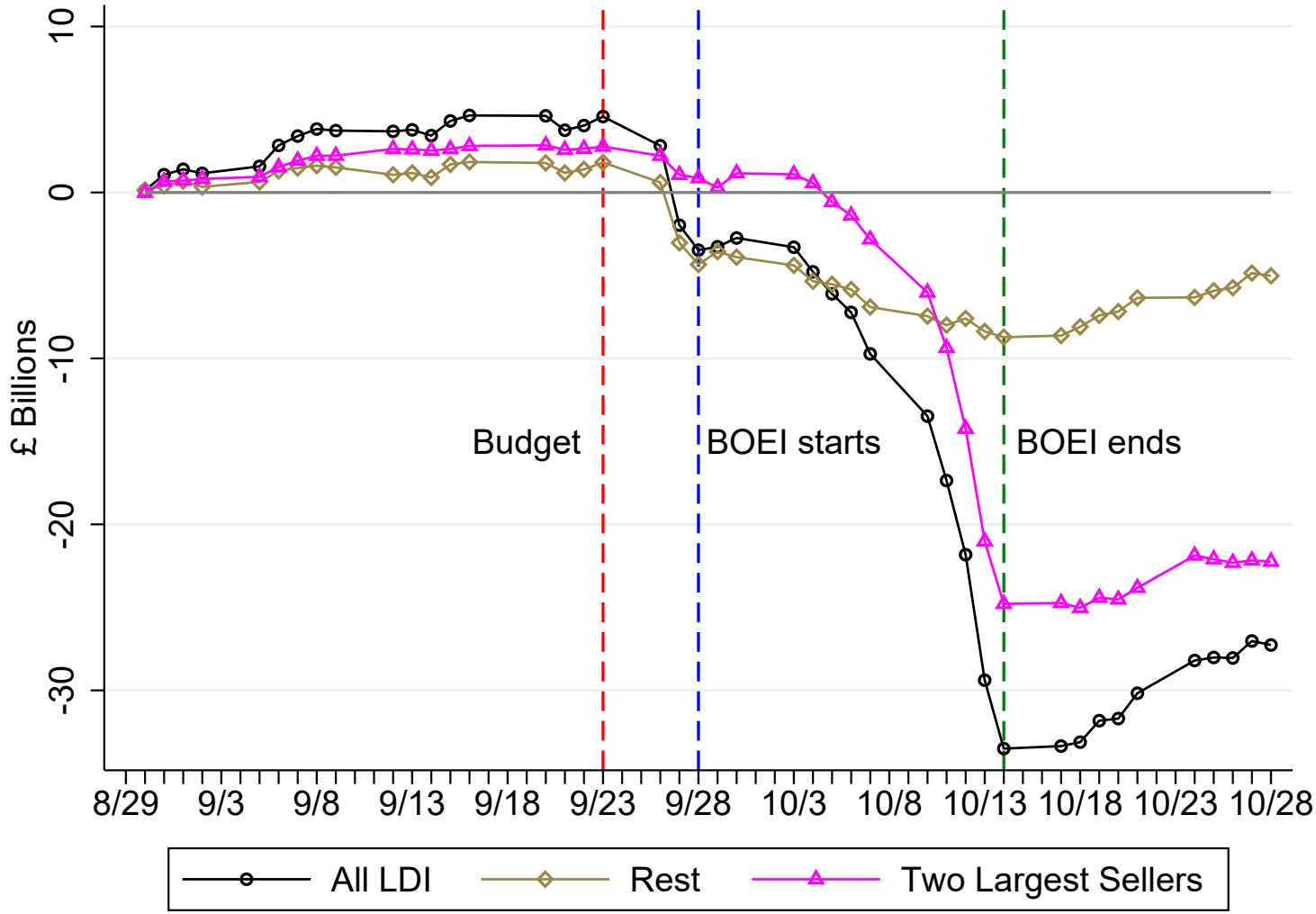


# Heterogeneity across LDI Firms

How uniform was the selling pressure across LDIs?

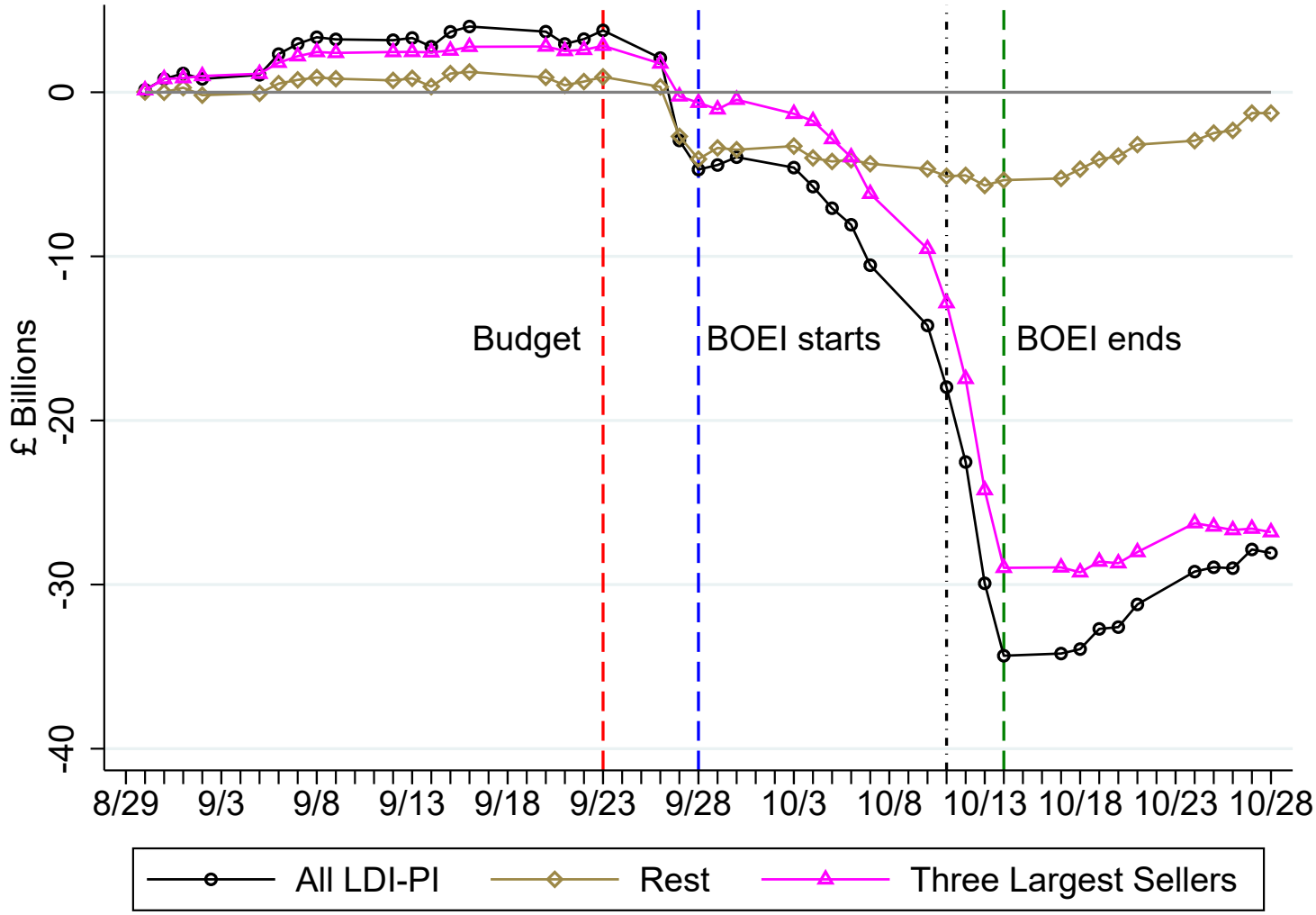
# The Role of Large LDI Firms

## Decomposing Total Bond Orderflow



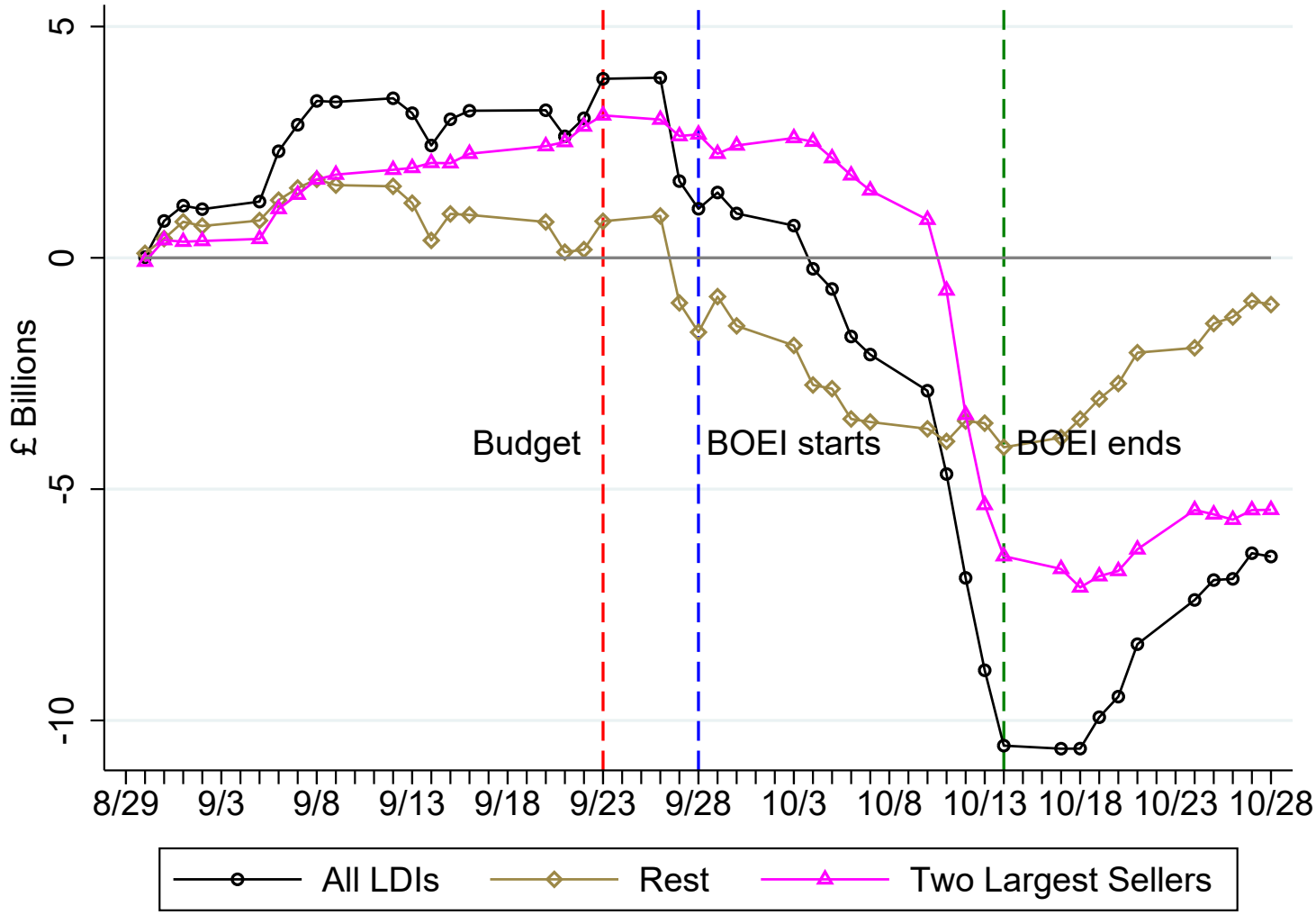
# The Role of Large LDI Firms

## Decomposing Total Bond Orderflow



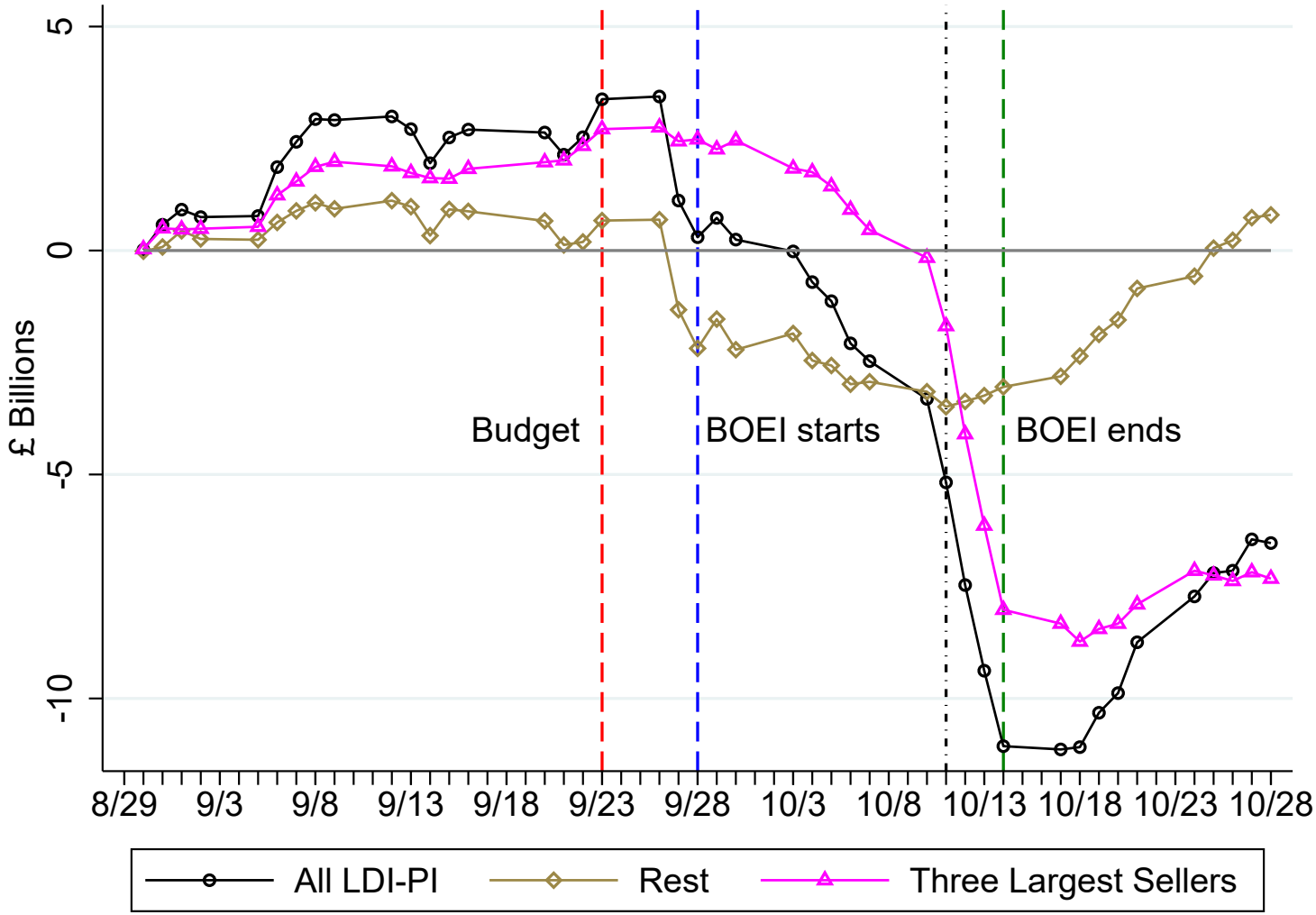
# The Role of Large LDI Firms

## Decomposing Nominal Bond Orderflow



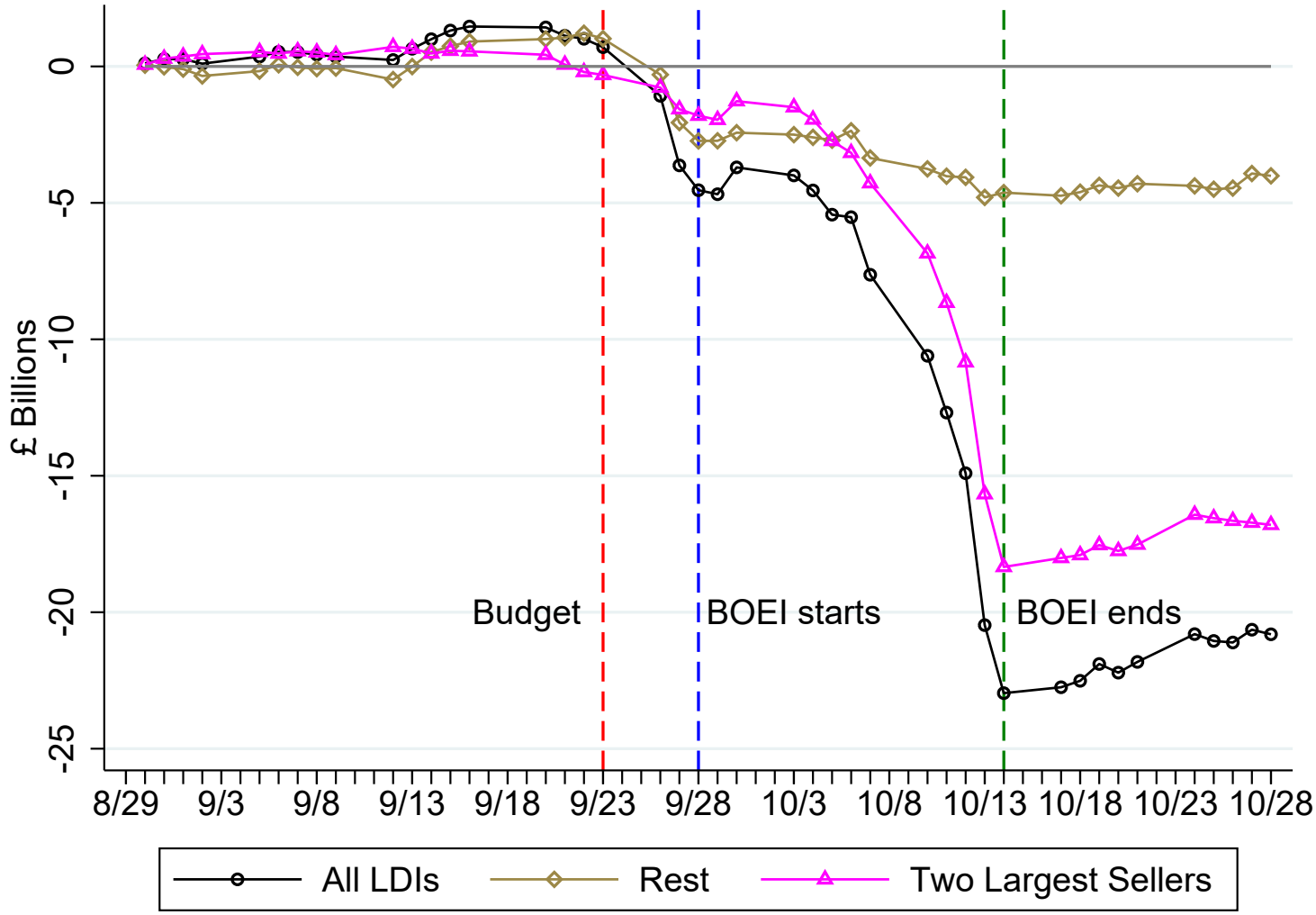
# The Role of Large LDI Firms

## Decomposing Nominal Bond Orderflow



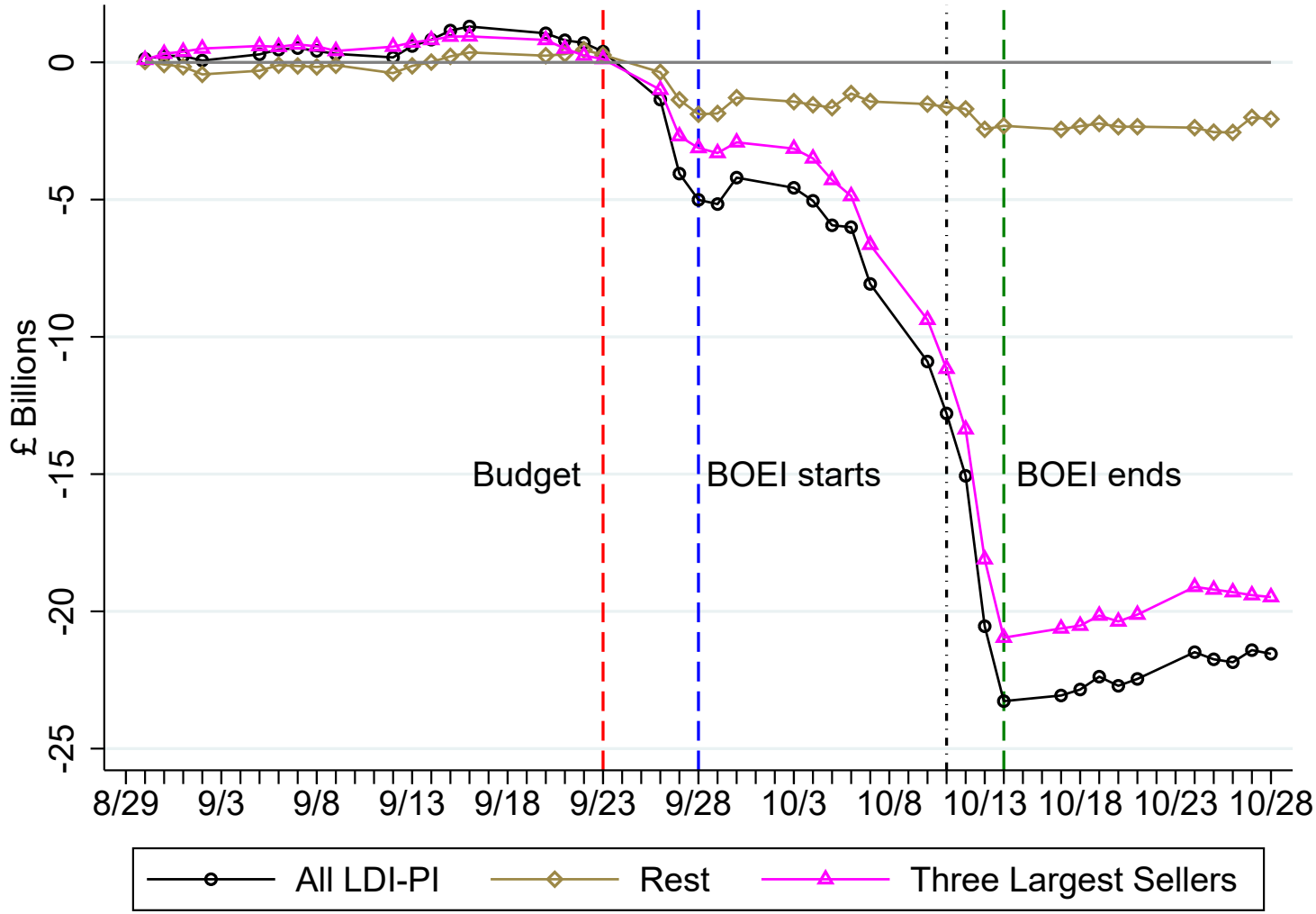
# The Role of Large LDI Firms

## Decomposing Linker Orderflow



# The Role of Large LDI Firms

## Decomposing Linker Orderflow



# Outline

1. Stylised Facts from UK Bond Markets
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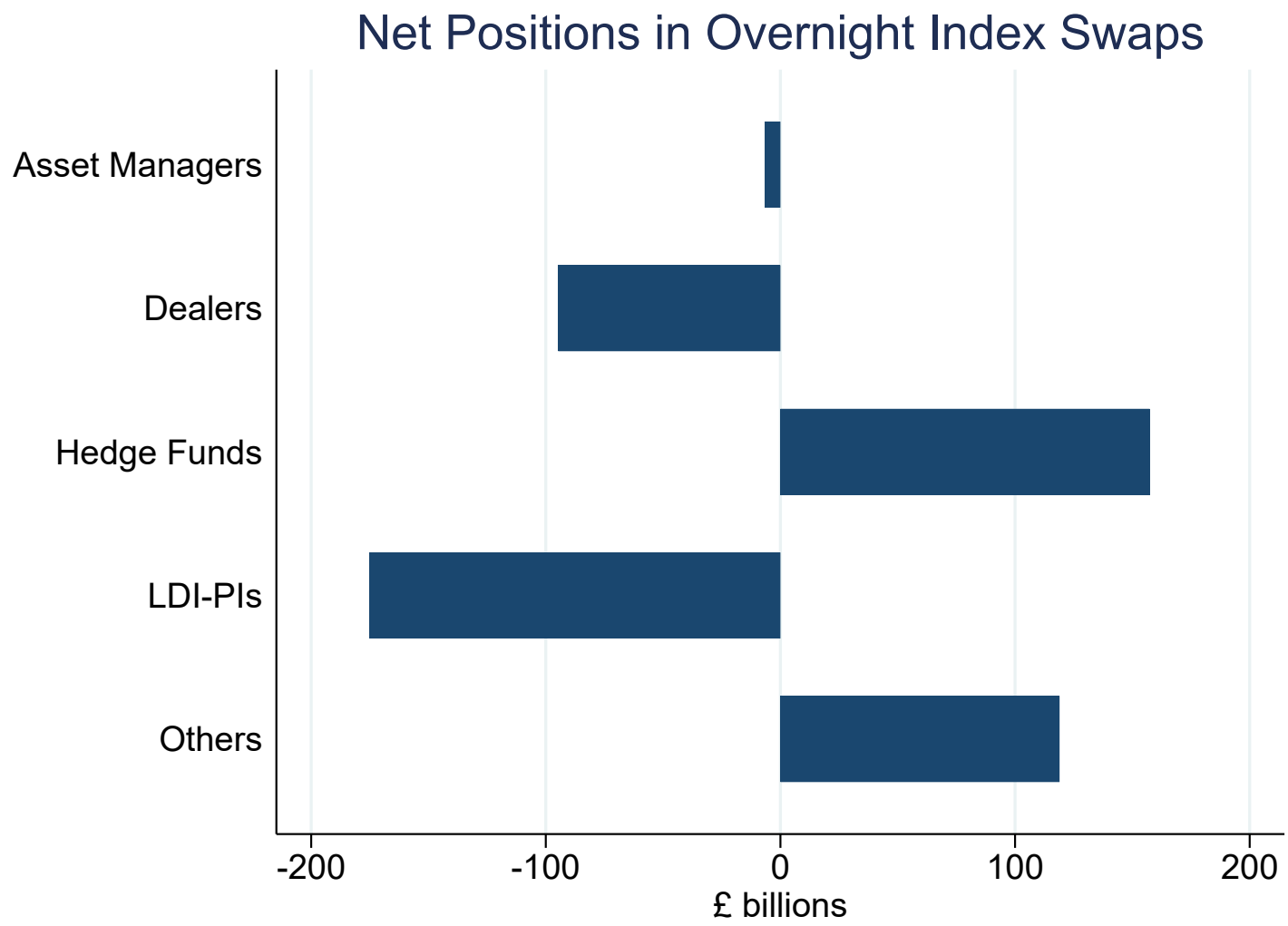
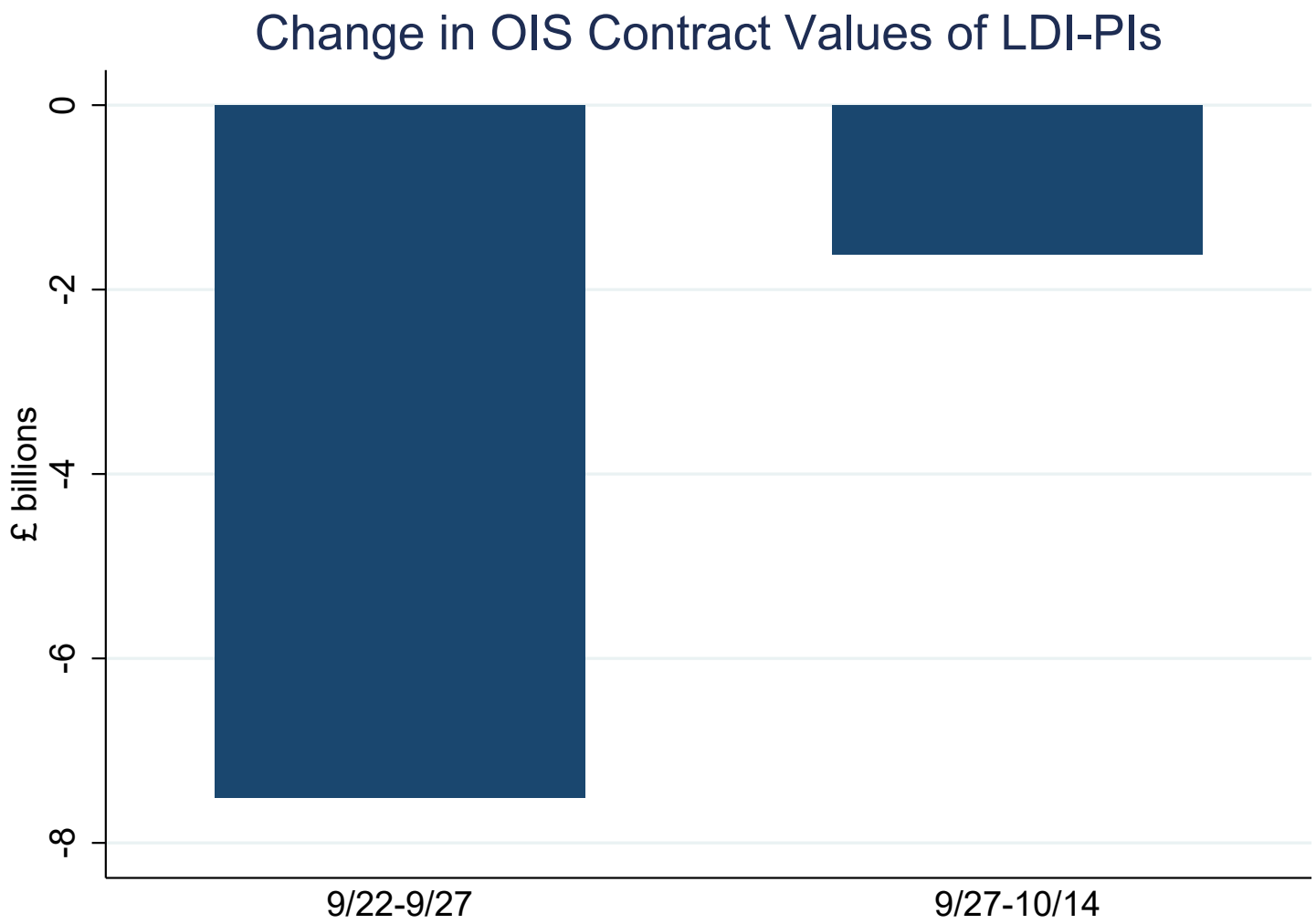
# Net Positions in the OIS Market (22 Sep, 2022)

## LDIs are the largest payer of floaters



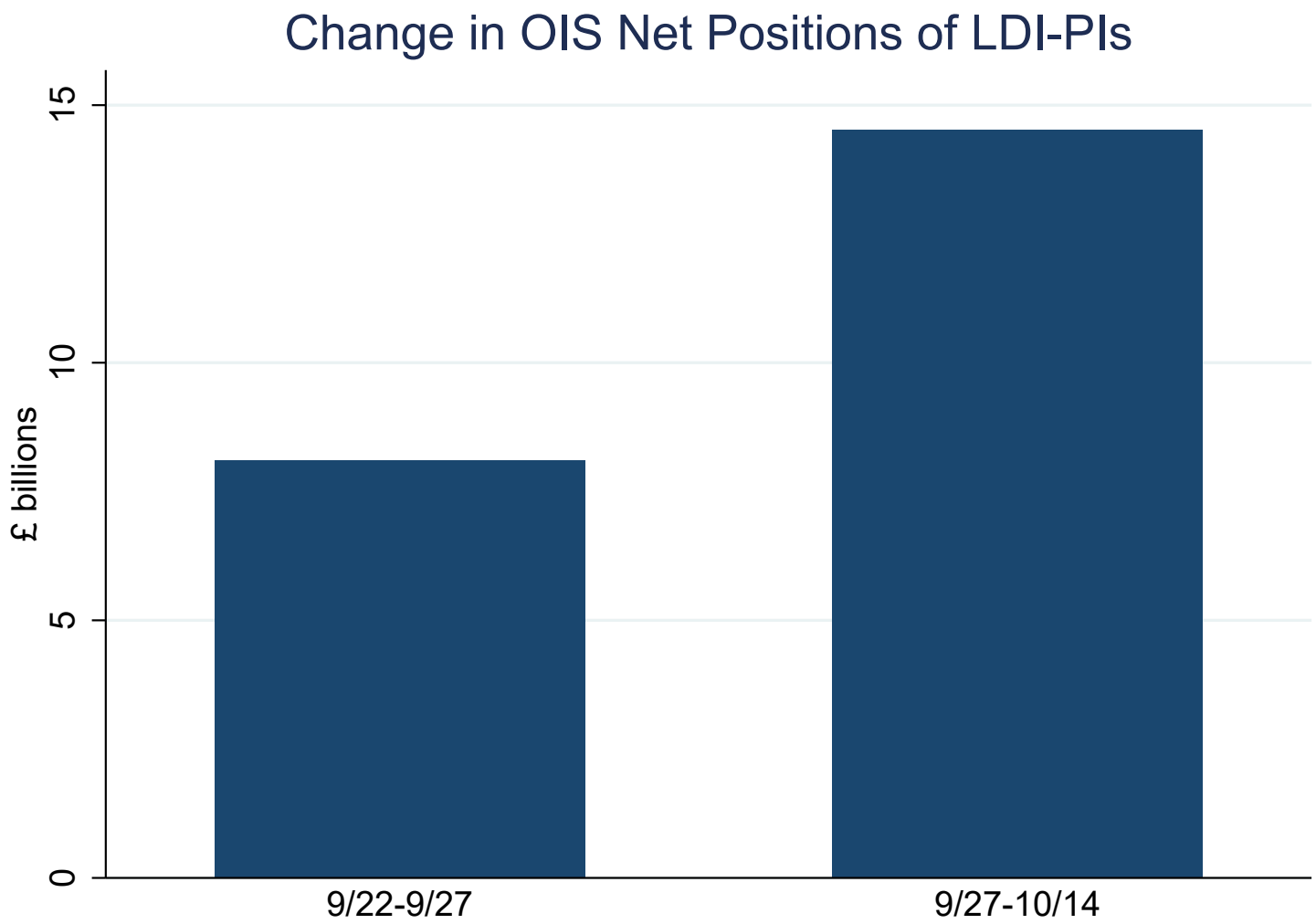
# LDIs' Deteriorating OIS Swap Positions

## Changes in Total (mark-to-market) Contract Values



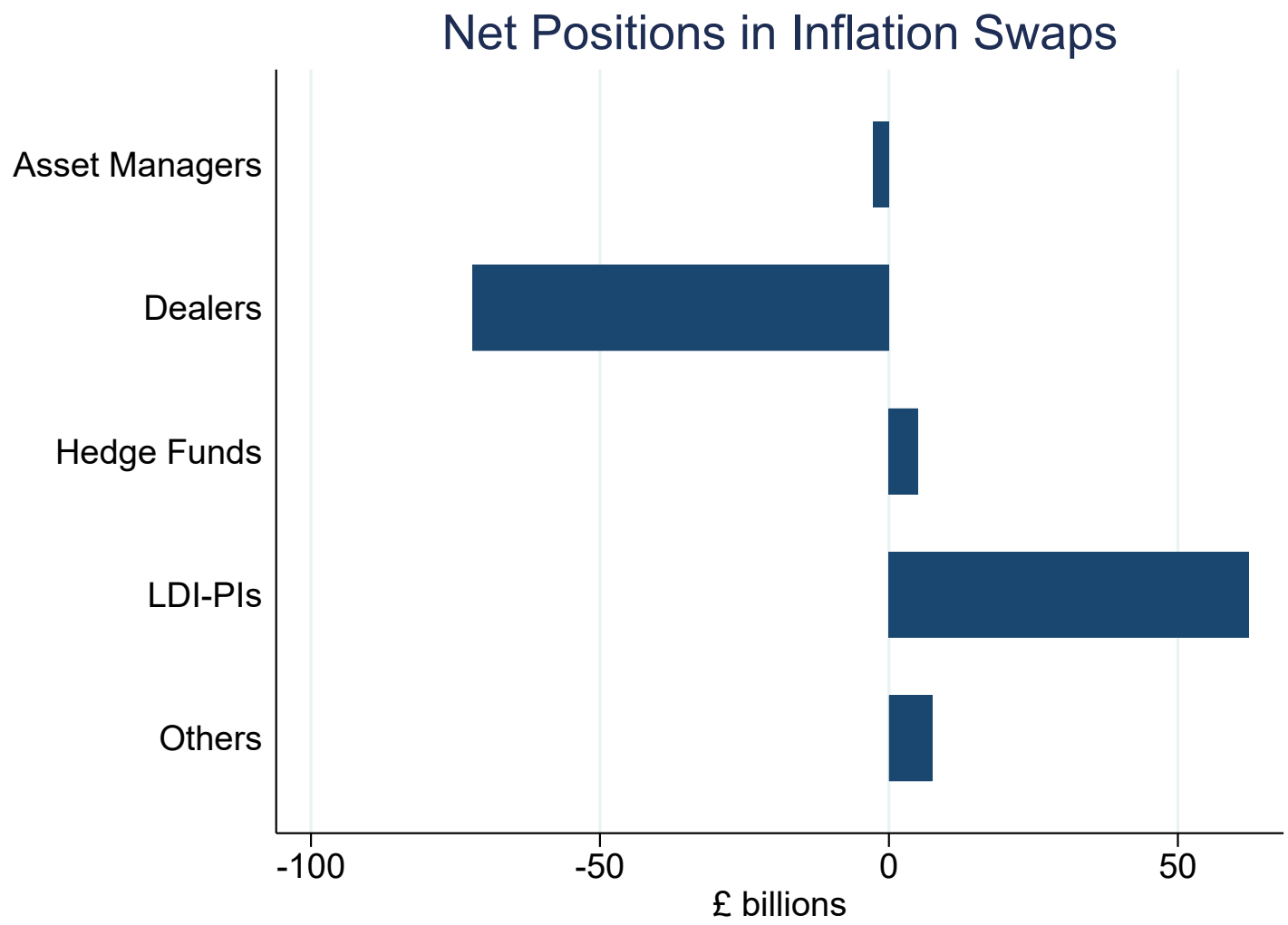
# Changing LDI Net Positions in the OIS Market

## LDIs reduce floating exposure



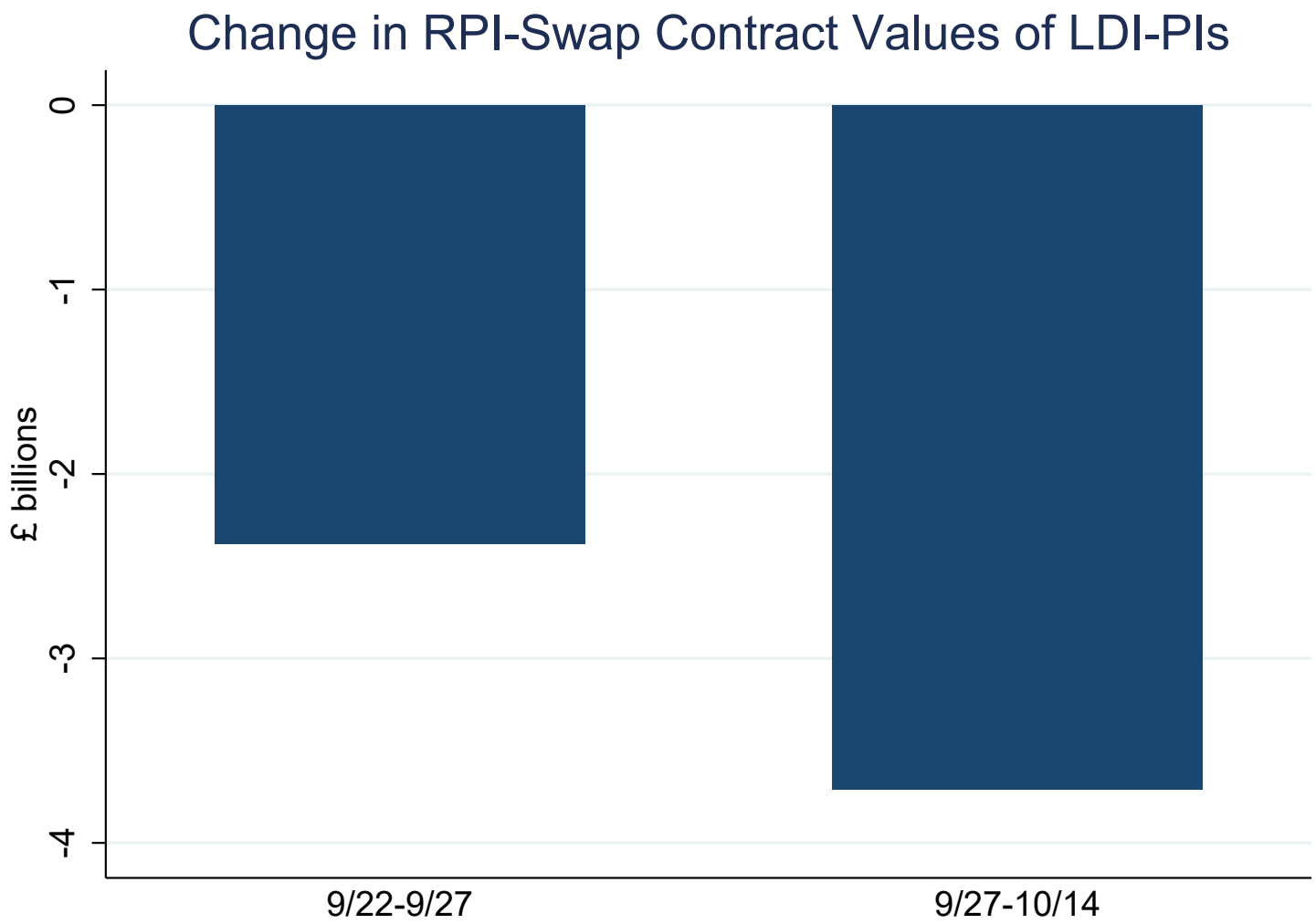
# Net Positions in the Inflation-swap Market (22 Sep, 2022)

## LDIs are the largest buyer of inflation



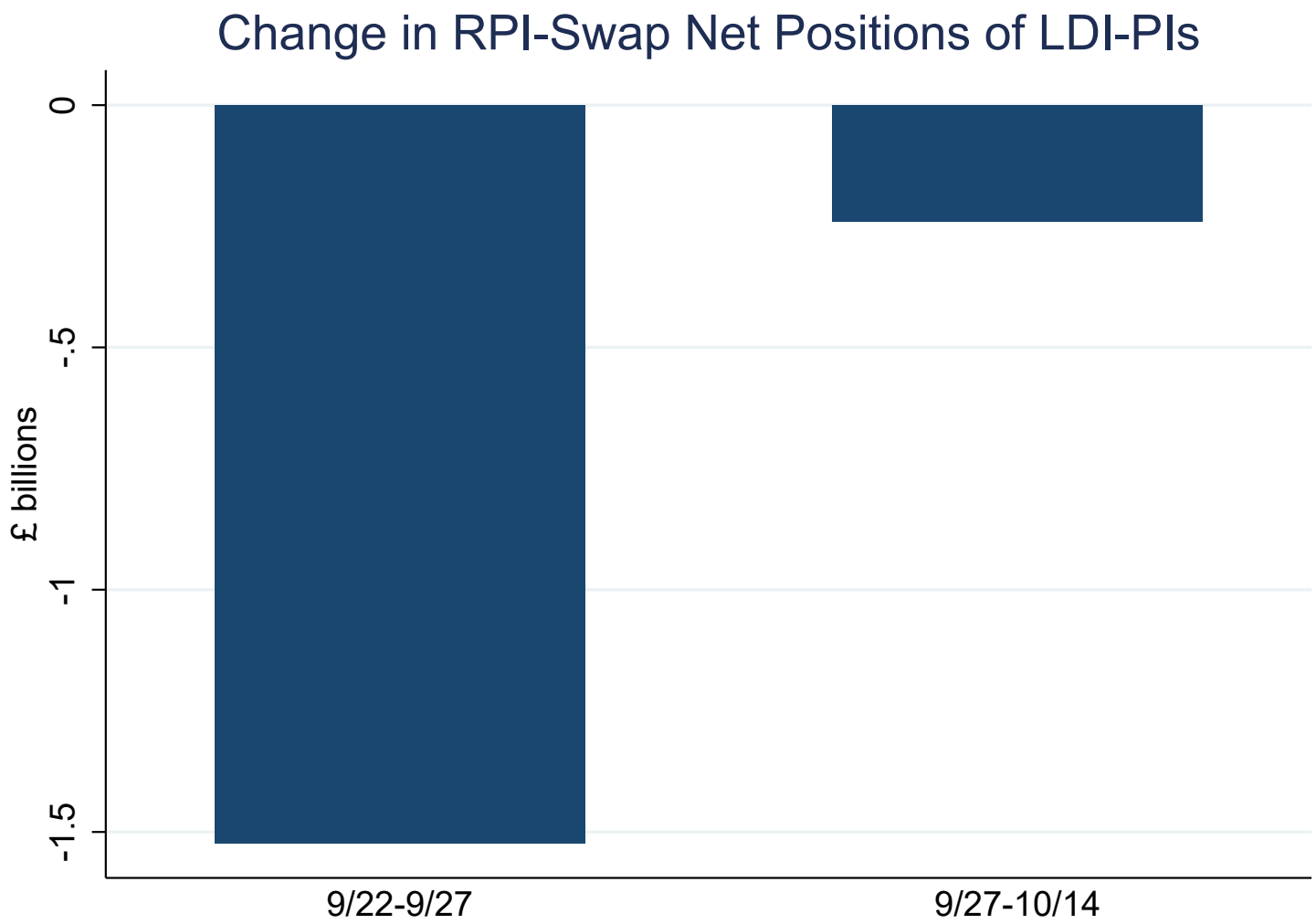
# LDIs' Deteriorating RPI Swap Positions

## Changes in Total (mark-to-market) Contract Values



# Changing LDI Net Positions in the Inflation Swap Market

## LDIs reduce inflation exposure



# Swap Exposure and Bond Liquidation by LDI Firms

## Cross-sectional Regressions

- Did LDI firms with larger swap exposures before the crisis end up liquidating more bonds during the crisis?

# Swap Exposure and Bond Liquidation by LDI Firms

## Cross-sectional Regressions

- Did LDI firms with larger swap exposures before the crisis end up liquidating more bonds during the crisis?
- Cross-sectional regression:

$$\begin{aligned} BondSales_i^{9/23-10/14} =& c + \beta_1 \times OISExposure_i^{9/22} \\ &+ \beta_2 \times RPIExposure_i^{9/22} + \varepsilon_i \end{aligned} \tag{3.1}$$

  - where $BondSales_i^{9/23-10/14}$ is the cumulative orderflow of firm $i$
  - $OISExposure_i^{9/22}$ is the net position of firm $i$ in OIS
  - $RPIExposure_i^{9/22}$ is the net position of firm $i$ in RPI-swaps

# Swap Exposure and Bond Liquidation by LDI Firms

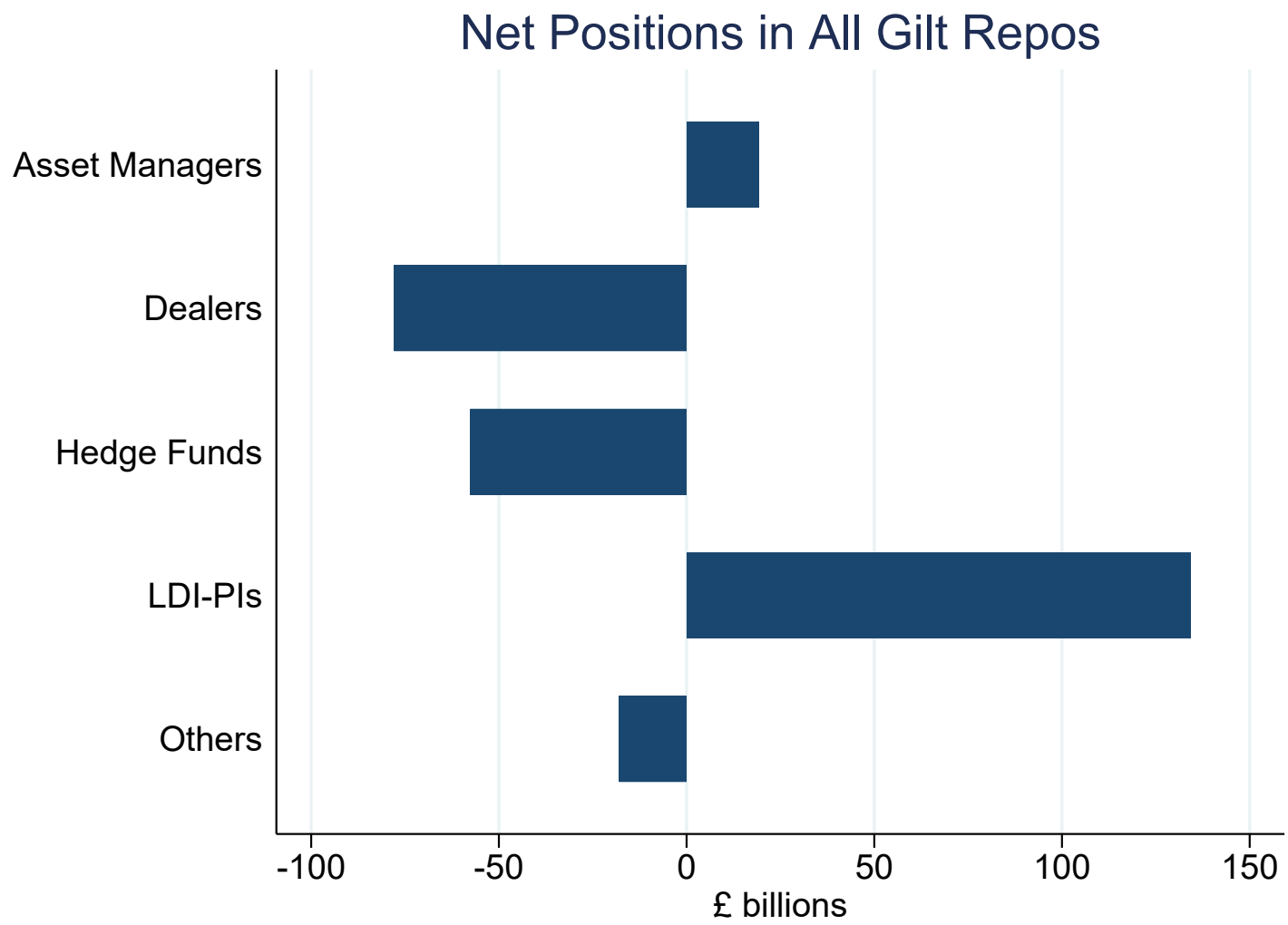
## Cross-sectional Regressions

| | (1) | (2) | (3) |
|---|---|---|---|
| $OISExposure_i^{9/22}$ | 0.039** | | 0.037* |
| | (2.30) | | (1.94) |
| $RPIExposure_i^{9/22}$ | | -0.052* | -0.006 |
| | | (-1.68) | (-0.20) |
| $N$ | 779 | 779 | 779 |
| $R^2$ | 0.078 | 0.039 | 0.077 |

Notes: this table regresses the cumulative order flow of LDI clients over the period 23 September – 14 October on the net positions (in £ millions) in the OIS and RPI-swap markets on 22 September. All variables are in £ millions. To reduce noise, we winsorise the sample at the 1%-level. T-statistics in parentheses are based on robust standard errors. Asterisks denote significance levels (* p<0.1, ** p<0.05, *** p<0.01).

# Net Positions in the Repo Market (22 Sep, 2022)

## LDIs are the largest borrowers



# Net Positions in the Repo Market (22 Sep, 2022)

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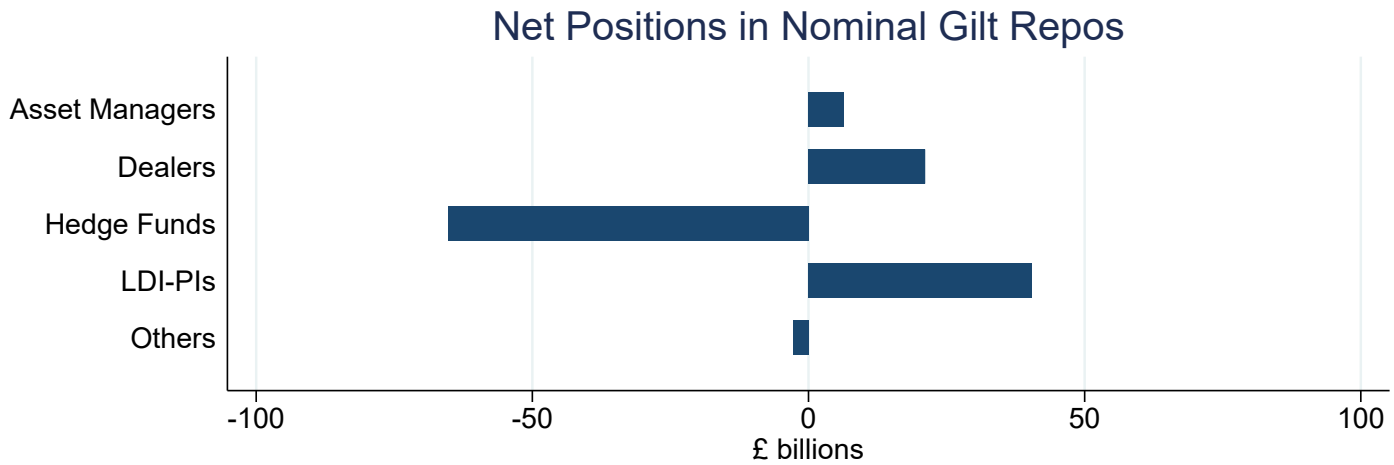
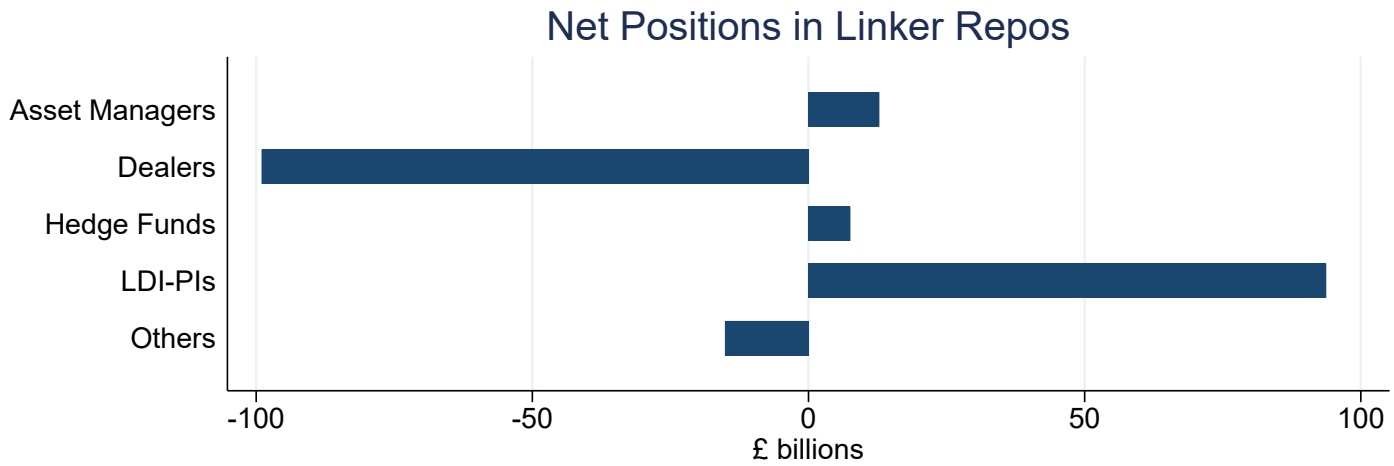
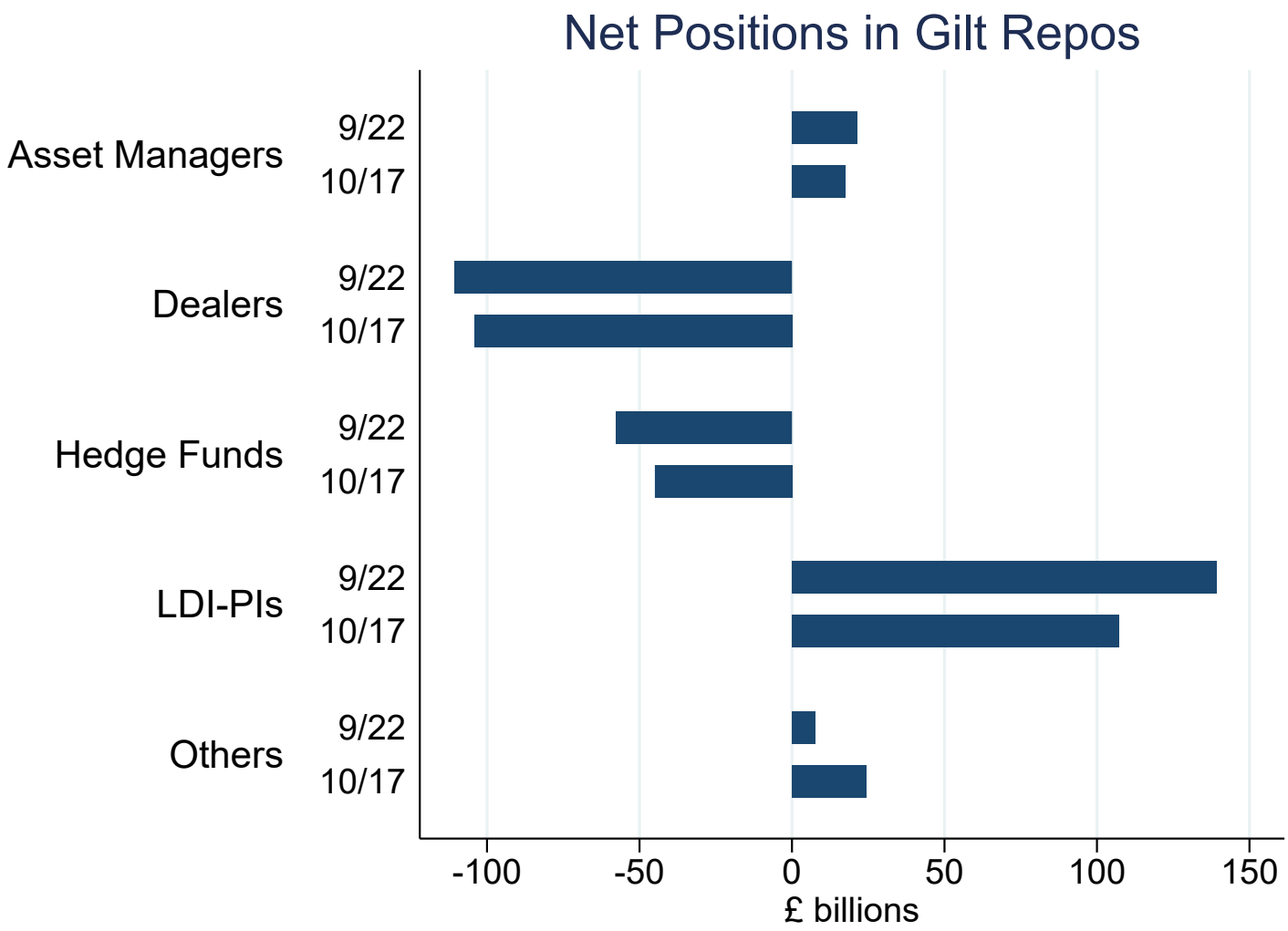


# Change in Net Repo Positions, Sep 22 - Oct 17

## LDIs cut back by more than £30 billion



# Swap or Repo Exposure Mattered More?

## Cross-sectional Regressions

- Add repo exposure (on 22 Sep), and distinguish between outstanding repo borrowing backed by (i) nominal bond or (ii) linker collateral
- Cross-sectional regression:

$$\begin{aligned} BondSales_i^{9/23-10/14} =& c + \beta_1 \times OISExposure_i^{9/22} \\ &+ \beta_2 \times RPIExposure_i^{9/22} \\ &+ \beta_3 \times RepoLinkerExposure_i^{9/22} \\ &+ \beta_4 \times RepoNomExposure_i^{9/22} \end{aligned} \tag{3.2}$$

  - where $RepoLinkerExposure_i^{9/22}$ is total borrowing backed by linkers as collateral
  - $RepoNomExposure_i^{9/22}$ is total borrowing backed by nominal gilts as collateral

# Swap or Repo Exposure Mattered More?

## Cross-sectional Regressions

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| $OISExposure_i^{9/22}$ | 0.046** | | | | | 0.014 |
| | (2.21) | | | | | (0.70) |
| $RPIExposure_i^{9/22}$ | | -0.072* | | | | -0.039 |
| | | (-1.78) | | | | (-1.08) |
| $RepoALLExposure_i^{9/22}$ | | | -0.003*** | | | |
| | | | (-8.73) | | | |
| $RepoLinkerExposure_i^{9/22}$ | | | | -0.003*** | | -0.003*** |
| | | | | (-12.27) | | (-5.19) |
| $RepoNomExposure_i^{9/22}$ | | | | | -0.019* | 0.009 |
| | | | | | (-1.80) | (1.35) |
| $N$ | 213 | 213 | 213 | 213 | 213 | 213 |
| $R^2$ | 0.122 | 0.078 | 0.228 | 0.241 | 0.078 | 0.291 |

# Swap or Repo Exposure Mattered More?

## Cross-sectional Regressions

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|---|---|---|---|---|---|---|
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| | | (-1.78) | | | | (-1.08) |
| $RepoALLExposure_i^{9/22}$ | | | -0.003*** | | | |
| | | | (-8.73) | | | |
| $RepoLinkerExposure_i^{9/22}$ | | | | **-0.003*** ** | | **-0.003*** ** |
| | | | | (-12.27) | | (-5.19) |
| $RepoNomExposure_i^{9/22}$ | | | | | -0.019* | 0.009 |
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# Trading Costs around the Crisis

## Measurement

- Measure of transaction costs (O'Hara-Zhou, 2021):

$$Cost_v = \left[\ln\left(P_v^{\star}\right) - \ln\left(\overline{P}\right)\right] \times \mathbf{1}_{B,S} \tag{4.1}$$

- Panel regression:

$$\begin{aligned} Cost_v =& \beta_1 \times D_t^{9/23-9/27} + \beta_2 \times D_t^{9/28-10/14} \\ &+ \beta_3 \times D_t^{10/17-10/28} + Size_v + \lambda_j + \delta_{i,j} + \varepsilon_v \end{aligned} \tag{4.2}$$

  - where $D$s are time dummies,
  - $\lambda_j$ are bond fixed effects
  - $\delta_{i,j}$ are client-dealer fixed effects
- Run regression 4.2 for (i) different trade sizes, (ii) dealers etc.

# Summary Statistics

| | Trade Size | Turnover | | Number of Firms | |
|---|---|---|---|---|---|
| | (£ million) | (£ billion) | % | N | % |
| Panel A: Pre-crisis (8/29-9/22) | | | | | |
| LDI & Pension | 5.22 | 3.40 | 27.5% | 97.24 | 32.6% |
| Hedge Funds | 16.45 | 4.83 | 39.0% | 39.94 | 13.4% |
| Asset Managers | 2.92 | 3.17 | 25.6% | 108.94 | 36.5% |
| Others | 3.41 | 0.99 | 8.0% | 52.53 | 17.6% |
| Panel B: Crisis (9/23-10/14) | | | | | |
| LDI & Pension | 7.33 | 7.01 | 34.8% | 125.50 | 31.7% |
| Hedge Funds | 14.67 | 6.21 | 30.8% | 51.94 | 13.1% |
| Asset Managers | 3.10 | 5.49 | 27.2% | 147.69 | 37.3% |
| Others | 2.09 | 1.46 | 7.2% | 71.00 | 17.9% |
| Panel C: Post-Crisis (10/14-10/28) | | | | | |
| LDI & Pension | 5.43 | 3.83 | 30.4% | 117.30 | 33.4% |
| Hedge Funds | 14.39 | 4.45 | 35.3% | 45.40 | 12.9% |
| Asset Managers | 2.06 | 3.10 | 24.6% | 125.80 | 35.9% |

# Trading Costs around the Crisis

## All Clients – All Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 7.400*** | 7.368*** | 5.766*** | 6.213** |
| | (3.91) | (3.87) | (2.85) | (2.41) |
| $D_t^{9/28-10/14}$ | 10.201*** | 10.108*** | 9.282*** | 9.038*** |
| | (3.58) | (3.62) | (3.59) | (4.26) |
| $D_t^{10/17-10/28}$ | 4.674* | 4.212* | 3.805 | 4.339* |
| | (1.84) | (1.70) | (1.51) | (1.76) |
| $N$ | 160161 | 160161 | 160161 | 157130 |
| $R^2$ | 0.015 | 0.018 | 0.026 | 0.101 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## All Clients – Nominal Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 7.755*** | 7.598*** | 5.889*** | 6.821*** |
| | (5.43) | (5.16) | (3.92) | (4.50) |
| $D_t^{9/28-10/14}$ | 7.885*** | 7.617*** | 6.742*** | 6.756*** |
| | (3.15) | (3.15) | (3.08) | (4.01) |
| $D_t^{10/17-10/28}$ | 5.217** | 4.468** | 4.080** | 4.813*** |
| | (2.62) | (2.31) | (2.04) | (2.83) |
| $N$ | 116018 | 116018 | 116018 | 113147 |
| $R^2$ | 0.011 | 0.016 | 0.028 | 0.113 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## All Clients – Linkers

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 4.157 | 4.542 | 3.565 | 1.392 |
| | (0.84) | (0.90) | (0.75) | (0.26) |
| $D_t^{9/28-10/14}$ | 15.460*** | 15.537*** | 15.020*** | 14.130*** |
| | (3.01) | (3.00) | (3.01) | (2.78) |
| $D_t^{10/17-10/28}$ | 3.450 | 3.501 | 3.088 | 3.251 |
| | (0.69) | (0.71) | (0.64) | (0.54) |
| $N$ | 44143 | 44143 | 44143 | 43013 |
| $R^2$ | 0.013 | 0.015 | 0.023 | 0.136 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Client Heterogeneity

Are changes in trading costs heterogeneous across client types?

# Trading Costs around the Crisis

## LDI Firms – All Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | -2.660 | -3.051 | -3.608 | 0.019 |
| | (-0.30) | (-0.35) | (-0.37) | (0.00) |
| $D_t^{9/28-10/14}$ | 8.943** | 8.763** | 8.050* | 8.891** |
| | (2.15) | (2.16) | (1.88) | (2.10) |
| $D_t^{10/17-10/28}$ | 1.029 | 1.319 | 1.244 | 3.703 |
| | (0.30) | (0.38) | (0.37) | (1.05) |
| $N$ | 45364 | 45364 | 45364 | 44156 |
| $R^2$ | 0.005 | 0.007 | 0.009 | 0.084 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## LDI Firms – Nominal Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 5.041*** | 4.961*** | 3.756 | 9.478* |
| | (3.30) | (3.14) | (1.01) | (1.70) |
| $D_t^{9/28-10/14}$ | 4.049 | 4.025 | 3.120 | 3.547 |
| | (1.00) | (0.99) | (0.82) | (1.11) |
| $D_t^{10/17-10/28}$ | -0.534 | -0.448 | -0.601 | 2.717 |
| | (-0.14) | (-0.12) | (-0.15) | (0.69) |
| $N$ | 29016 | 29016 | 29016 | 27848 |
| $R^2$ | 0.003 | 0.003 | 0.007 | 0.092 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## LDI Firms – Linkers

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | -18.376 | -19.285 | -17.959 | -16.075 |
| | (-0.87) | (-0.93) | (-0.91) | (-0.68) |
| $D_t^{9/28-10/14}$ | 17.749** | 16.840** | 17.523** | 19.928** |
| | (2.25) | (2.29) | (2.40) | (2.39) |
| $D_t^{10/17-10/28}$ | 4.011 | 4.639 | 4.693 | 6.636* |
| | (1.38) | (1.59) | (1.50) | (1.74) |
| $N$ | 16348 | 16348 | 16348 | 15756 |
| $R^2$ | 0.012 | 0.015 | 0.019 | 0.128 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Other Clients – All Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 11.691*** | 10.547*** | 7.796*** | 7.715*** |
| | (4.48) | (6.92) | (13.23) | (4.20) |
| $D_t^{9/28-10/14}$ | 21.153*** | 19.738*** | 17.421*** | 17.578*** |
| | (3.61) | (3.89) | (5.24) | (3.97) |
| $D_t^{10/17-10/28}$ | 13.138*** | 11.463*** | 10.511*** | 11.294*** |
| | (3.61) | (3.73) | (5.23) | (4.62) |
| $N$ | 27370 | 27370 | 27370 | 26209 |
| $R^2$ | 0.083 | 0.098 | 0.109 | 0.231 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Other Clients – Nominal Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 9.791*** | 8.259*** | 5.280*** | 5.646*** |
| | (7.35) | (5.22) | (5.85) | (4.94) |
| $D_t^{9/28-10/14}$ | 17.889*** | 16.191*** | 13.732*** | 14.102*** |
| | (3.57) | (3.73) | (4.11) | (3.49) |
| $D_t^{10/17-10/28}$ | 11.286*** | 9.541*** | 8.490*** | 8.411*** |
| | (3.84) | (3.91) | (4.37) | (3.42) |
| $N$ | 22520 | 22520 | 22520 | 21450 |
| $R^2$ | 0.082 | 0.102 | 0.121 | 0.232 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Other Clients – Linkers

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 14.776 | 17.529* | 14.227** | 4.033 |
| | (1.52) | (1.84) | (2.52) | (0.35) |
| $D_t^{9/28-10/14}$ | 34.169*** | 35.311*** | 31.918*** | 24.655*** |
| | (3.01) | (3.23) | (5.08) | (2.93) |
| $D_t^{10/17-10/28}$ | 20.977** | 20.202*** | 16.660*** | 16.920*** |
| | (2.62) | (2.82) | (5.19) | (3.62) |
| $N$ | 4850 | 4850 | 4850 | 4574 |
| $R^2$ | 0.041 | 0.054 | 0.071 | 0.290 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Hedge Funds – All Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 13.279** | 13.205*** | 13.561*** | 12.682** |
| | (2.66) | (2.75) | (2.92) | (2.33) |
| $D_t^{9/28-10/14}$ | -0.025 | 0.191 | 0.168 | -0.442 |
| | (-0.01) | (0.09) | (0.09) | (-0.17) |
| $D_t^{10/17-10/28}$ | -3.873 | -3.870 | -4.524 | -5.000 |
| | (-0.53) | (-0.52) | (-0.57) | (-0.55) |
| $N$ | 18633 | 18633 | 18633 | 18499 |
| $R^2$ | 0.075 | 0.075 | 0.079 | 0.116 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Hedge Funds – Nominal Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | -0.345 | -0.037 | 0.615 | 0.291 |
| | (-0.06) | (-0.01) | (0.11) | (0.07) |
| $D_t^{9/28-10/14}$ | 0.584 | 0.916 | 1.257 | 1.196 |
| | (0.41) | (0.68) | (0.96) | (0.74) |
| $D_t^{10/17-10/28}$ | 4.628*** | 4.974*** | 4.825*** | 4.095** |
| | (2.85) | (3.02) | (2.94) | (2.31) |
| $N$ | 12654 | 12654 | 12654 | 12537 |
| $R^2$ | 0.019 | 0.020 | 0.023 | 0.080 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Hedge Funds – Linkers

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 56.712*** | 56.200*** | 55.694*** | 49.591*** |
| | (8.71) | (9.22) | (9.93) | (6.44) |
| $D_t^{9/28-10/14}$ | -3.785 | -3.384 | -4.932 | -6.738 |
| | (-0.50) | (-0.44) | (-0.69) | (-0.84) |
| $D_t^{10/17-10/28}$ | -20.615 | -21.227 | -22.887 | -28.015 |
| | (-1.37) | (-1.36) | (-1.40) | (-1.55) |
| $N$ | 5979 | 5979 | 5979 | 5901 |
| $R^2$ | 0.085 | 0.087 | 0.098 | 0.140 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Asset Managers – All Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 9.167*** | 9.265*** | 9.484*** | 8.271** |
| | (2.77) | (2.72) | (3.22) | (2.51) |
| $D_t^{9/28-10/14}$ | 7.822** | 8.006** | 9.097*** | 8.759*** |
| | (2.65) | (2.68) | (3.16) | (3.70) |
| $D_t^{10/17-10/28}$ | 4.765* | 4.522* | 5.602** | 5.050* |
| | (1.92) | (1.81) | (2.02) | (1.91) |
| $N$ | 68794 | 68794 | 68794 | 68196 |
| $R^2$ | 0.013 | 0.015 | 0.025 | 0.085 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Asset Managers – Nominal Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 9.390*** | 9.440*** | 8.958*** | 8.615*** |
| | (3.44) | (3.40) | (3.67) | (3.62) |
| $D_t^{9/28-10/14}$ | 6.052** | 6.128** | 6.626*** | 6.665*** |
| | (2.65) | (2.64) | (2.87) | (3.43) |
| $D_t^{10/17-10/28}$ | 4.570** | 4.152* | 4.759* | 4.786* |
| | (2.05) | (1.85) | (1.87) | (1.84) |
| $N$ | 51828 | 51828 | 51828 | 51275 |
| $R^2$ | 0.009 | 0.012 | 0.025 | 0.097 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Asset Managers – Linkers

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 6.236 | 6.572 | 7.758 | -1.251 |
| | (0.97) | (1.01) | (1.21) | (-0.16) |
| $D_t^{9/28-10/14}$ | 12.523** | 12.693** | 14.998** | 13.466** |
| | (2.09) | (2.04) | (2.51) | (2.54) |
| $D_t^{10/17-10/28}$ | 5.295 | 5.420 | 7.682 | 6.302 |
| | (1.04) | (1.04) | (1.46) | (1.09) |
| $N$ | 16966 | 16966 | 16966 | 16760 |
| $R^2$ | 0.012 | 0.015 | 0.032 | 0.114 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Dealer Heterogeneity

Are changes in trading costs heterogeneous across dealer size?

# Trading Costs around the Crisis

## Small Dealers – All Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 10.923*** | 10.486*** | 8.437*** | 7.281*** |
| | (5.06) | (5.34) | (7.27) | (3.23) |
| $D_t^{9/28-10/14}$ | 16.783*** | 16.571*** | 15.451*** | 14.004*** |
| | (4.46) | (4.93) | (5.48) | (4.88) |
| $D_t^{10/17-10/28}$ | 10.098*** | 9.875*** | 9.444*** | 9.045*** |
| | (3.41) | (3.63) | (3.61) | (3.43) |
| $N$ | 54827 | 54827 | 54827 | 53745 |
| $R^2$ | 0.041 | 0.051 | 0.062 | 0.143 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Large Dealers – All Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 4.933 | 4.883 | 4.795 | 6.213 |
| | (1.42) | (1.40) | (1.26) | (1.42) |
| $D_t^{9/28-10/14}$ | 6.645** | 6.659** | 6.491** | 6.980*** |
| | (2.39) | (2.39) | (2.26) | (2.98) |
| $D_t^{10/17-10/28}$ | 1.325 | 1.415 | 1.404 | 2.344 |
| | (0.48) | (0.51) | (0.50) | (0.82) |
| $N$ | 105334 | 105334 | 105334 | 103385 |
| $R^2$ | 0.010 | 0.010 | 0.011 | 0.082 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Small Dealers – Nominal Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 11.229*** | 10.445*** | 8.709*** | 8.818*** |
| | (8.03) | (6.43) | (5.74) | (4.22) |
| $D_t^{9/28-10/14}$ | 15.578*** | 15.131*** | 13.928*** | 13.812*** |
| | (4.65) | (5.13) | (5.56) | (5.85) |
| $D_t^{10/17-10/28}$ | 10.191*** | 9.642*** | 9.170*** | 9.676*** |
| | (4.34) | (4.33) | (4.09) | (5.00) |
| $N$ | 40367 | 40367 | 40367 | 39370 |
| $R^2$ | 0.048 | 0.067 | 0.080 | 0.177 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Large Dealers – Nominal Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 4.843*** | 4.840*** | 4.512** | 6.227** |
| | (2.97) | (2.94) | (2.35) | (2.63) |
| $D_t^{9/28-10/14}$ | 3.455 | 3.455 | 3.192 | 3.327** |
| | (1.63) | (1.63) | (1.51) | (2.10) |
| $D_t^{10/17-10/28}$ | 1.743 | 1.753 | 1.697 | 2.592 |
| | (0.85) | (0.84) | (0.81) | (1.29) |
| $N$ | 75651 | 75651 | 75651 | 73777 |
| $R^2$ | 0.003 | 0.003 | 0.005 | 0.084 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Small Dealers – Linkers

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 5.056 | 5.968 | 3.229 | -1.089 |
| | (0.71) | (0.86) | (0.60) | (-0.15) |
| $D_t^{9/28-10/14}$ | 18.781*** | 19.172*** | 18.149*** | 15.558** |
| | (3.27) | (3.38) | (3.16) | (2.31) |
| $D_t^{10/17-10/28}$ | 9.362 | 9.973 | 8.223 | 7.443 |
| | (1.38) | (1.50) | (1.28) | (0.92) |
| $N$ | 14460 | 14460 | 14460 | 14047 |
| $R^2$ | 0.023 | 0.028 | 0.040 | 0.160 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Large Dealers – Linkers

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 3.919 | 3.809 | 4.089 | 2.840 |
| | (0.34) | (0.33) | (0.36) | (0.24) |
| $D_t^{9/28-10/14}$ | 14.171** | 13.785** | 14.126** | 14.114** |
| | (2.27) | (2.21) | (2.27) | (2.36) |
| $D_t^{10/17-10/28}$ | 0.926 | 0.895 | 1.061 | 1.495 |
| | (0.18) | (0.18) | (0.21) | (0.27) |
| $N$ | 29683 | 29683 | 29683 | 28966 |
| $R^2$ | 0.013 | 0.014 | 0.015 | 0.124 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Bond Heterogeneity

Are changes in trading costs heterogeneous across bond maturity?

# Trading Costs around the Crisis

## 0-10 Year Maturity – All Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 5.676*** | 5.441*** | 3.747*** | 4.027*** |
| | (9.84) | (10.71) | (6.49) | (6.11) |
| $D_t^{9/28-10/14}$ | 8.198*** | 7.843*** | 7.493*** | 8.121*** |
| | (5.08) | (5.41) | (5.99) | (6.16) |
| $D_t^{10/17-10/28}$ | 5.641*** | 4.851*** | 4.945*** | 5.647*** |
| | (5.86) | (5.52) | (4.95) | (5.33) |
| $N$ | 68288 | 68288 | 68288 | 65832 |
| $R^2$ | 0.059 | 0.099 | 0.181 | 0.298 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## 10-25 Year Maturity – All Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 5.313 | 5.406 | 4.145 | 5.394 |
| | (1.21) | (1.24) | (0.94) | (1.33) |
| $D_t^{9/28-10/14}$ | 8.233*** | 8.358*** | 7.585** | 7.428*** |
| | (2.75) | (2.77) | (2.68) | (3.21) |
| $D_t^{10/17-10/28}$ | 4.249 | 3.793 | 3.561 | 4.252 |
| | (1.44) | (1.32) | (1.27) | (1.65) |
| $N$ | 44772 | 44772 | 44772 | 43074 |
| $R^2$ | 0.007 | 0.010 | 0.026 | 0.130 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## >25 Year Maturity – All Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 12.002*** | 11.889*** | 10.251*** | 11.388 |
| | (3.40) | (3.28) | (2.82) | (1.54) |
| $D_t^{9/28-10/14}$ | 13.935** | 13.770** | 11.309** | 10.892** |
| | (2.45) | (2.42) | (2.11) | (2.29) |
| $D_t^{10/17-10/28}$ | 3.722 | 3.534 | 1.832 | 2.994 |
| | (0.63) | (0.60) | (0.31) | (0.45) |
| $N$ | 47101 | 47101 | 47101 | 45585 |
| $R^2$ | 0.012 | 0.013 | 0.020 | 0.131 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

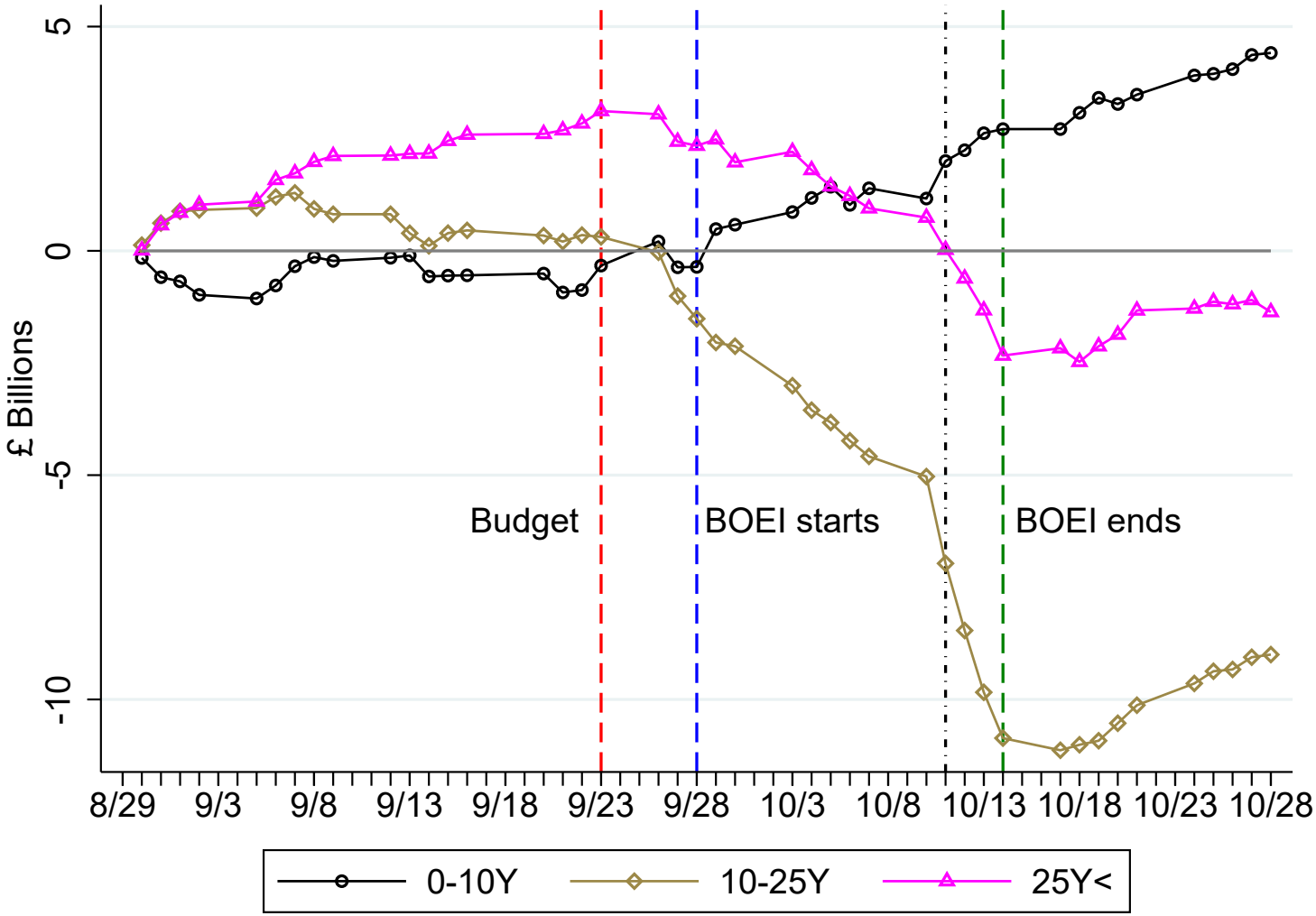
# Trading Costs around the Crisis

## 0-10 Year Maturity – Nominal Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 5.507*** | 5.220*** | 3.530*** | 3.678*** |
| | (7.61) | (7.61) | (4.95) | (4.32) |
| $D_t^{9/28-10/14}$ | 7.763*** | 7.269*** | 6.805*** | 7.243*** |
| | (4.70) | (4.93) | (5.25) | (5.33) |
| $D_t^{10/17-10/28}$ | 4.749*** | 3.905*** | 3.901*** | 4.419*** |
| | (5.63) | (5.02) | (3.93) | (4.16) |
| $N$ | 57024 | 57024 | 57024 | 54795 |
| $R^2$ | 0.067 | 0.107 | 0.192 | 0.319 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Recall: no LDI selling pressure in short-dated nominals

## Yet, trading costs rise!



# Trading Costs around the Crisis

## 10-25 Year Maturity – Nominal Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 8.868*** | 8.816*** | 8.049*** | 10.353*** |
| | (3.23) | (3.18) | (2.92) | (3.54) |
| $D_t^{9/28-10/14}$ | 5.655** | 5.673** | 5.211* | 5.494** |
| | (2.04) | (2.04) | (1.97) | (2.54) |
| $D_t^{10/17-10/28}$ | 5.528** | 4.799* | 4.862* | 5.555** |
| | (2.02) | (1.83) | (1.78) | (2.20) |
| $N$ | 31132 | 31132 | 31132 | 29657 |
| $R^2$ | 0.005 | 0.010 | 0.025 | 0.136 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## >25 Year Maturity – Nominal Bonds

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 12.012*** | 12.010*** | 9.285*** | 14.094*** |
| | (4.52) | (4.30) | (2.80) | (2.89) |
| $D_t^{9/28-10/14}$ | 10.430* | 10.323* | 7.058 | 7.745** |
| | (1.93) | (1.94) | (1.52) | (2.09) |
| $D_t^{10/17-10/28}$ | 5.973 | 5.318 | 3.256 | 5.739 |
| | (1.26) | (1.15) | (0.69) | (1.40) |
| $N$ | 27862 | 27862 | 27862 | 26561 |
| $R^2$ | 0.009 | 0.011 | 0.022 | 0.155 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## 0-10 Year Maturity – Linkers

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 4.852*** | 5.138*** | 4.521** | 4.392*** |
| | (3.24) | (3.13) | (2.18) | (4.45) |
| $D_t^{9/28-10/14}$ | 10.492*** | 11.666*** | 12.382*** | 14.347*** |
| | (5.69) | (5.61) | (6.07) | (5.50) |
| $D_t^{10/17-10/28}$ | 10.674*** | 10.732*** | 10.954*** | 13.618*** |
| | (3.47) | (3.47) | (3.59) | (3.59) |
| $N$ | 11264 | 11264 | 11264 | 10621 |
| $R^2$ | 0.037 | 0.090 | 0.191 | 0.346 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## 10-25 Year Maturity – Linkers

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | -6.600 | -5.949 | -8.191 | -10.105 |
| | (-0.68) | (-0.62) | (-0.83) | (-1.39) |
| $D_t^{9/28-10/14}$ | 14.221*** | 14.492*** | 13.503*** | 12.058*** |
| | (2.98) | (3.00) | (2.98) | (2.82) |
| $D_t^{10/17-10/28}$ | 1.486 | 1.510 | 1.018 | 2.514 |
| | (0.38) | (0.38) | (0.29) | (0.73) |
| $N$ | 13640 | 13640 | 13640 | 12922 |
| $R^2$ | 0.010 | 0.012 | 0.032 | 0.201 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## >25 Year Maturity – Linkers

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $D_t^{9/23-9/27}$ | 12.188* | 11.295 | 10.421 | 1.828 |
| | (1.85) | (1.68) | (1.62) | (0.19) |
| $D_t^{9/28-10/14}$ | 19.082** | 18.088** | 15.976* | 12.759 |
| | (2.18) | (2.05) | (1.80) | (1.28) |
| $D_t^{10/17-10/28}$ | 1.086 | 0.720 | -0.518 | -3.912 |
| | (0.11) | (0.08) | (-0.06) | (-0.30) |
| $N$ | 19239 | 19239 | 19239 | 18465 |
| $R^2$ | 0.010 | 0.012 | 0.017 | 0.168 |
| Bond FE | Yes | Yes | Yes | Yes |
| Size FE | No | Yes | Yes | Yes |
| Dealer FE | No | No | Yes | No |
| Client#Dealer FE | No | No | No | Yes |

# Trading Costs around the Crisis

## Size Heterogeneity

Are changes in trading costs heterogeneous across trade sizes?

# Trading Costs around the Crisis

## Small Trades (<£100,000) – All Bonds

| | (1) | (2) | (3) |
|---|---|---|---|
| $D_t^{9/23-9/27}$ | 19.021*** | 14.543*** | 14.092** |
| | (5.58) | (3.95) | (2.64) |
| $D_t^{9/28-10/14}$ | 16.909*** | 15.377*** | 14.320*** |
| | (4.08) | (4.42) | (3.81) |
| $D_t^{10/17-10/28}$ | 12.145*** | 12.083*** | 12.209*** |
| | (3.16) | (3.15) | (3.26) |
| $N$ | 54416 | 54416 | 53231 |
| $R^2$ | 0.039 | 0.069 | 0.170 |
| Bond FE | Yes | Yes | Yes |
| Dealer FE | No | Yes | No |
| Client#Dealer FE | No | No | Yes |

# Trading Costs around the Crisis

## Small Trades (<£100,000) – Nominal Bonds

| | (1) | (2) | (3) |
|---|---|---|---|
| $D_t^{9/23-9/27}$ | 17.201*** | 12.279** | 11.294*** |
| | (3.51) | (2.59) | (2.78) |
| $D_t^{9/28-10/14}$ | 15.651*** | 14.192*** | 12.562*** |
| | (4.17) | (4.62) | (3.69) |
| $D_t^{10/17-10/28}$ | 11.840*** | 11.647*** | 10.500*** |
| | (4.52) | (4.31) | (4.32) |
| $N$ | 39137 | 39137 | 38198 |
| $R^2$ | 0.047 | 0.098 | 0.207 |
| Bond FE | Yes | Yes | Yes |
| Dealer FE | No | Yes | No |
| Client#Dealer FE | No | No | Yes |

# Trading Costs around the Crisis

## Small Trades (<£100,000) – Linkers

| | (1) | (2) | (3) |
|---|---|---|---|
| $D_t^{9/23-9/27}$ | 16.011** | 16.605*** | 21.353** |
| | (2.64) | (2.74) | (2.40) |
| $D_t^{9/28-10/14}$ | 17.871** | 16.592** | 16.423** |
| | (2.64) | (2.67) | (2.57) |
| $D_t^{10/17-10/28}$ | 12.140 | 10.829 | 12.018 |
| | (1.20) | (1.08) | (1.09) |
| $N$ | 15279 | 15279 | 14781 |
| $R^2$ | 0.025 | 0.053 | 0.204 |
| Bond FE | Yes | Yes | Yes |
| Dealer FE | No | Yes | No |
| Client#Dealer FE | No | No | Yes |

# Trading Costs around the Crisis

## Medium Trades (£100,000-£1,000,000) – All Bonds

| | (1) | (2) | (3) |
|---|---|---|---|
| $D_t^{9/23-9/27}$ | 1.920 | 0.800 | 1.714 |
| | (0.24) | (0.10) | (0.31) |
| $D_t^{9/28-10/14}$ | 5.428 | 4.864 | 4.398 |
| | (1.45) | (1.32) | (1.54) |
| $D_t^{10/17-10/28}$ | -0.024 | -0.553 | -0.611 |
| | (-0.01) | (-0.17) | (-0.23) |
| $N$ | 44054 | 44053 | 42154 |
| $R^2$ | 0.006 | 0.009 | 0.124 |
| Bond FE | Yes | Yes | Yes |
| Dealer FE | No | Yes | No |
| Client#Dealer FE | No | No | Yes |

# Trading Costs around the Crisis

## Medium Trades (£100,000-£1,000,000) – Nominal Bonds

| | (1) | (2) | (3) |
|---|---|---|---|
| $D_t^{9/23-9/27}$ | 6.377* | 5.236 | 7.068** |
| | (1.79) | (1.56) | (2.35) |
| $D_t^{9/28-10/14}$ | 4.901 | 4.208 | 5.127* |
| | (1.37) | (1.23) | (1.90) |
| $D_t^{10/17-10/28}$ | -0.221 | -0.598 | -0.115 |
| | (-0.06) | (-0.18) | (-0.04) |
| $N$ | 31634 | 31633 | 30035 |
| $R^2$ | 0.006 | 0.011 | 0.138 |
| Bond FE | Yes | Yes | Yes |
| Dealer FE | No | Yes | No |
| Client#Dealer FE | No | No | Yes |

# Trading Costs around the Crisis

## Medium Trades (£100,000-£1,000,000) – Linkers

| | (1) | (2) | (3) |
|---|---|---|---|
| $D_t^{9/23-9/27}$ | -10.754 | -11.482 | -17.444 |
| | (-0.50) | (-0.55) | (-1.24) |
| $D_t^{9/28-10/14}$ | 6.871 | 6.651 | -1.386 |
| | (1.14) | (1.11) | (-0.26) |
| $D_t^{10/17-10/28}$ | 0.743 | 0.321 | -1.433 |
| | (0.16) | (0.07) | (-0.28) |
| $N$ | 12420 | 12420 | 11681 |
| $R^2$ | 0.007 | 0.011 | 0.181 |
| Bond FE | Yes | Yes | Yes |
| Dealer FE | No | Yes | No |
| Client#Dealer FE | No | No | Yes |

# Trading Costs around the Crisis

## Large Trades (>£1,000,000) – All Bonds

| | (1) | (2) | (3) |
|---|---|---|---|
| $D_t^{9/23-9/27}$ | 1.226 | 1.927 | 2.911 |
| | (0.62) | (0.85) | (0.57) |
| $D_t^{9/28-10/14}$ | 7.793*** | 7.897*** | 7.744*** |
| | (3.29) | (3.30) | (4.22) |
| $D_t^{10/17-10/28}$ | -0.136 | -0.263 | 0.130 |
| | (-0.06) | (-0.12) | (0.06) |
| $N$ | 61691 | 61691 | 59839 |
| $R^2$ | 0.019 | 0.021 | 0.102 |
| Bond FE | Yes | Yes | Yes |
| Dealer FE | No | Yes | No |
| Client#Dealer FE | No | No | Yes |

# Trading Costs around the Crisis

## Large Trades (>£1,000,000) – Nominal Bonds

| | (1) | (2) | (3) |
|---|---|---|---|
| $D_t^{9/23-9/27}$ | 0.446 | 0.766 | 3.143 |
| | (0.13) | (0.22) | (0.92) |
| $D_t^{9/28-10/14}$ | 3.234 | 3.222 | 2.907** |
| | (1.55) | (1.54) | (2.13) |
| $D_t^{10/17-10/28}$ | 1.817 | 1.628 | 2.847* |
| | (0.96) | (0.84) | (1.81) |
| $N$ | 45247 | 45247 | 43450 |
| $R^2$ | 0.006 | 0.007 | 0.107 |
| Bond FE | Yes | Yes | Yes |
| Dealer FE | No | Yes | No |
| Client#Dealer FE | No | No | Yes |

# Trading Costs around the Crisis

## Large Trades (>£1,000,000) – Linkers

| | (1) | (2) | (3) |
|---|---|---|---|
| $D_t^{9/23-9/27}$ | 4.892 | 5.877 | -1.306 |
| | (0.82) | (1.05) | (-0.11) |
| $D_t^{9/28-10/14}$ | 20.075*** | 20.100*** | 21.717*** |
| | (3.88) | (3.82) | (3.52) |
| $D_t^{10/17-10/28}$ | -2.720 | -2.657 | -2.679 |
| | (-0.65) | (-0.58) | (-0.45) |
| $N$ | 16444 | 16444 | 15769 |
| $R^2$ | 0.026 | 0.030 | 0.149 |
| Bond FE | Yes | Yes | Yes |
| Dealer FE | No | Yes | No |
| Client#Dealer FE | No | No | Yes |

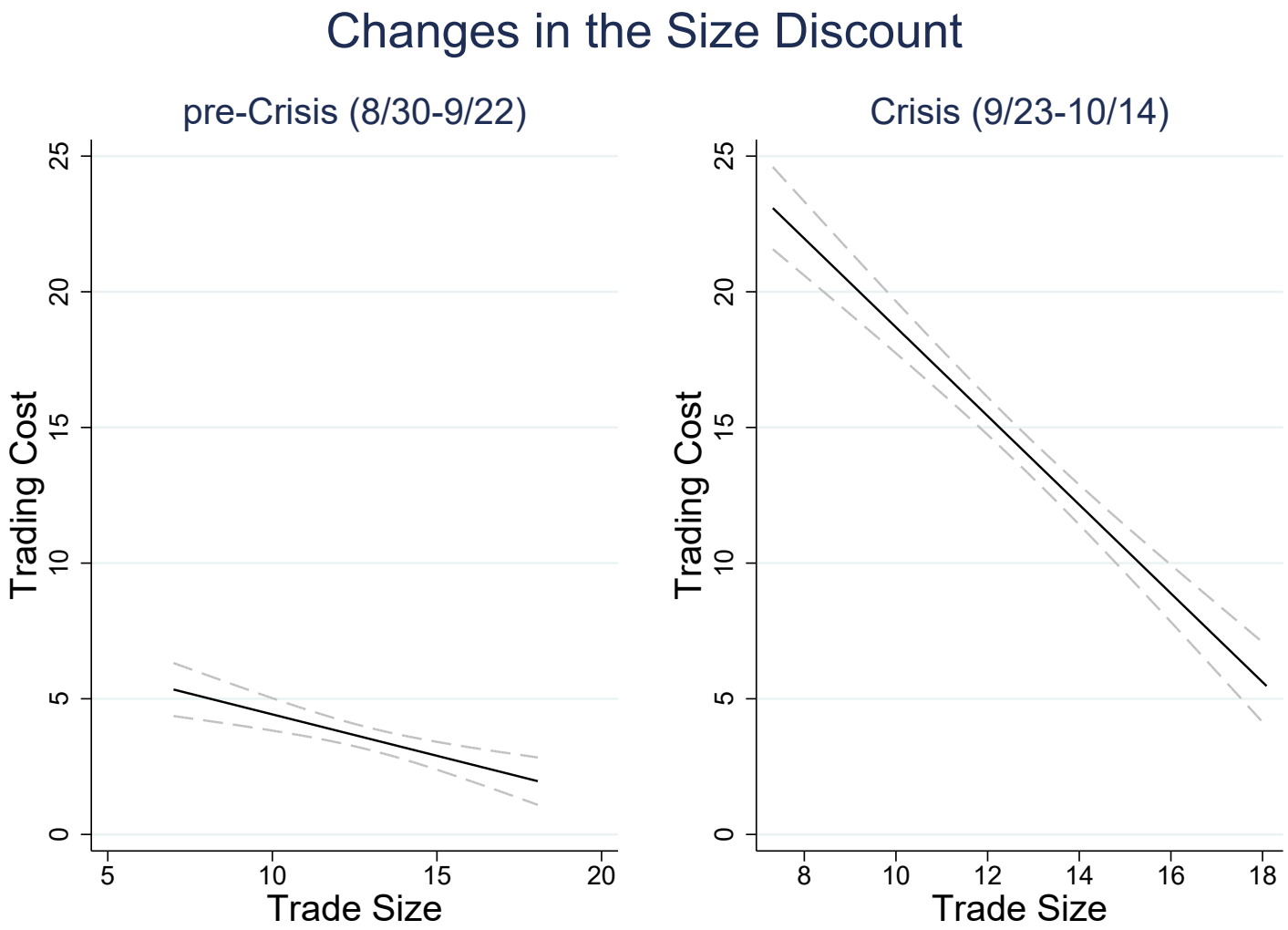
# Trading Costs around the Crisis

## Size Heterogeneity

How do the size penalty and size discount change?
(Pinter-Wang-Zou, 2022)

# Size Discount Increases

## Cross-client Relationship between trade size and trading costs



# Size Penalty Increases

## Within-client Relationship between trade size and trading costs

# Outline

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# Trading Costs around the Crisis

## Did relationships mitigate cost hikes?

- Did trading relationships mitigate (client-specific) cost hikes? (Di Maggio et al (2017), Jurkatis-Schrimpf-Todorov-Vause (2022))

# Trading Costs around the Crisis

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# Trading Costs around the Crisis

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- Favorite dealer: defined as the dealer with which a client traded the most before the crisis
- Favorite clients: defined as the top 3 clients with which a dealer traded the most before the crisis

# Trading Costs around the Crisis

## Did relationships mitigate cost hikes?

- Did trading relationships mitigate (client-specific) cost hikes? (Di Maggio et al (2017), Jurkatis-Schrimpf-Todorov-Vause (2022))
- Favorite dealer: defined as the dealer with which a client traded the most before the crisis
- Favorite clients: defined as the top 3 clients with which a dealer traded the most before the crisis
- Did trading costs increase by less if the given trade was with (i) the favorite dealer, or with (ii) favorite clients?

# Trading Costs around the Crisis

## The Role of Favorite Dealers

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | All Bonds | | Nominal Bonds | | Linkers | |
| Dealer type | Other | Favorite | Other | Favorite | Other | Favorite |
| $D_t^{9/23-9/27}$ | 9.648** | -1.261 | 10.486*** | -0.418 | 5.418 | -9.356 |
| | (2.61) | (-0.24) | (3.89) | (-0.17) | (0.80) | (-0.88) |
| $D_t^{9/28-10/14}$ | 6.660*** | 15.098*** | 4.189** | 11.914*** | 12.841** | 22.285*** |
| | (2.87) | (4.69) | (2.33) | (3.58) | (2.60) | (2.89) |
| $N$ | 91231 | 30295 | 64528 | 23617 | 26000 | 6552 |
| $R^2$ | 0.106 | 0.150 | 0.104 | 0.170 | 0.150 | 0.201 |
| Bond FE | Yes | Yes | Yes | Yes | Yes | Yes |
| CL#DE FE | Yes | Yes | Yes | Yes | Yes | Yes |

# Trading Costs around the Crisis

## The Role of Favorite Clients

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | All Bonds | | Nominal Bonds | | Linkers | |
| Client type | Other | Favorite | Other | Favorite | Other | Favorite |
| $D_t^{9/23-9/27}$ | 10.641** | -15.513 | 10.476*** | -11.929 | 8.086 | -21.180 |
| | (2.71) | (-0.83) | (3.78) | (-1.12) | (0.90) | (-0.53) |
| $D_t^{9/28-10/14}$ | 9.798*** | 4.561 | 7.716*** | 0.462 | 14.838*** | 14.962 |
| | (4.88) | (0.92) | (4.65) | (0.15) | (3.07) | (1.05) |
| $N$ | 101697 | 19829 | 74474 | 13671 | 26396 | 6156 |
| $R^2$ | 0.130 | 0.043 | 0.137 | 0.051 | 0.179 | 0.065 |
| Bond FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Bond FE | Yes | Yes | Yes | Yes | Yes | Yes |

# Did The Entire Trade Network Change during the Crisis?

- Construct 2 snapshots of the gilt market trading network: pre-crisis (09/01 – 09/22) and crisis (09/23 – 10/14)

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- nodes: clients and dealers participating in the market
  - to illustrate the importance of firms, the size of nodes captures the first-order connections of the given firm
- edges: determined by transactions

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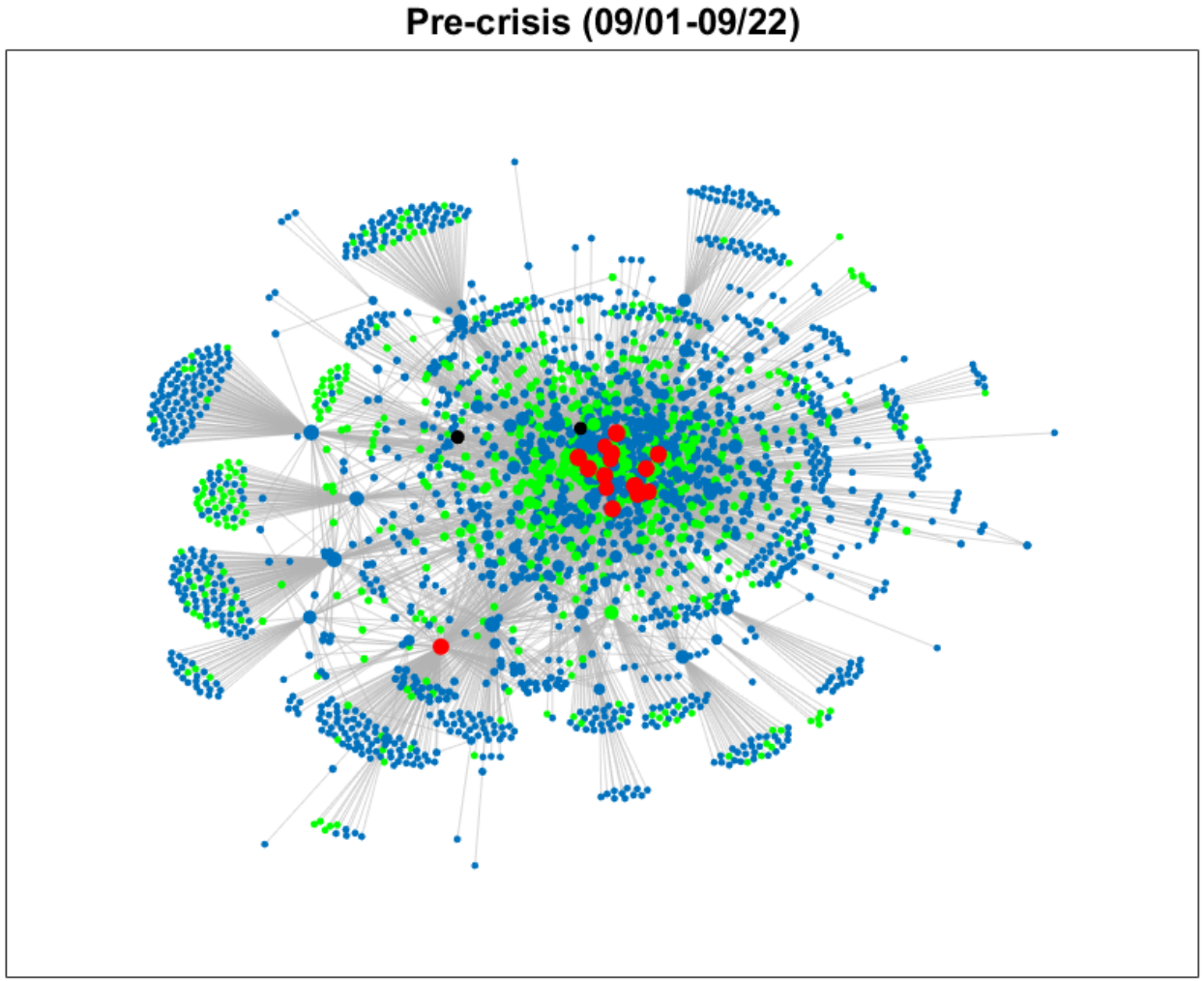
- Construct 2 snapshots of the gilt market trading network: pre-crisis (09/01 – 09/22) and crisis (09/23 – 10/14)
- nodes: clients and dealers participating in the market
  - to illustrate the importance of firms, the size of nodes captures the first-order connections of the given firm
- edges: determined by transactions
- colour scheme: dealers = red; two biggest LDI sellers = black, all other LDIs = green, all other clients = blue
- take-aways: in the crisis (i) network becomes denser, (ii) new (local) hubs appear (non-LDIs as centers)

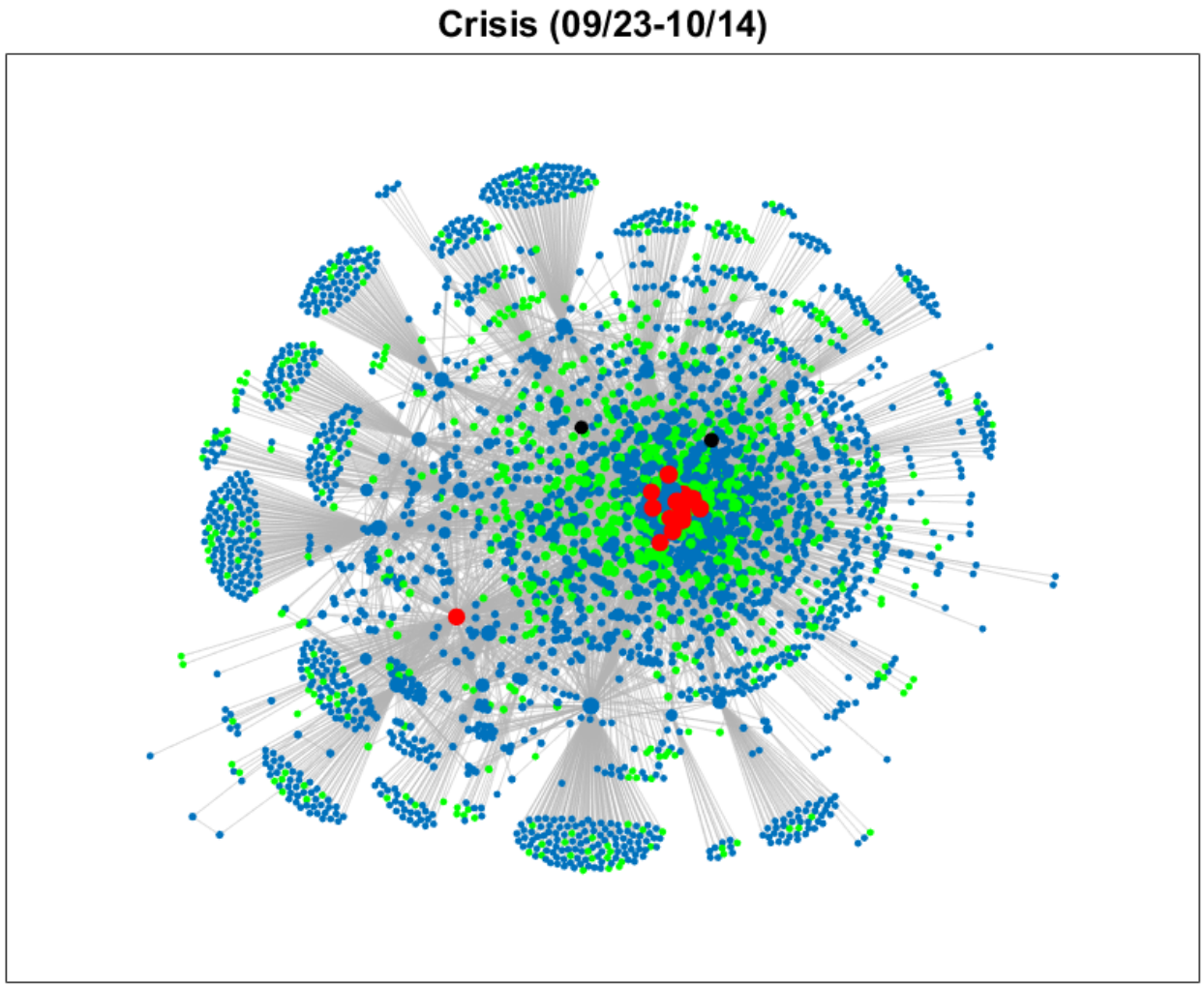
# Trade Network Before the Crisis

## Dealers (red), Two Largest LDIs (black), Other LDIs (green)



# Trade Network During the Crisis

## Dealers (red), Two Largest LDIs (black), Other LDIs (green)



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# Price Dispersion around the Crisis

## A Measure of Liquidity

- Price dispersion as a measure of market liquidity (Jankowitsch-Nashikkar-Subrahmanyam, 2011):

$$D = \sqrt{\frac{1}{N}\sum_{v}^{N}\left(\ln\left(P_v^{\star}\right) - \ln\left(\overline{P}\right)\right)^2} \tag{6.1}$$

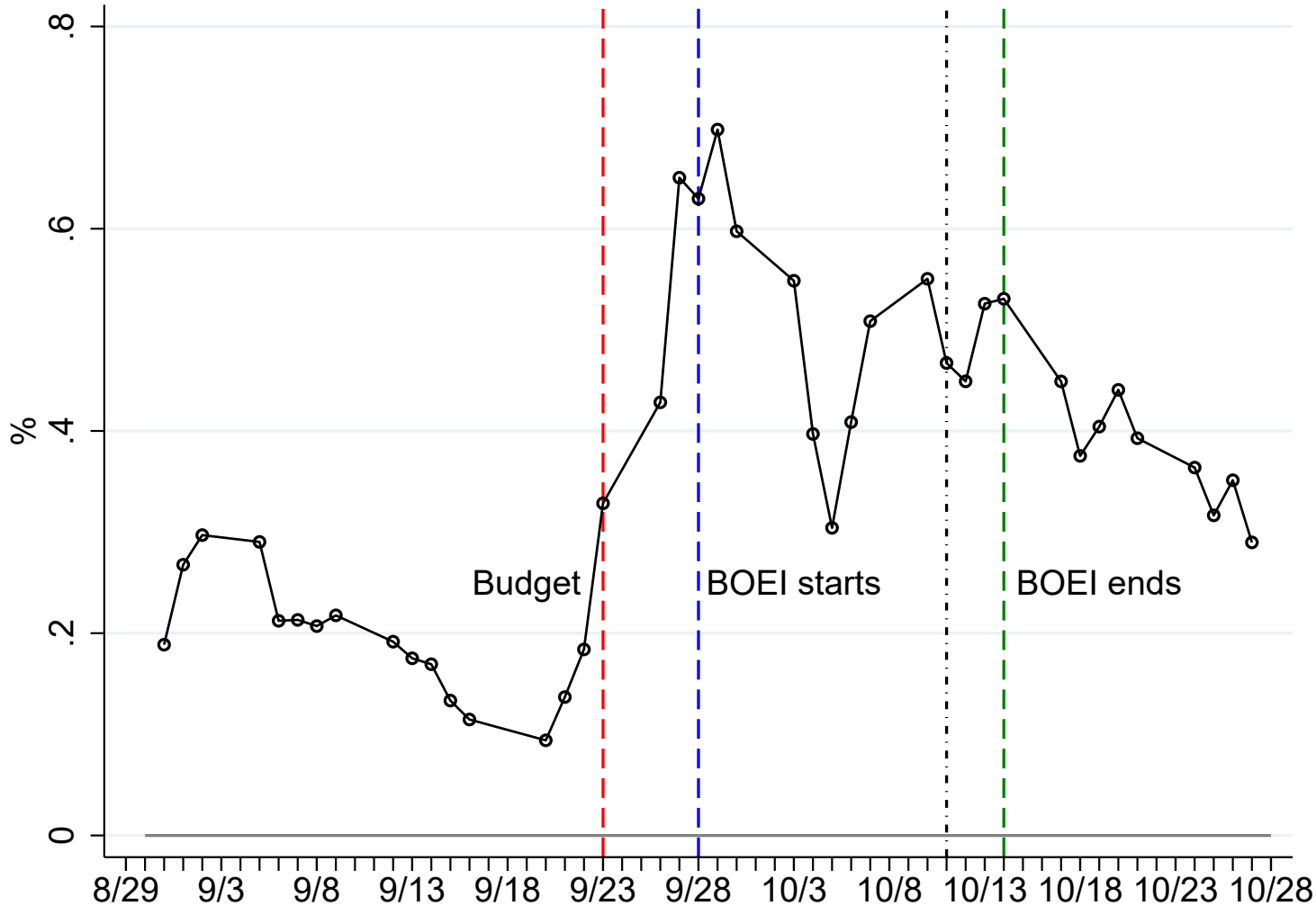
- Using dealer IDs, we can decompose 6.1:

$$D^2 = D^2_{within-dealer} + D^2_{cross-dealer} \tag{6.2}$$

- document the estimated measures 6.1–6.2 for (i) different periods around the crisis, and for (ii) nominals and linkers

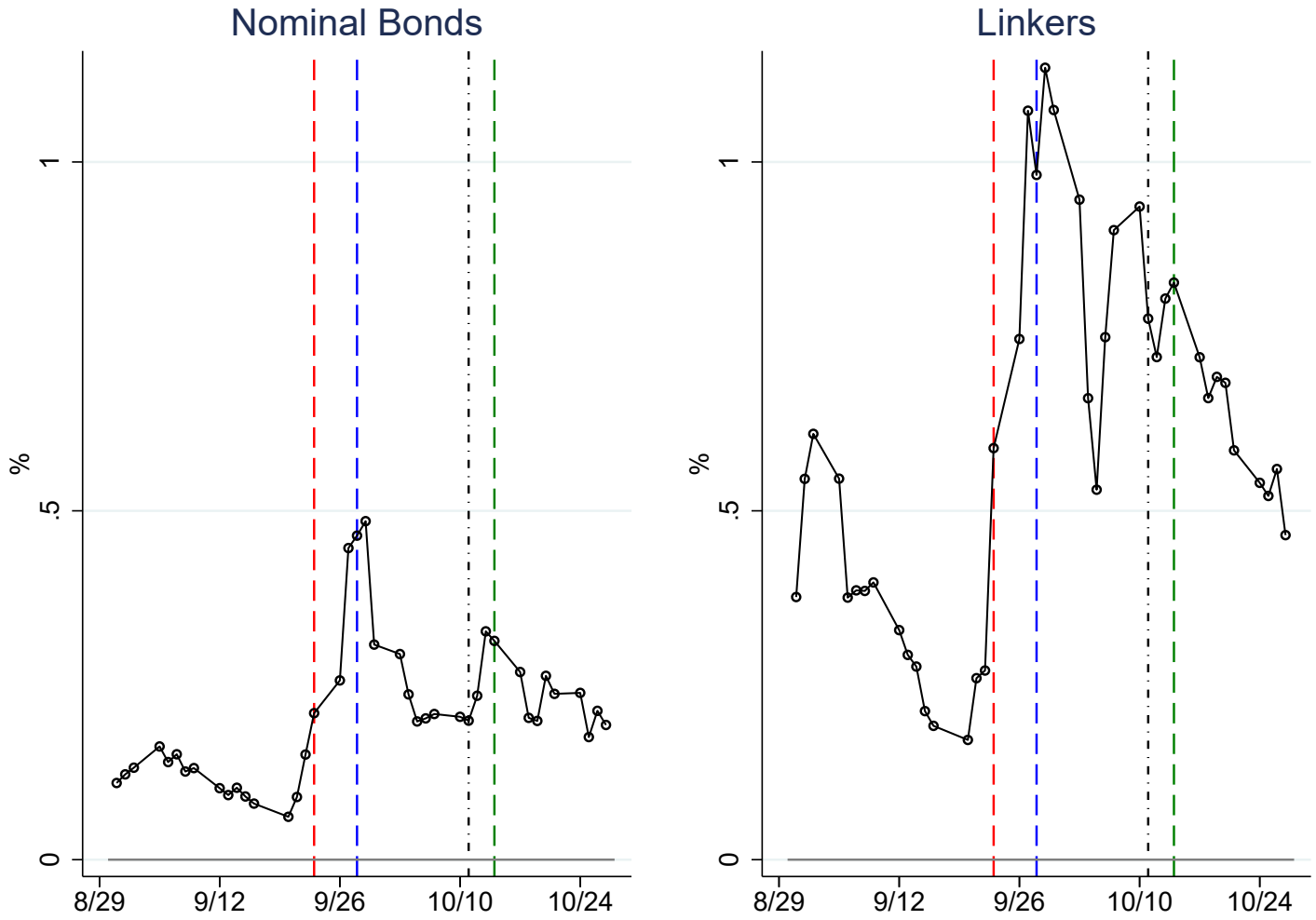
# Elevated Price Dispersion

## Measured as standard deviation; All Bonds



# Larger Price Dispersion in Linkers

## Measured as standard deviation; Nominals vs Linkers



# Price Dispersion During the Crisis

## Hourly Benchmark Price

| | Pre-crisis (8/30-9/22) | | Crisis (9/23-10/14) | | Post-Crisis (10/17-10/28) | |
|---|---|---|---|---|---|---|
| | Variance | % | Variance | % | Variance | % |
| Panel A: All Bonds | | | | | | |
| Cross-Dealer | 0.02885 | 68.2% | 0.15415 | 48.8% | 0.08139 | 60.8% |
| Within-Dealer | 0.01343 | 31.8% | 0.16164 | 51.2% | 0.05255 | 39.2% |
| Total Dispersion | 0.04228 | 100.0% | 0.31579 | 100.0% | 0.13393 | 100.0% |
| Panel B: Nominal Bonds | | | | | | |
| Cross-Dealer | 0.00986 | 62.6% | 0.06895 | 55.5% | 0.02389 | 50.9% |
| Within-Dealer | 0.00588 | 37.4% | 0.05518 | 44.5% | 0.0231 | 49.2% |
| Total Dispersion | 0.01574 | 100.0% | 0.12413 | 100.0% | 0.04698 | 100.0% |
| Panel C: Linkers | | | | | | |
| Cross-Dealer | 0.09719 | 70.5% | 0.39582 | 46.1% | 0.2352 | 64.2% |
| Within-Dealer | 0.04062 | 29.5% | 0.46363 | 53.9% | 0.13131 | 35.8% |
| Total Dispersion | 0.13782 | 100.0% | 0.85945 | 100.0% | 0.36651 | 100.0% |

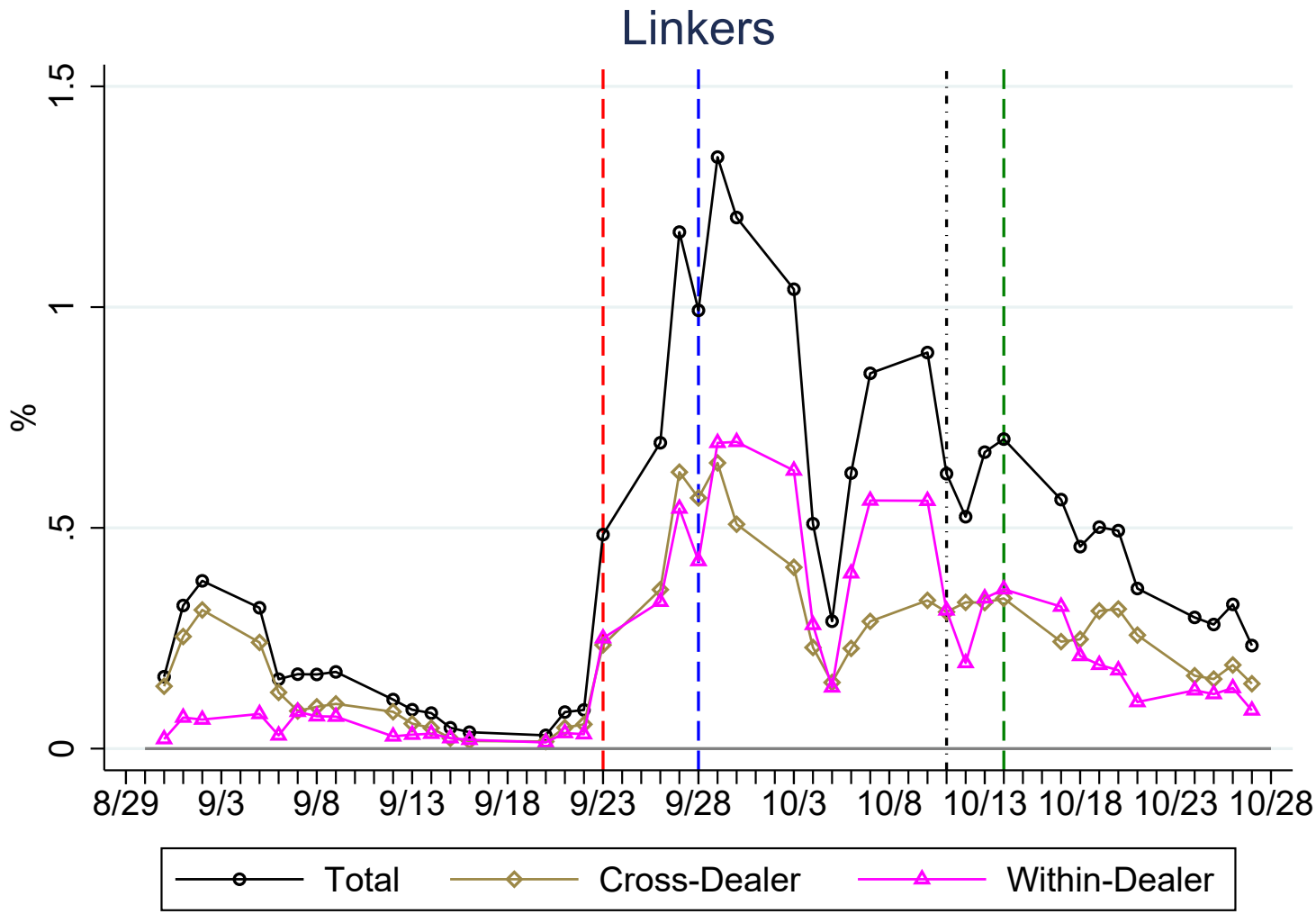
# Price Dispersion During the Crisis

## Daily Benchmark Price

| | Pre-crisis (8/30-9/22) | | Crisis (9/23-10/14) | | Post-Crisis (10/17-10/28) | |
|---|---|---|---|---|---|---|
| | Variance | % | Variance | % | Variance | % |
| Panel A: All Bonds | | | | | | |
| Cross-Dealer | 0.19804 | 48.4% | 2.2683 | 38.1% | 0.54075 | 40.1% |
| Within-Dealer | 0.21077 | 51.6% | 3.69194 | 61.9% | 0.80736 | 59.9% |
| Total Dispersion | 0.40881 | 100.0% | 5.96025 | 100.0% | 1.34811 | 100.0% |
| Panel B: Nominal Bonds | | | | | | |
| Cross-Dealer | 0.07886 | 41.7% | 0.52313 | 32.6% | 0.11666 | 38.9% |
| Within-Dealer | 0.11038 | 58.3% | 1.08103 | 67.4% | 0.18327 | 61.1% |
| Total Dispersion | 0.18924 | 100.0% | 1.60415 | 100.0% | 0.29993 | 100.0% |
| Panel C: Linkers | | | | | | |
| Cross-Dealer | 0.57783 | 52.1% | 6.8085 | 39.4% | 1.58404 | 40.3% |
| Within-Dealer | 0.53067 | 47.9% | 10.48444 | 60.6% | 2.34268 | 59.7% |
| Total Dispersion | 1.10850 | 100.0% | 17.29294 | 100.0% | 3.92672 | 100.0% |

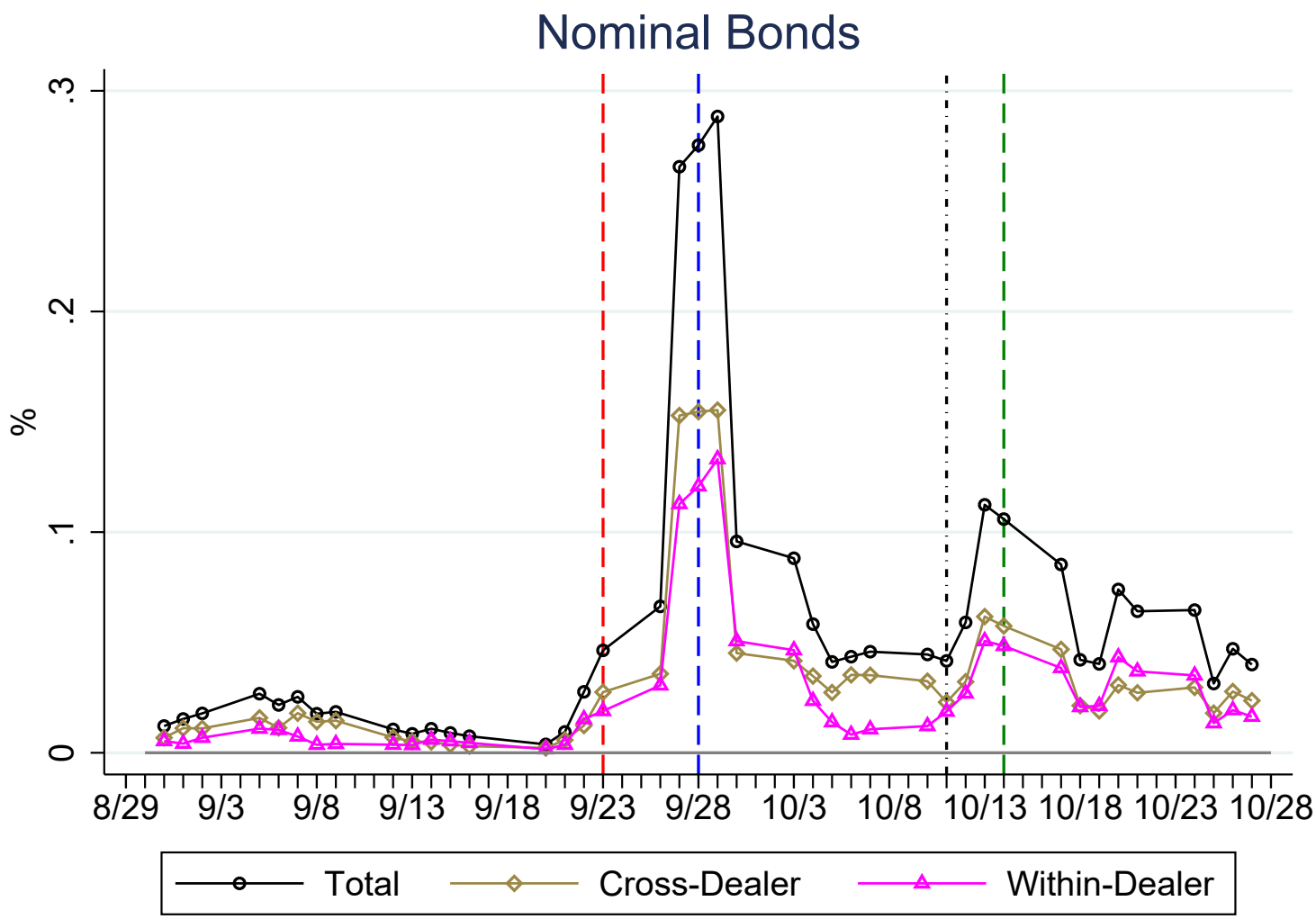
# Cross-Dealer Component is Sizeable

## Measured as variance; Linkers



# Cross-Dealer Component is Sizeable

## Measured as variance; Nominals



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# Hedge Fund Trading around the Crisis

## Measurement

- Measure of trading performance (Di Maggio et al, 2018; Kondor-Pinter, 2022):

$$\Pi_h = \left[\ln\left(\overline{P}_{t+h}\right) - \ln\left(P_t^{\star}\right)\right] \times \mathbf{1}_{B,S} \tag{7.1}$$

- where $\overline{P}_{t+h}$ is the benchmark price $h$ days after transaction
- compute the estimated measure 7.1 for hedge funds; compute for $h = \{1, 3, 6\}$
  - unweighted mean
  - mean weighted by trade size
  - median

# Hedge Fund Trading around the Crisis

## Example

- Apply our measure of trading performance:

$$\Pi_h = \left[\ln\left(\overline{P}_{t+h}\right) - \ln\left(P_t^{\star}\right)\right] \times \mathbf{1}_{B,S} \tag{7.2}$$

- Take the 22mar2046 linker on 28 September 2022:
  - at 8am a star hedge fund bought £100.8million at £49
  - at 1pm, this bond was trading at around £83

# Hedge Fund Trading around the Crisis

## Example

- Apply our measure of trading performance:

$$\Pi_h = \left[\ln\left(\overline{P}_{t+h}\right) - \ln\left(P_t^\star\right)\right] \times \mathbf{1}_{B,S} \tag{7.2}$$

- Take the 22mar2046 linker on 28 September 2022:
  - at 8am a star hedge fund bought £100.8million at £49
  - at 1pm, this bond was trading at around £83
- Plug in the values

$$\begin{aligned}\Pi_h &= \left[\ln\left(\overline{P}_{t+h}\right) - \ln\left(P_t^\star\right)\right] \times \mathbf{1}_{B,S} \\ &= \left[\ln\left(83\right) - \ln\left(49\right)\right] \times \mathbf{1}_{B,S} \\ &\approx 53\%\end{aligned}$$

so the 5-hour log return is 53% (arithmetic return is 69%)

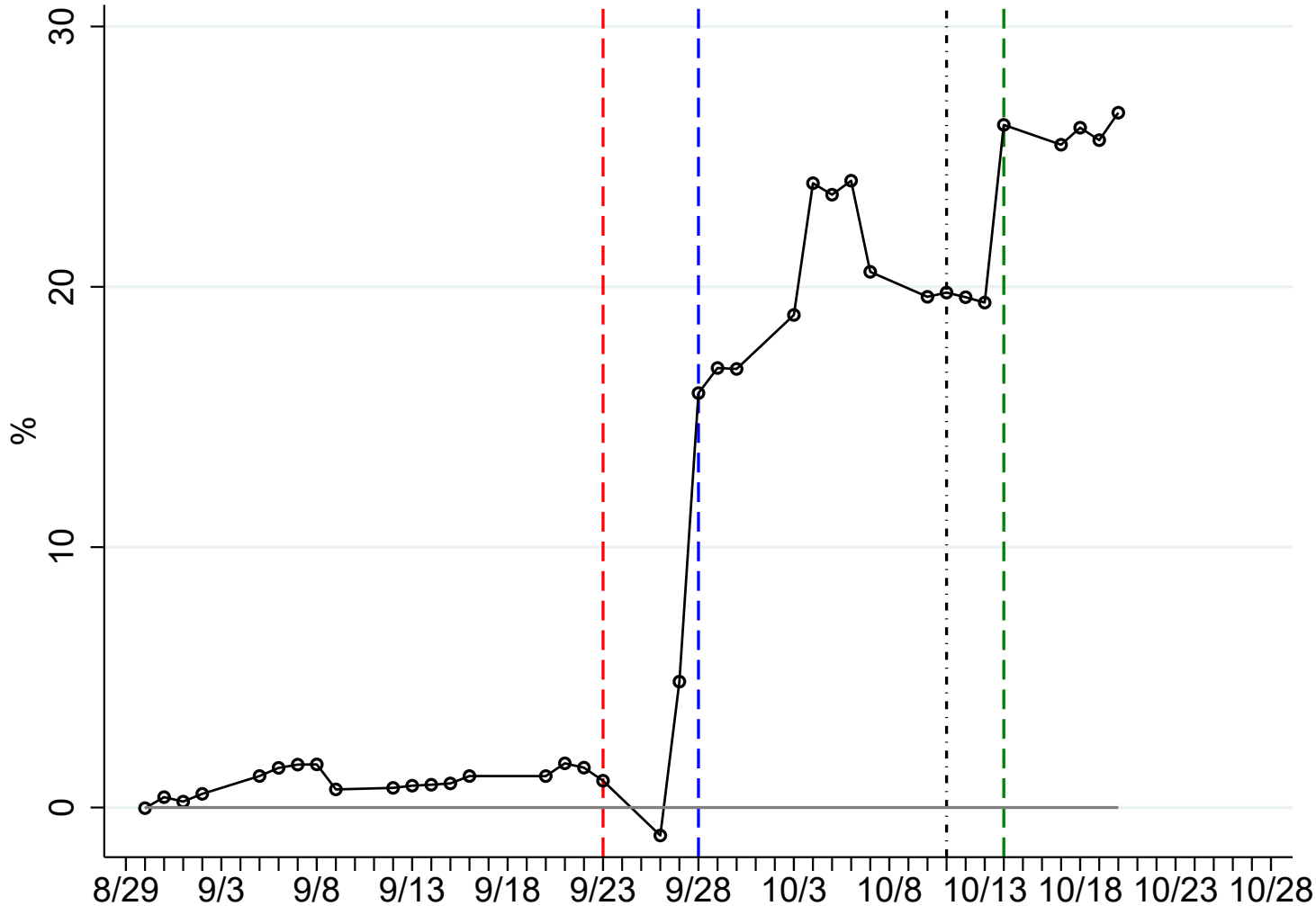
# Hedge Fund Trading around the Crisis

## Hedge Fund Returns

Did hedge funds profit from the forced selling of LDIs?

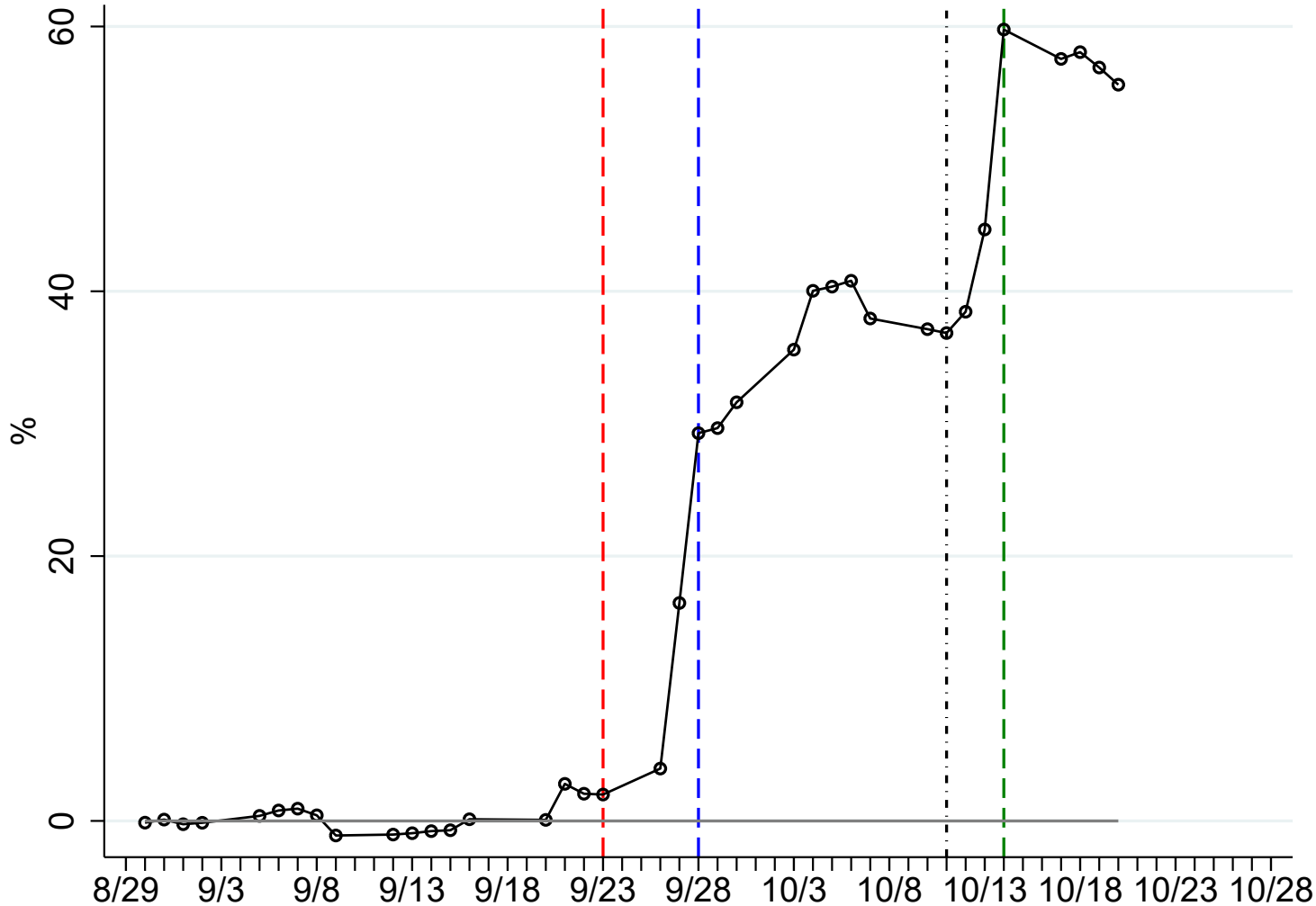
# Cumulative Hedge Fund Returns

## 1-day Horizon; Unweighted Mean



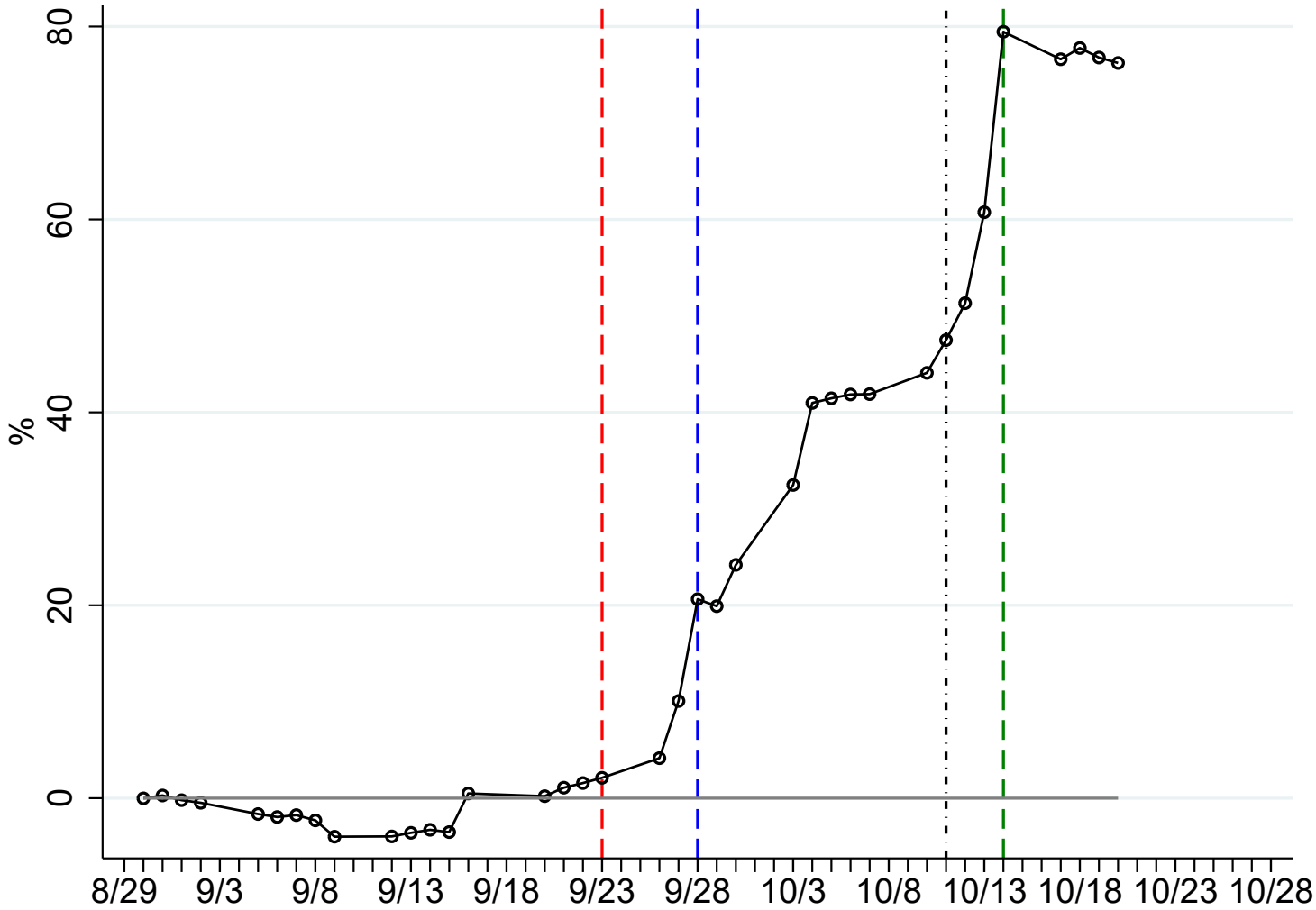
# Cumulative Hedge Fund Returns

## 3-day Horizon; Unweighted Mean



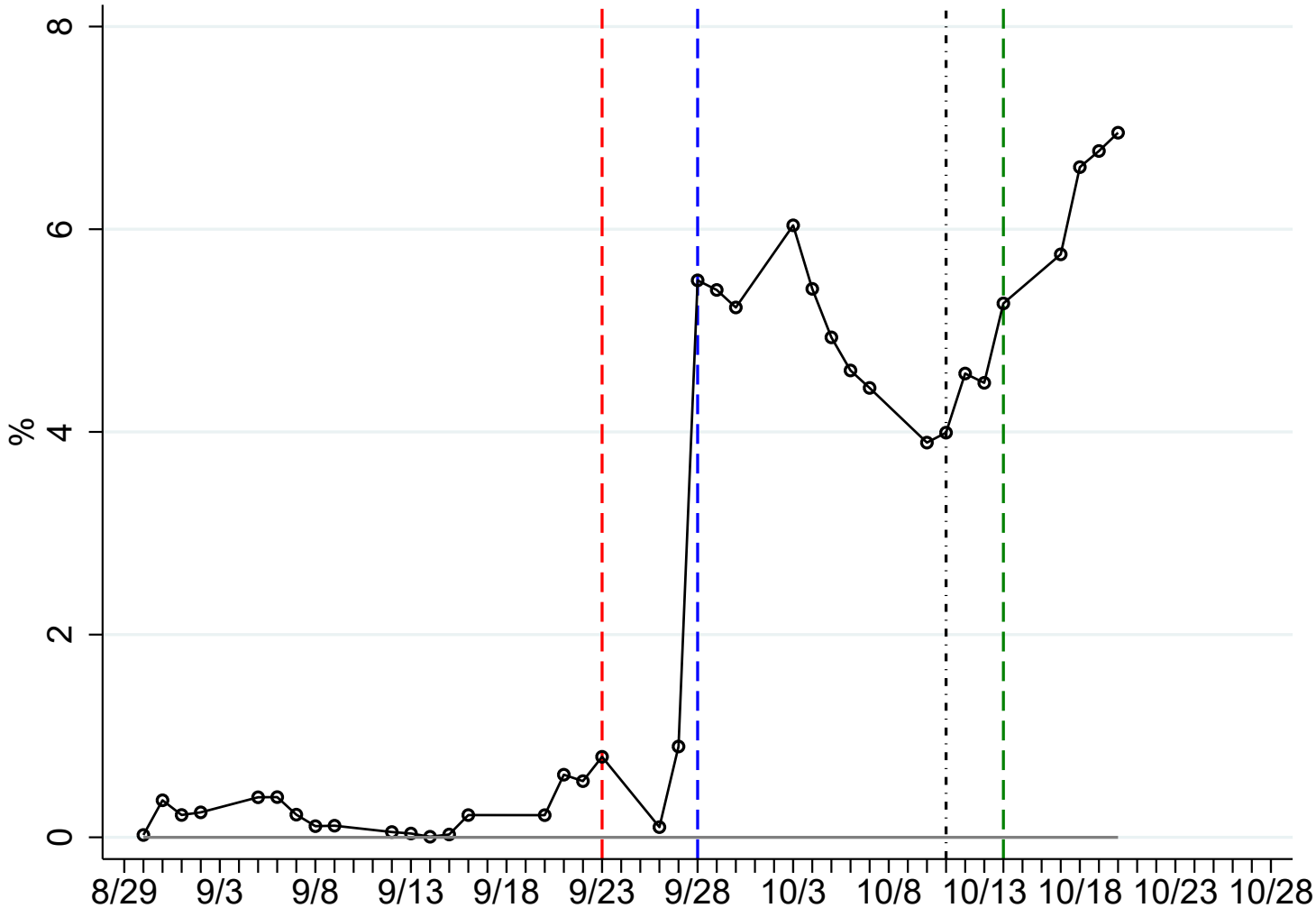
# Cumulative Hedge Fund Returns

## 6-day Horizon; Unweighted Mean



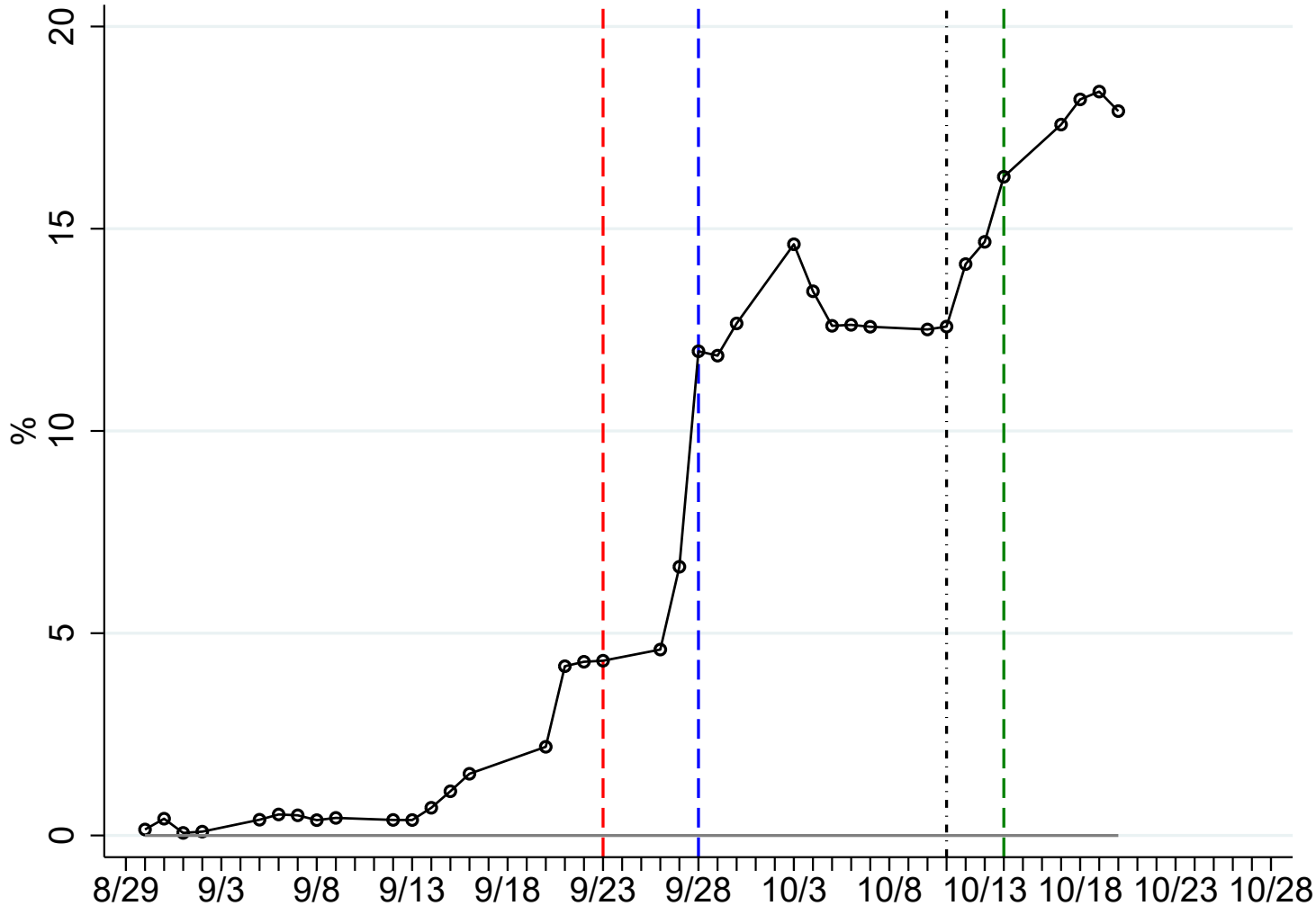
# Cumulative Hedge Fund Returns

## 1-day Horizon; Weighted Mean



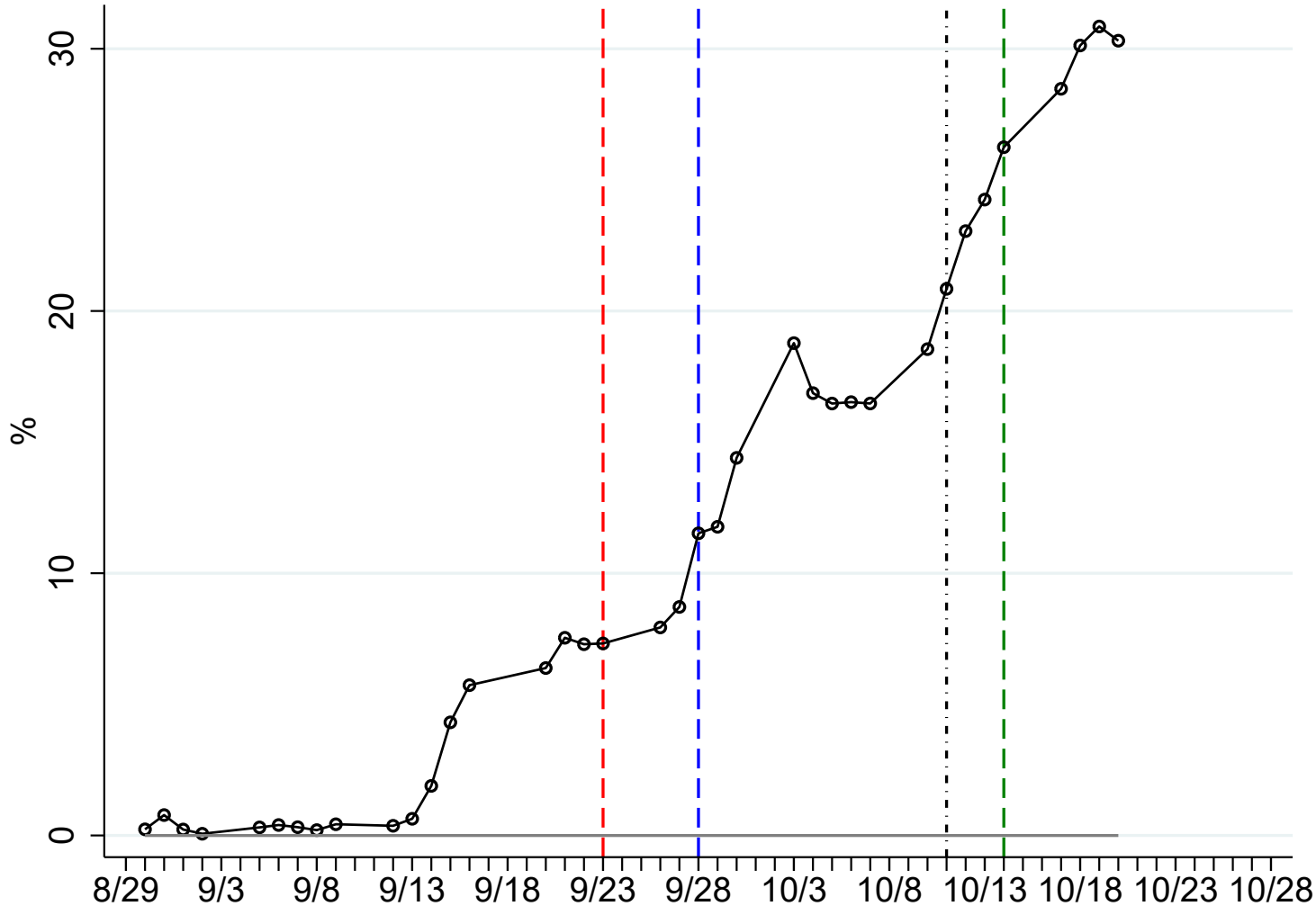
# Cumulative Hedge Fund Returns

## 3-day Horizon; Weighted Mean



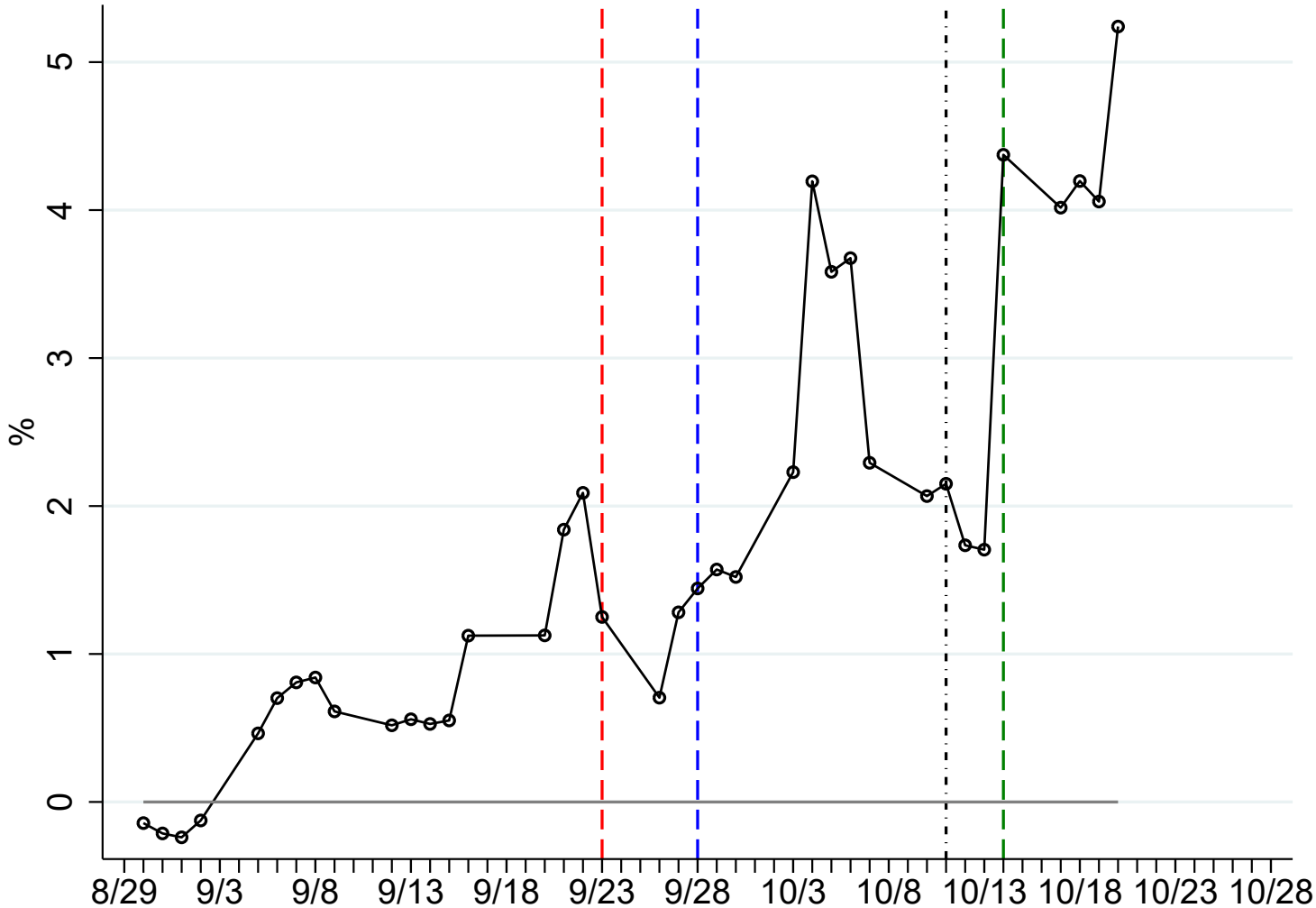
# Cumulative Hedge Fund Returns

## 6-day Horizon; Weighted Mean



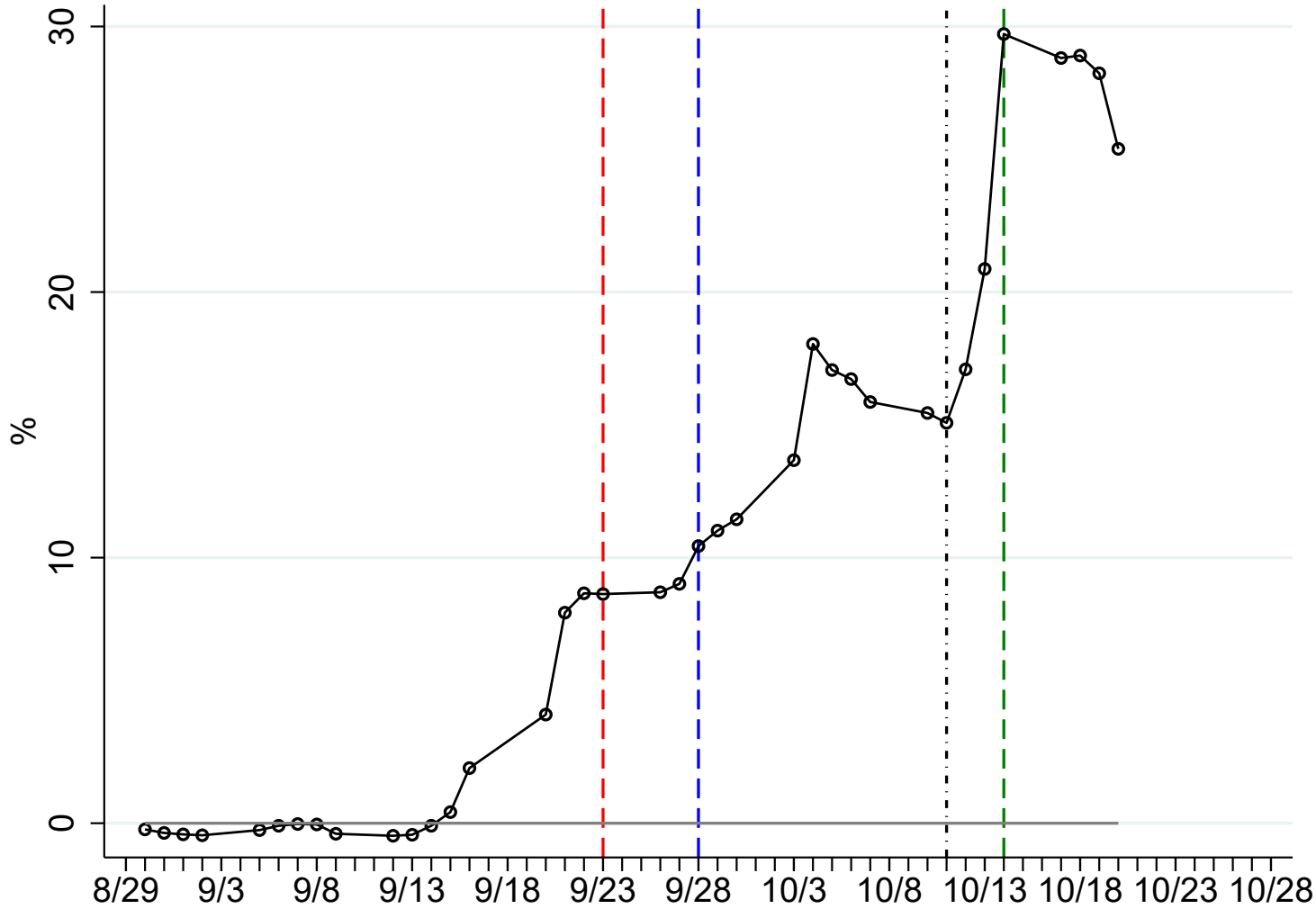
# Cumulative Hedge Fund Returns

## 1-day Horizon; Median



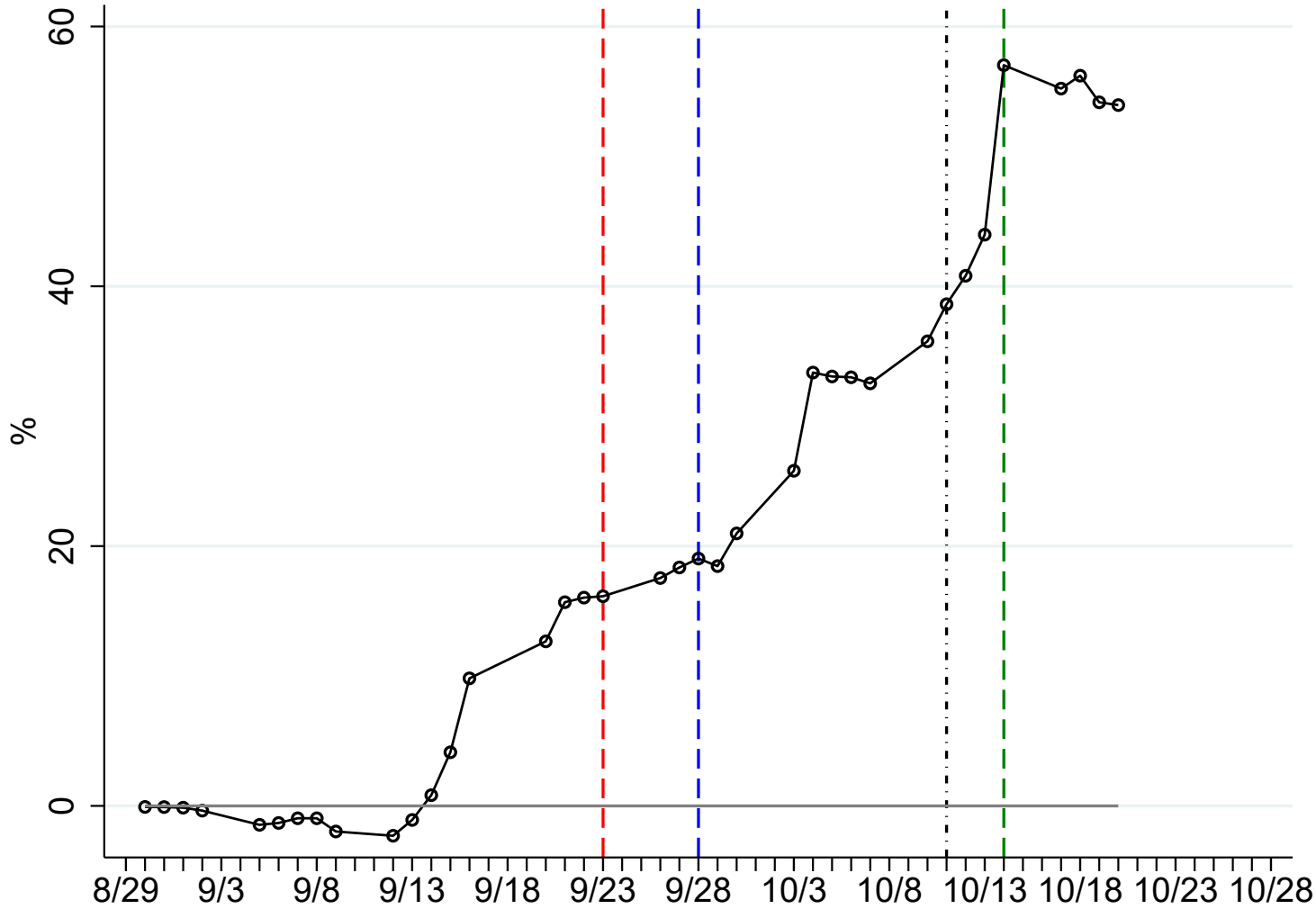
# Cumulative Hedge Fund Returns

## 3-day Horizon; Median



# Cumulative Hedge Fund Returns

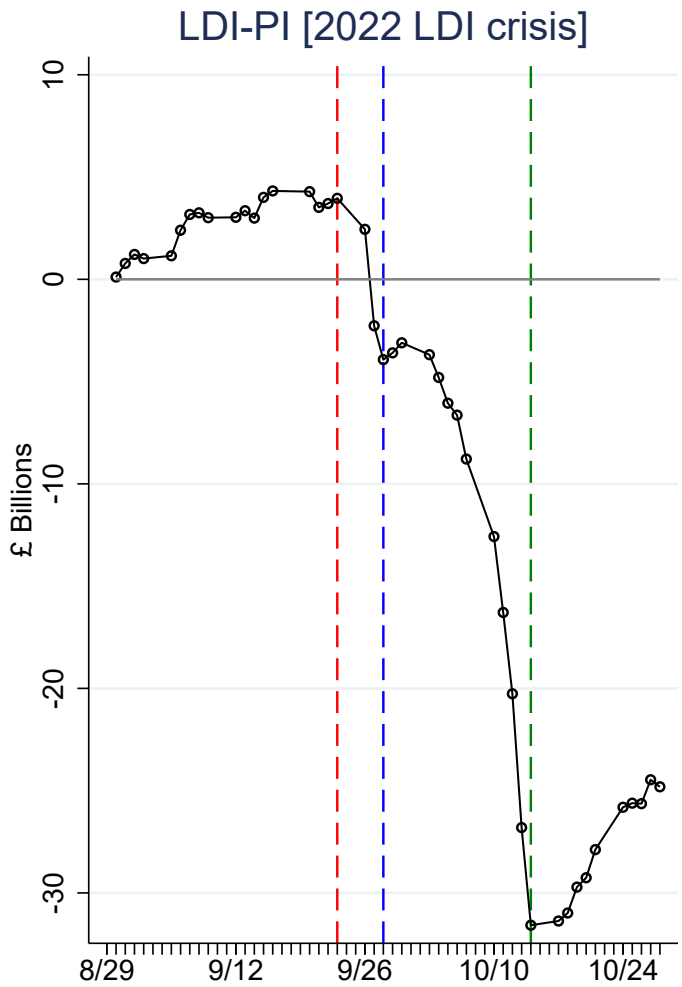
## 6-day Horizon; Median

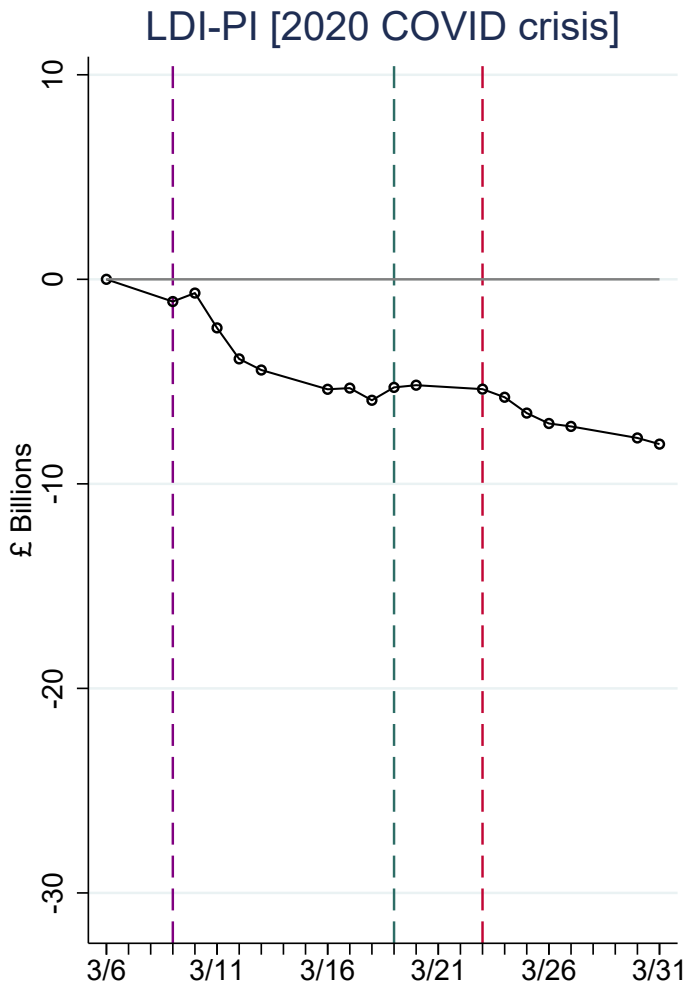


1. Stylised Facts from UK Bond Markets
2. Stylised Facts from UK Swap and Repo Markets
3. Trading Costs around the Crisis
4. Trading Relationships and Trade Networks
5. Aggregate Price Dispersion
6. Hedge Fund Trading
7. Comparisons with COVID-19

# Comparing LDI Orderflow: Sep-Oct 2022 vs March 2020

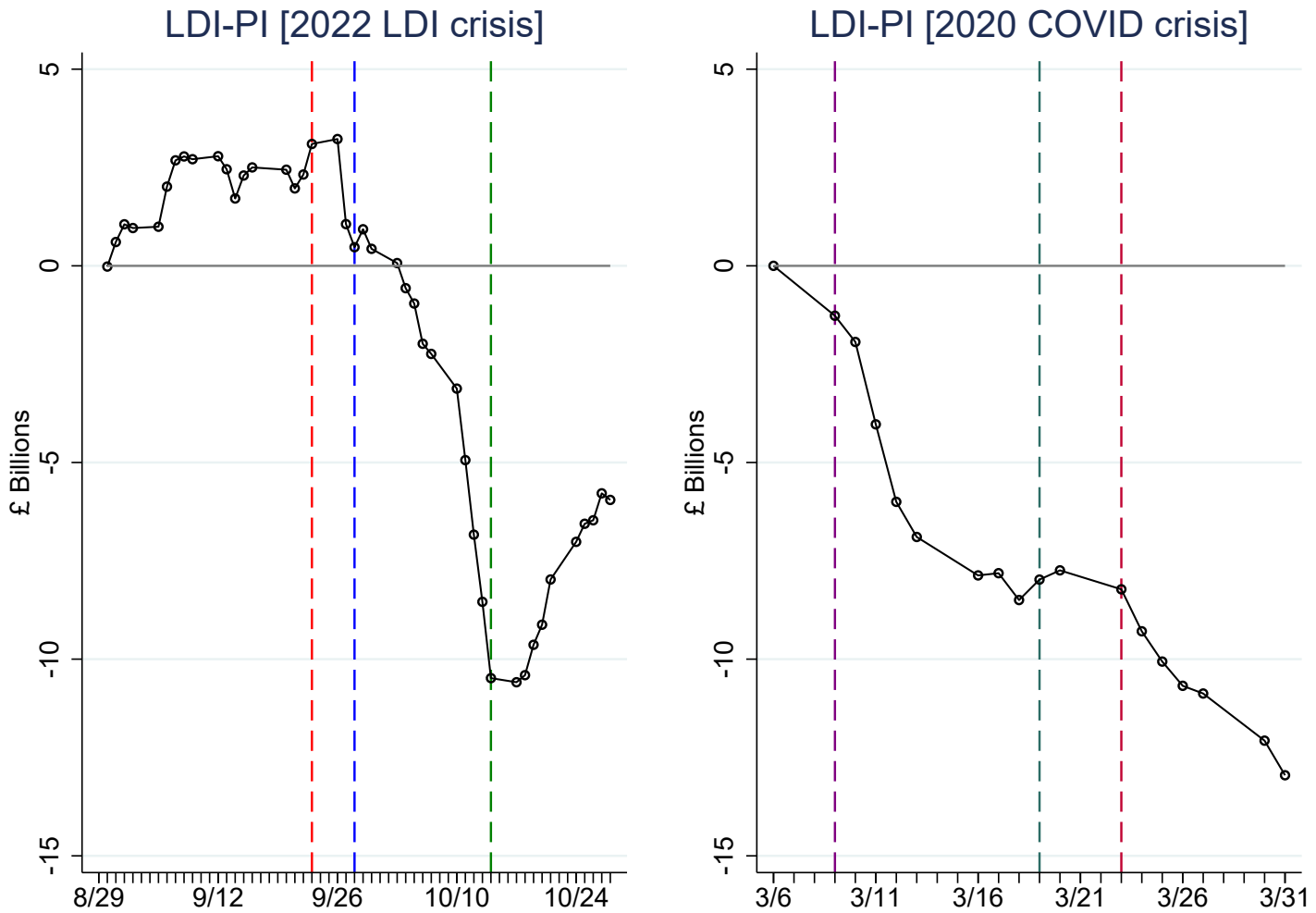
## All Bonds



# Comparing LDI Orderflow: Sep-Oct 2022 vs March 2020

## Nominal Bonds



# Comparing LDI Orderflow: Sep-Oct 2022 vs March 2020

## Linkers