# Outages in Sovereign Bond Markets

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# Risk-free yield curve is key for all asset pricing

## We know ***why*** bond yields change: news and flows

see literature on news (Fleming and Remolona, 1999; Andersen et al., 2003, 2007; Gürkaynak et al., 2020) and flows (Brandt and Kavajecz, 2004; Green, 2004; Pasquariello and Vega, 2007; Deuskar and Johnson, 2011; Gabaix and Koijen, 2021)

## We study the ***how***, ***where*** and ***who*** of the price formation process

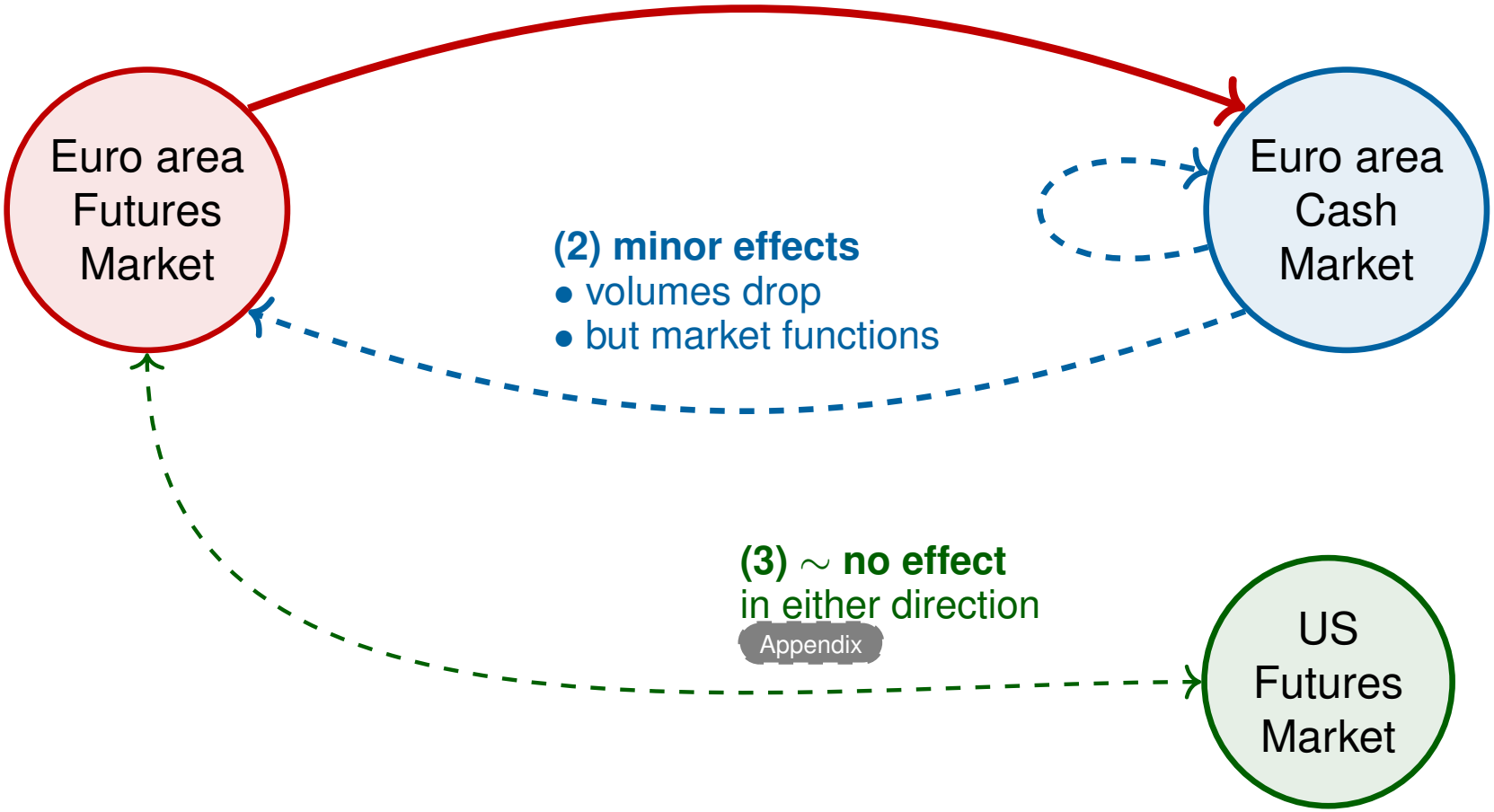
- on what trading venues?
- via which instruments?
- by which investor types?

## Exploit market outages as natural experiments

- unanticipated and exogenous shocks
- highly informative about how market functions in normal times

# Results preview: macro-level effect of outages

**(1) dramatic effects**
- trading volumes drop
- liquidity evaporates
- transaction prices deviate from fundamentals




**(2) minor effects**
- volumes drop
- but market functions

**(3) $\sim$ no effect**
in either direction

Appendix

based on
- 14 Eurex outages between 2009-2020
- MTS outage in 2010/2019, Bloomberg 2015, FWB 2015, Brokertec 2019
- 6 CBOT outages in 2006-2007 and CME outage 2019

# European Government Bond Market Structure

| | Futures Market | Cash Market |
|---|---|---|
| # assets per country link | 1-4 futures | ∼100 bonds |
| trading venue link | Eurex | OTC, Tradeweb, Bloomberg, MTS, ..., or via broker |
| trading protocol | central limit order book (CLOB) | voice/chat, RFQ, CLOB |
| transparency | full pre- and post-trade transparency | firm quotes only on MTS, no consolidated tape, MiFID II |
| our data | all intraday transactions & quotes | see next slide |

# Cash market data

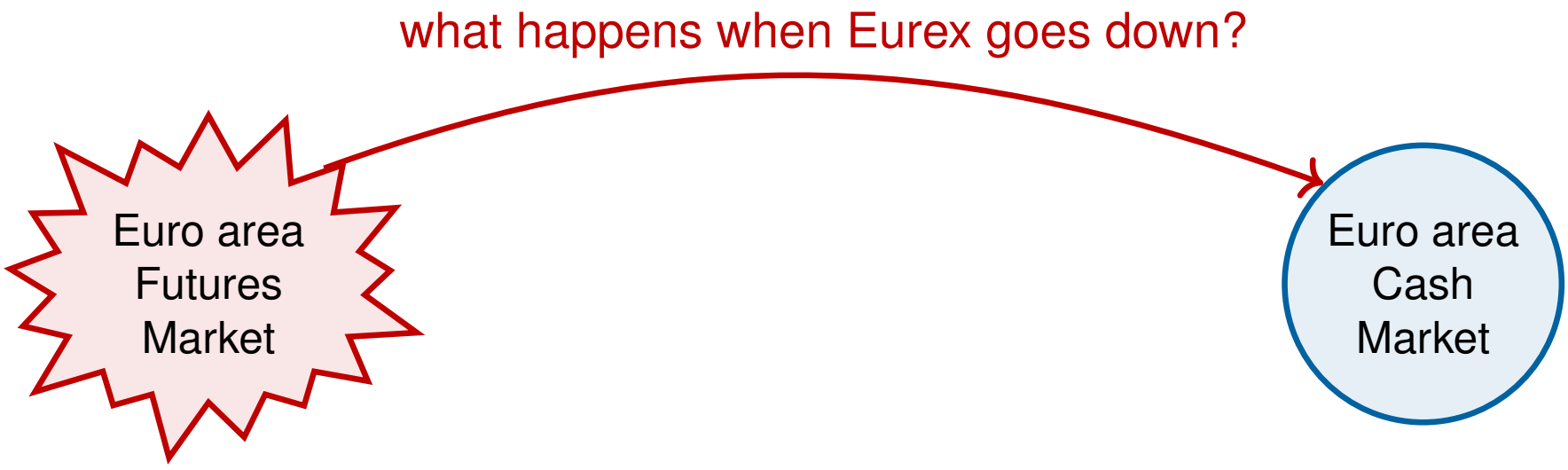
- start with non-anonymous transaction-level dataset
  MiFIR dataset (MiFID II); successor of "Bafin" dataset (MiFID I), see de Roure et al. (2019); Gündüz et al. (2023) and Bundesbank website

- **caveat**: trades in German bonds over-represented
  due to reporting obligation of trades by German counterparties and in German securities

⇒ **hence**: augment with external data
  - sourced directly from trading platforms (MTS, MTS BondVision, Tradeweb)
  - and interdealer brokers (TPICAP, BGC, GFI, Aurel)

- besides transactions, study cash market liquidity
  - executable quotes and volumes (MTS)
  - indicative quotes (Bloomberg, Refinitiv and TPICAP)

# Futures Market Outages



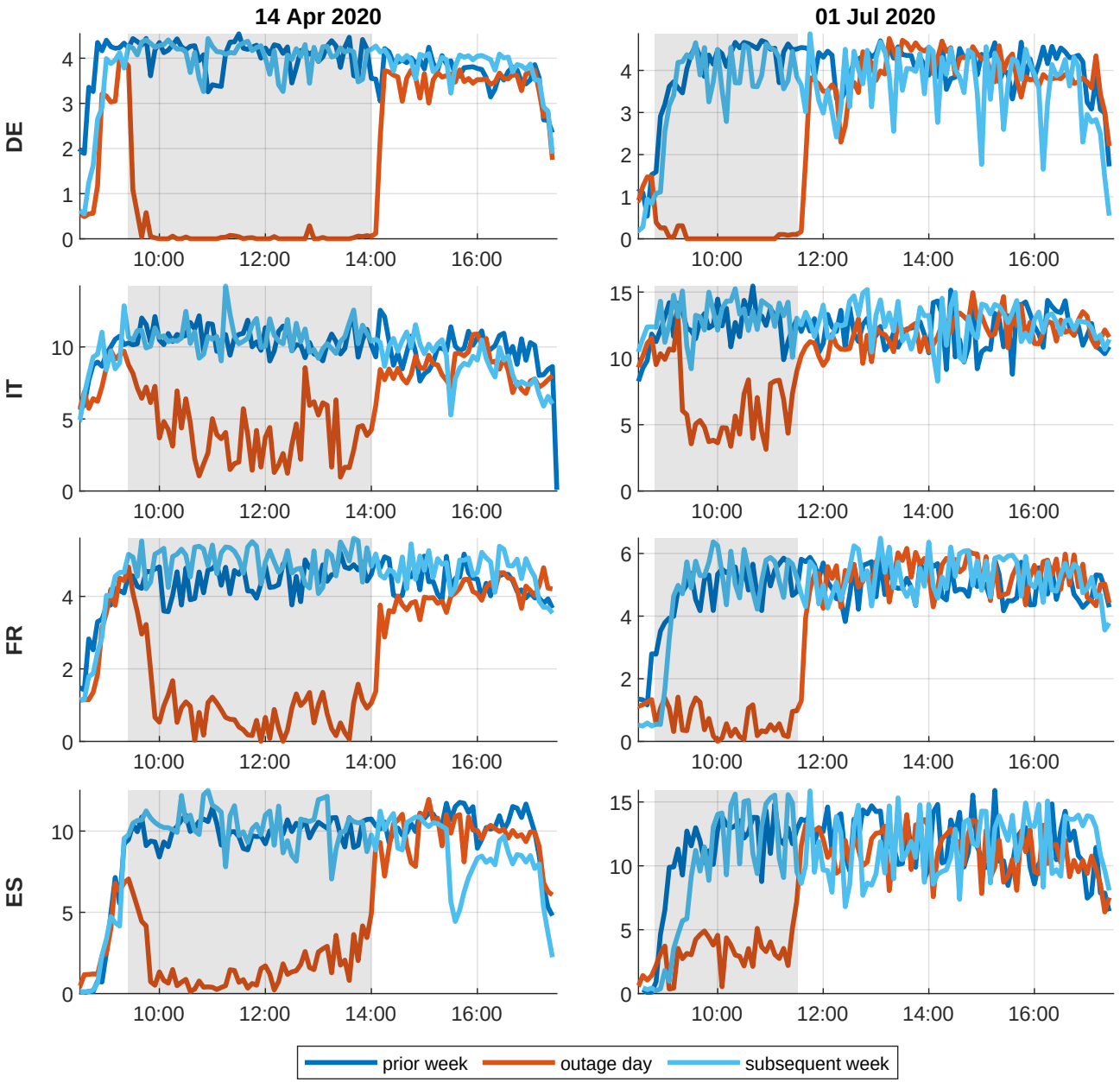

focus on two most recent outages:

- 14 April 2020 for $\sim$ 4.5 hours
- 1 July 2020 for $\sim$ 3 hours

Deutsche Börse: *"the disruption [..] in April and today's failure had the same origin. They were due to faulty third-party software"*

12 previous outages between 2009-2018 serve as robustness check

# Executable quotes evaporate




MTS is the major EGB cash trading venue with a CLOB, i.e. firm quotes.

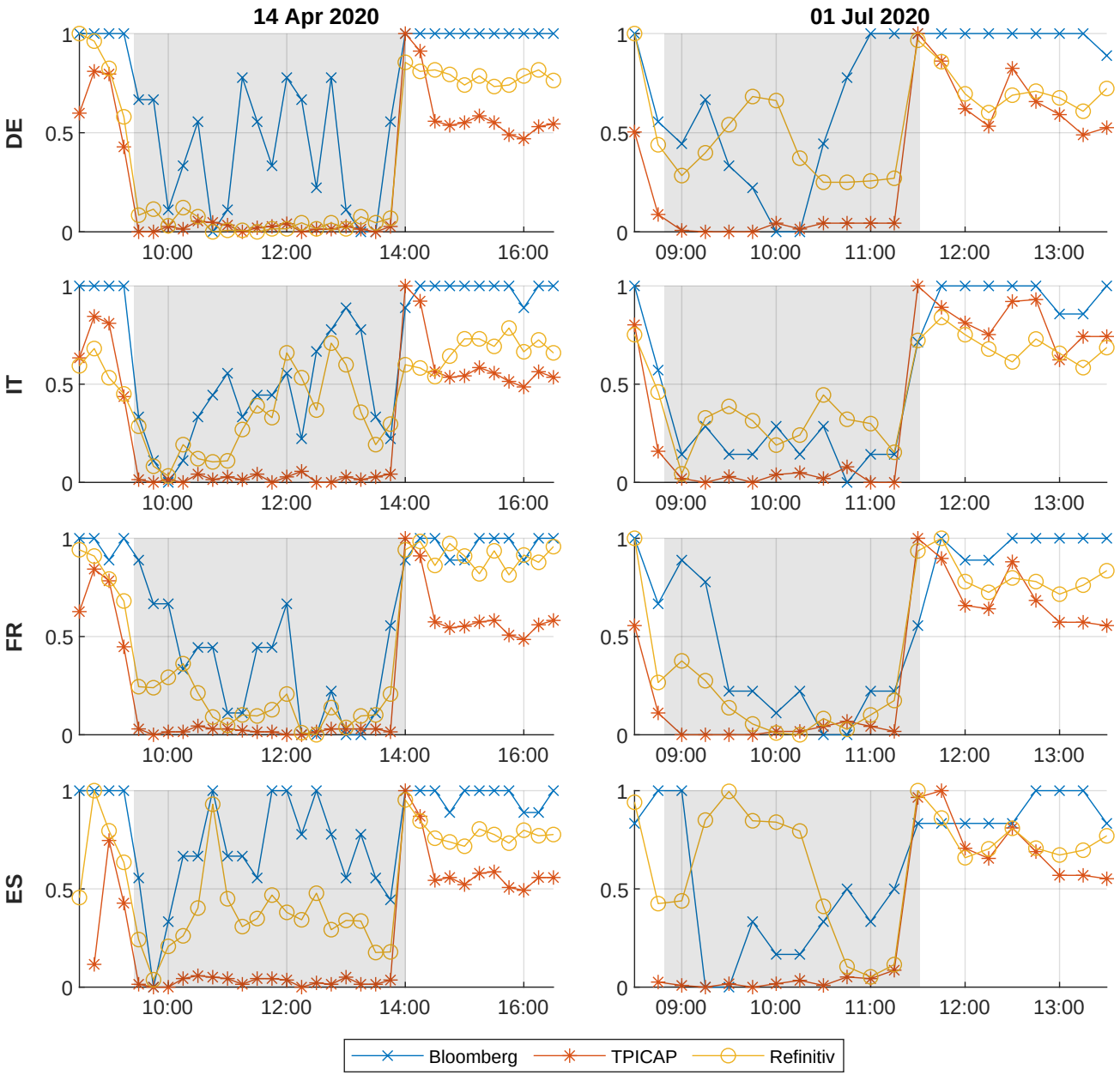
Look at total quoted volume (in billion Euro) of all bonds, across all three levels and both sides of the order book, at 5-minute snapshots.

Compare outage day with previous and subsequent week.

Liquidity most 'robust' for Italian bonds and short-term bonds

Appendix

# Indicative quotes become stale




number of new bid quotes per 15min window, normalized to 0-1 range per data provider

Bloomberg: approximate 'new quotes' as price changes in 10y CTD bond

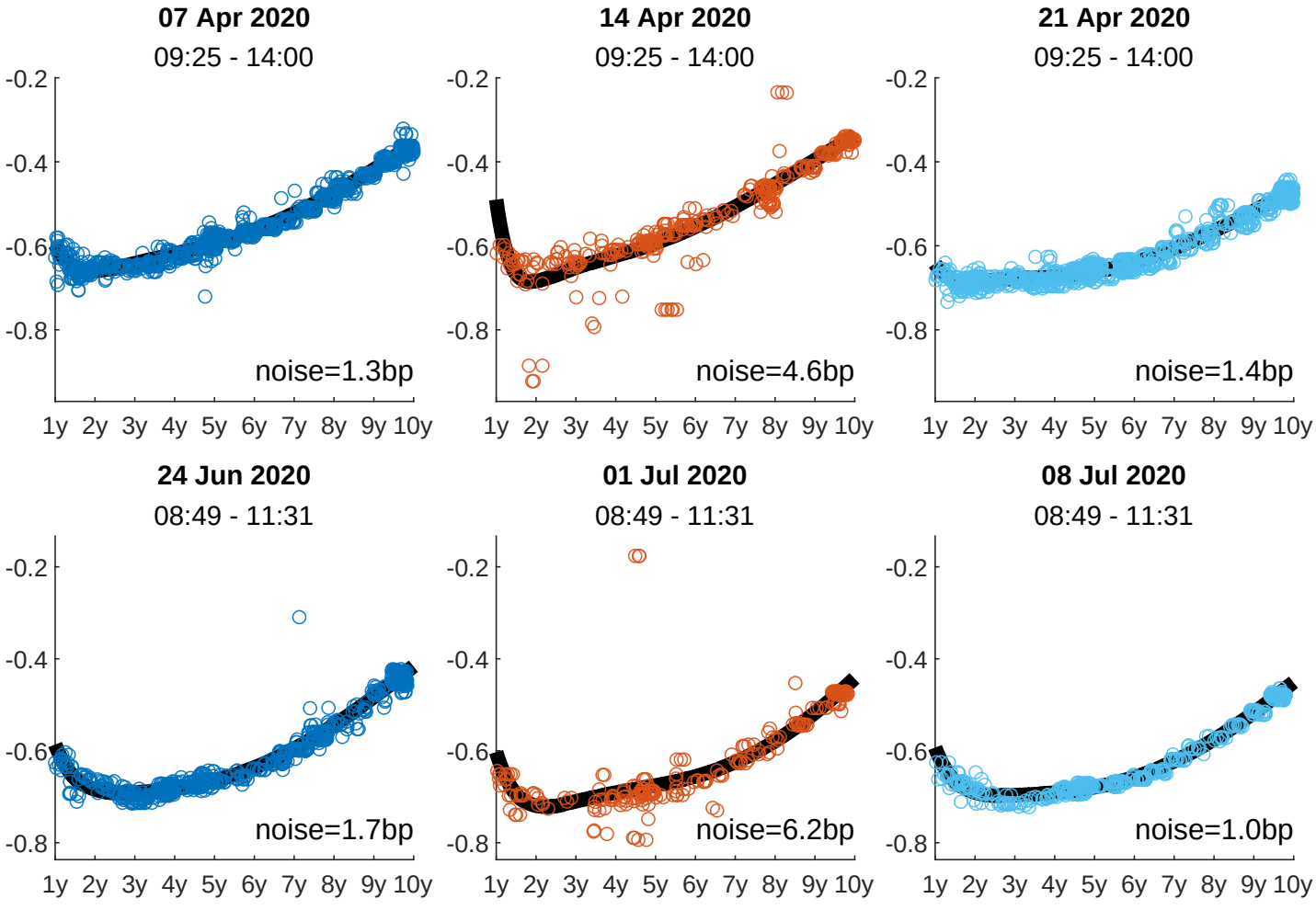
TPICAP: new quotes in 10y CTD bond

Refinitiv (Eikon): real-time feed updates for 10y OTR bond from "Tick History"

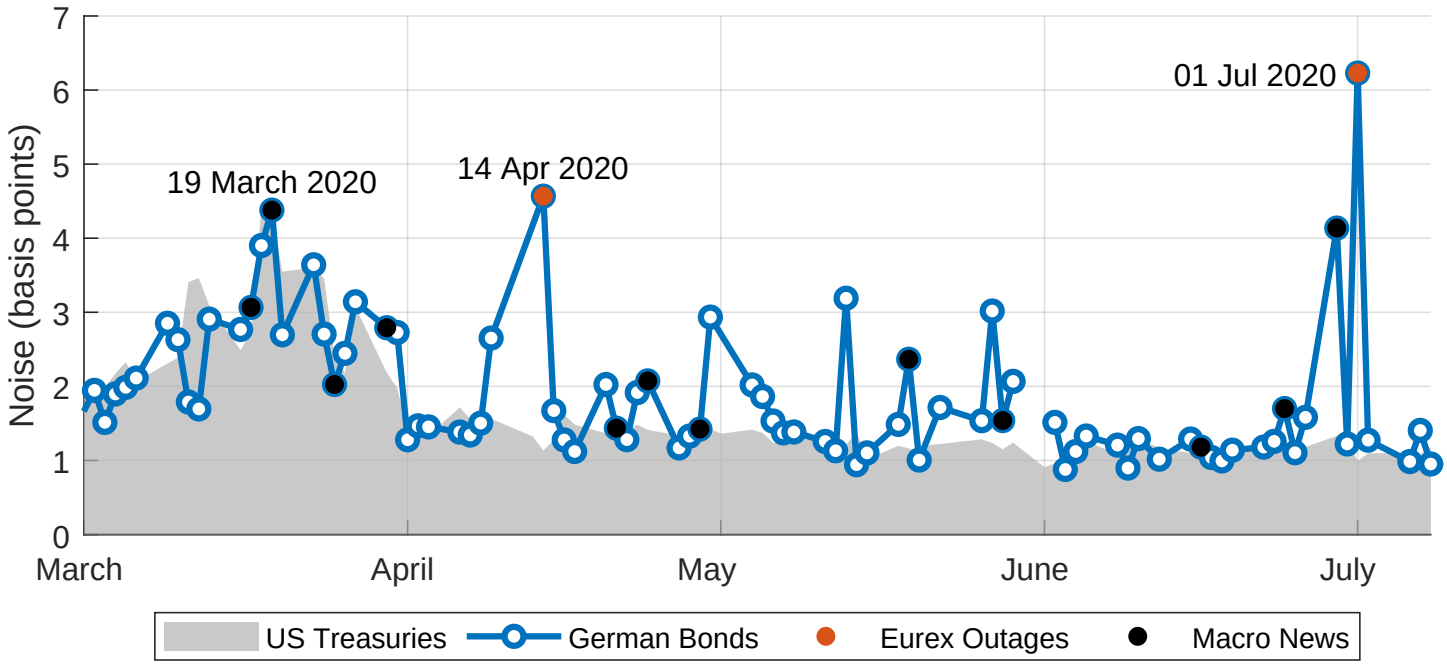
clear drop in number of quote updates

# Pricing errors spike

- compare actual yields (derived from transaction prices) with fitted curve
- focus on 1y-10y German bonds: risk-free Euro benchmark curve
- compare outage windows with previous/subsequent week



# Pricing errors are economically large




- repeat previous exercise for all trading days between 1 March and 8 July 2020
- compute root mean squared pricing error: Hu et al. (2013)'s noise measure

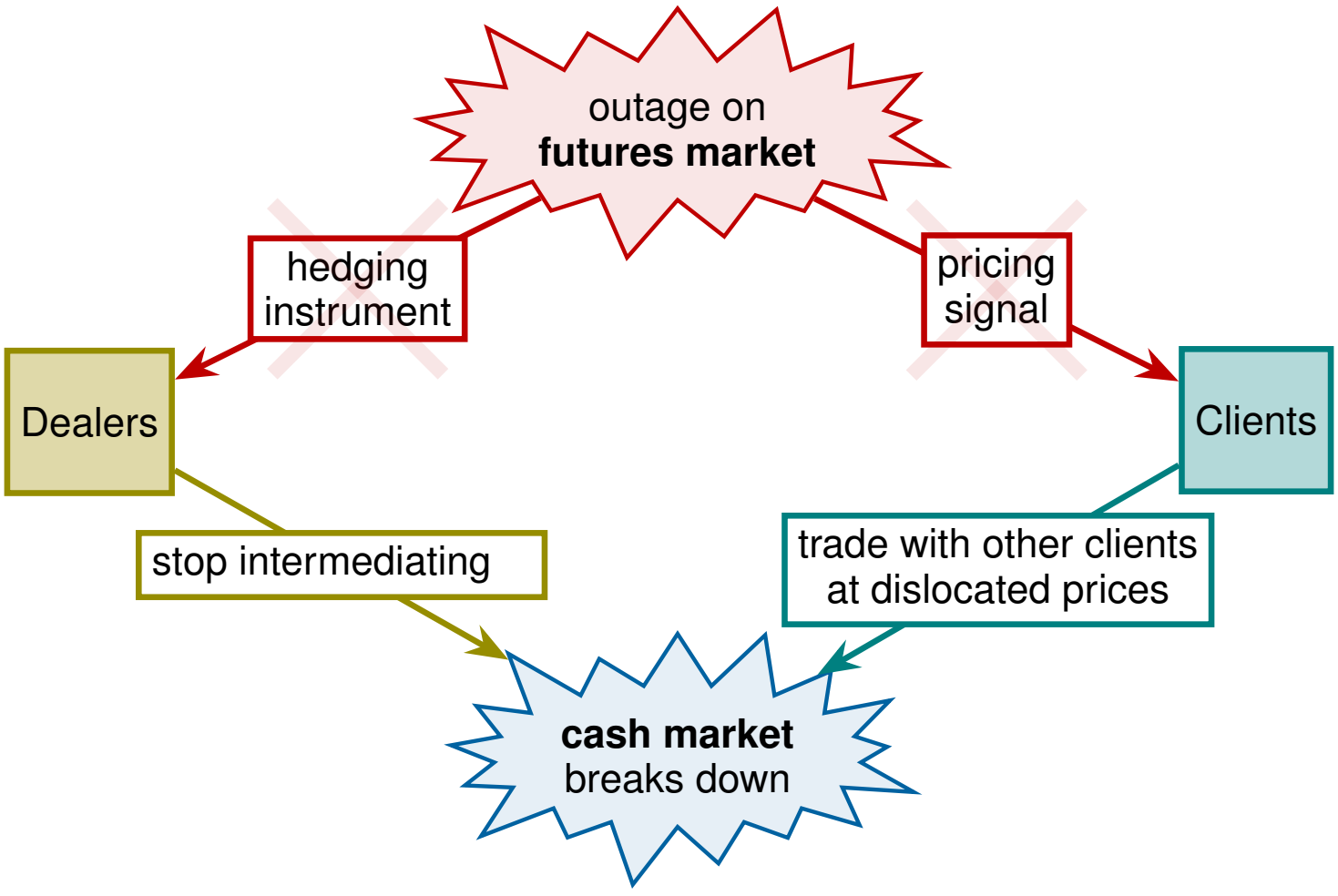
→ Eurex outage caused huge pricing errors in German yields

recall: peak of Covid-19 market turmoil ∼19 March (ECB announced PEPP the night before)

→ German yield curve noise remarkably similar to US Treasuries

despite more noisy sample (intraday vs. end-of-day prices)

# Micro-level mechanism



# Micro-level evidence (1)

trading volume drops *most*, mispricing spikes *least* in D2D segment

| | Volume | Mispricing |
|---|---|---|
| Outage × Dealer-to-Dealer | -5.53*** | 0.32 |
| Outage × Dealer-to-Client | -2.45*** | 0.65*** |
| Outage × Client-to-Client | -1.60* | 2.39*** |
| FE Day | ✓ | ✓ |
| FE Time | ✓ | ✓ |
| FE Maturity Bucket | ✓ | |
| FE ISIN | | ✓ |
| Observations | 1080 | 3207 |
| Adjusted $R^2$ | 0.363 | 0.128 |

→ bond futures = hedging instrument for dealers, pricing signal for clients

- explains **who** commits pricing errors
  - → clients > dealers
    HHs > Investment Funds > Banks
    non-dealer banks > dealer banks
  - → only HHs consistently incur losses
    other mispricings "net out" at investor-category-level

link

# Micro-level evidence (2)

- explains **where** pricing errors occur link
  - → bilateral OTC trades, electronic platforms and regular exchanges
  - → **not** for OTC trades on dealer platforms or via interdealer brokers

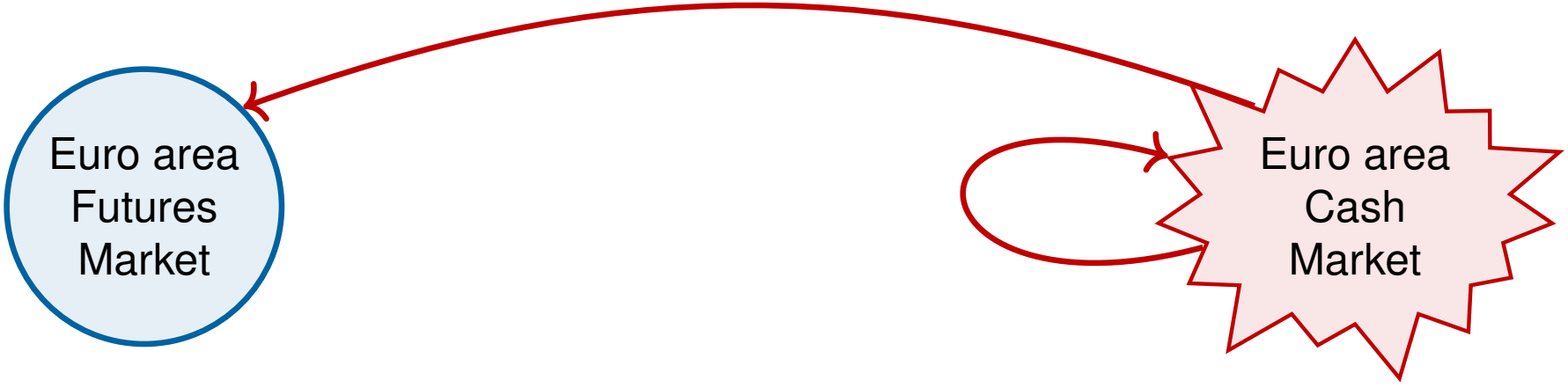
- explains **which** bonds & trades become mispriced link
  - → small trades in short-term, non-CTD bonds

- explains **why** trading volumes and liquidity link link
  - → drop *more* but pricing errors increase *less* for long-term bonds

✓ confirms dealers are better informed than clients

# Cash market outages

what happens when cash market venues go down?



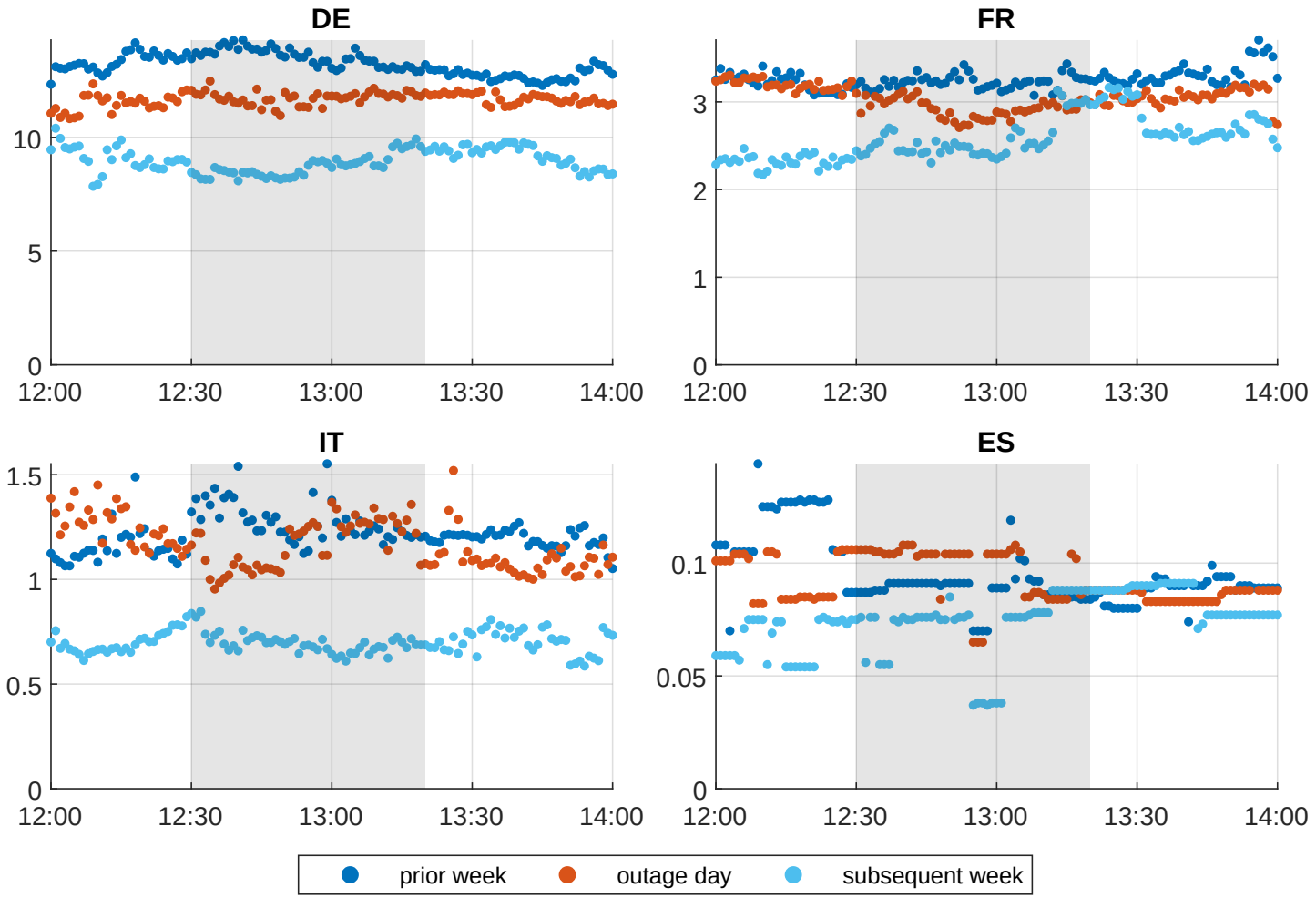

5 outages affecting 4 different venues

- MTS (2x)
- Bloomberg
- Frankfurt stock exchange (FWB)
- Brokertec

# Example: MTS outage on 26 July 2019

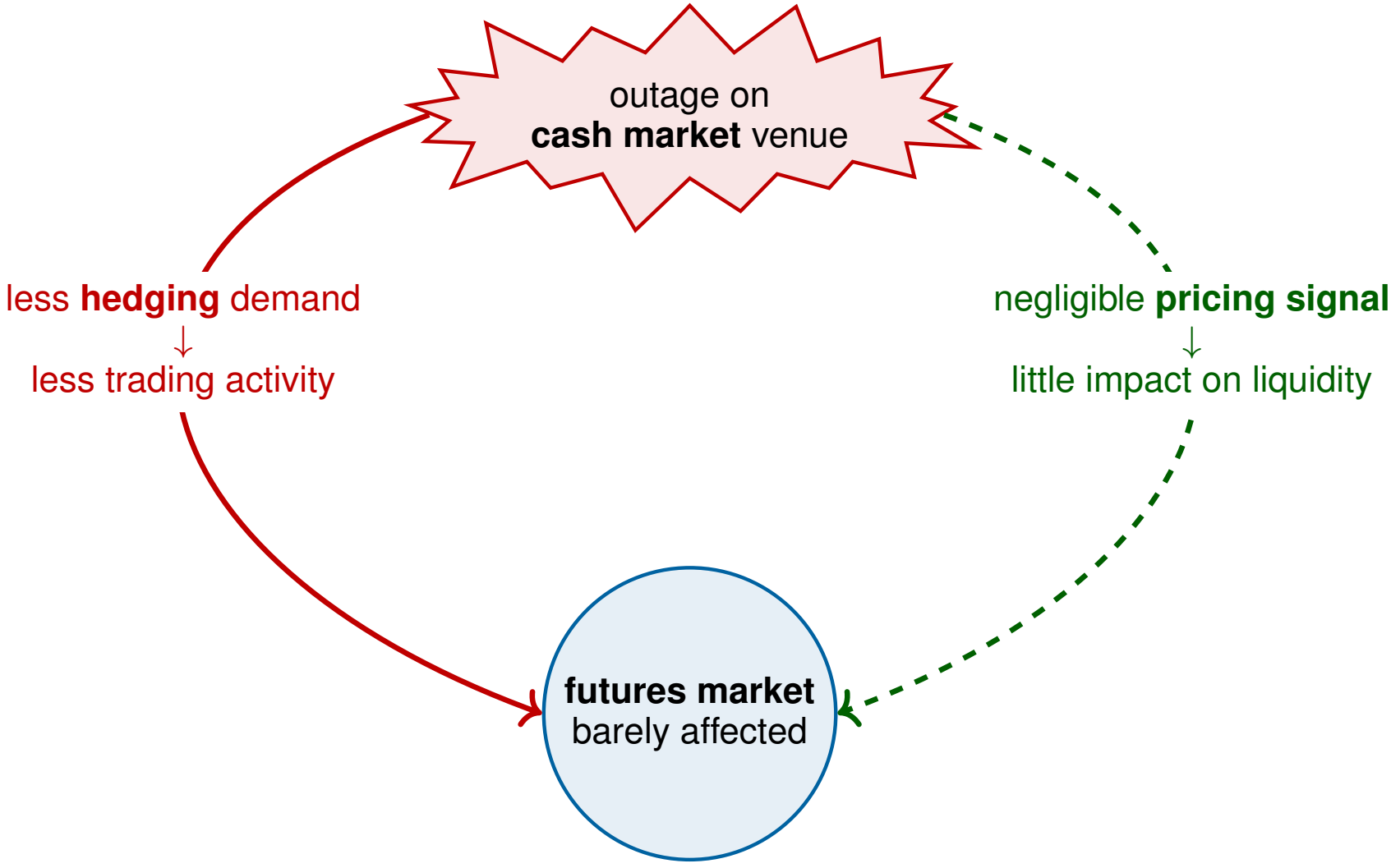
- for most recent outage, we can directly observe Eurex liquidity
- recall: Eurex outages reduce MTS liquidity by ∼100% for most countries

→ virtually no effect in other direction, even for Italy




total number of 10-year bond future contracts (in thousands), quoted on first fifteen levels on both sides of Eurex order book

# Micro-level mechanism




see regression results

# Summary

## Bond futures are key for EGB cash market functioning

- lack of hedging instrument: well-informed dealers stop intermediating
- lack of pricing signal: clients trade at dislocated prices

## Asymmetry: little outage effect from cash $\longrightarrow$ future market

- less hedging demand $\rightarrow$ less trading; liquidity barely affected
- price discovery and liquidity provision one-way street from futures $\longrightarrow$ cash market

## No outage spillovers between US $\longleftrightarrow$ Euro area bond futures

in contrast to strong & swift price spillovers

# Contribution to literature

**Competing theories of liquidity spillovers:**

- ✗ cross-market arbitrage
  implies symmetric outage effects: future ↔ cash (Gromb and Vayanos, 2010, 2018; Harding and Ma, 2010)
- ✓ cross-asset learning
  more informative asset price used to price other assets (Admati, 1985; Veldkamp, 2006; Cespa and Foucault, 2014; Asriyan et al., 2017)

**Market structure trade-offs:**

- decentralized cash market free-rides on centralized futures market
  (positive benchmark externality, see Duffie et al., 2017)
- centralization brings liquidity, price discovery, ... but also systemic risk

**Limits to arbitrage & dealer capacity:**

- importance of intermediaries in financial markets
  (Long et al., 1990; Shleifer and Vishny, 1997; Gromb and Vayanos, 2002, ...)
- natural experiment confirming recent US Treasury evidence
  Duffie et al. (2023)

Thanks for your attention

# References I

Admati, A. R. (1985). A noisy rational expectations equilibrium for multi-asset securities markets. *Econometrica 53*(3), 629–657.

Andersen, T. G., T. Bollerslev, F. X. Diebold, and C. Vega (2003). Micro Effects of Macro Announcements: Real-time Price Discovery in Foreign Exchange. *American Economic Review 93*, 38–62.

Andersen, T. G., T. Bollerslev, F. X. Diebold, and C. Vega (2007). Real-time price discovery in global stock, bond and foreign exchange markets. *Journal of International Economics 73*(2), 251–277.

Asriyan, V., W. Fuchs, and B. Green (2017). Information spillovers in asset markets with correlated values. *American Economic Review 107*(7), 2007–40.

Boehm, C. E. and T. N. Kroner (2023). The US, economic news, and the global financial cycle. Technical report, National Bureau of Economic Research.

Brandt, M. W. and K. A. Kavajecz (2004). Price discovery in the US Treasury market: The impact of orderflow and liquidity on the yield curve. *The Journal of Finance 59*(6).

# References II

Cespa, G. and T. Foucault (2014). Illiquidity Contagion and Liquidity Crashes. *The Review of Financial Studies 27*(6), 1615–1660.

de Roure, C., E. Moench, L. Pelizzon, and M. Schneider (2019). OTC Discount. *Deutsche Bundesbank Discussion Paper* (No 42/2019).

Deuskar, P. and T. C. Johnson (2011). Market Liquidity and Flow-driven Risk. *The Review of Financial Studies 24*(3), 721–753.

Duffie, D. (2023). Resilience redux in the US Treasury market. *Jackson Hole Symposium, Federal Reserve Bank of Kansas City*.

Duffie, D., P. Dworzcak, and H. Zhu (2017). Benchmarks in search markets. *The Journal of Finance 72*(5), 1983–2044.

Duffie, D., M. J. Fleming, F. M. Keane, C. Nelson, O. Shachar, and P. Van Tassel (2023). Dealer capacity and US Treasury market functionality. *FRB of New York Staff Report* (1070).

Fleming, M. J. and E. M. Remolona (1999). Price formation and liquidity in the US Treasury market: The response to public information. *The Journal of Finance 54*(5).

# References III

Gabaix, X. and R. S. J. Koijen (2021). In Search of the Origins of Financial Fluctuations: The Inelastic Markets Hypothesis. *NBER Working Paper 24122*.

Garriott, C., S. Lefebvre, G. Nolin, F. Rivadeneyra, and A. Walton (2020). Alternative futures for Government of Canada debt management. *Journal of Financial Economic Policy 12*(4), 659–685.

Green, T. C. (2004). Economic news and the impact of trading on bond prices. *The Journal of Finance 59*(3), 1201–1233.

Gromb, D. and D. Vayanos (2002). Equilibrium and welfare in markets with financially constrained arbitrageurs. *Journal of Financial Economics 66*(2), 361–407.

Gromb, D. and D. Vayanos (2010). Limits of arbitrage. *Annu. Rev. Financ. Econ. 2*(1), 251–275.

Gromb, D. and D. Vayanos (2018). The dynamics of financially constrained arbitrage. *The Journal of Finance 73*(4), 1713–1750.

Gündüz, Y., G. Ottonello, L. Pelizzon, M. Schneider, and M. G. Subrahmanyam (2023). Lighting up the dark: liquidity in the German corporate bond market. *The Journal of Fixed Income*.

# References IV

Gürkaynak, R. S., B. Kısacıkoğlu, and J. H. Wright (2020). Missing Events in Event Studies: Identifying the Effects of Partially-Measured News Surprises. *American Economic Review 110*(12), 3871–3912.

Harding, M. and P. Ma (2010). The impact of high frequency market makers upon market liquidity: Evidence from exchange outages. *Stanford University, Tech. Rep.*.

Hu, G. X., J. Pan, and J. Wang (2013). Noise as Information for Illiquidity. *The Journal of Finance 68*(6), 2341–2382.

Long, J. B. D., A. Shleifer, L. H. Summers, and R. J. Waldmann (1990). Noise trader risk in financial markets. *Journal of Political Economy 98*(4), 703–738.

Pasquariello, P. and C. Vega (2007). Informed and Strategic Order Flow in the Bond Markets. *The Review of Financial Studies 20*(6), 1975–2019.

Shkilko, A. and K. Sokolov (2020). Every Cloud Has a Silver Lining: Fast Trading, Microwave Connectivity, and Trading Costs. *The Journal of Finance 75*(6), 2899–2927.

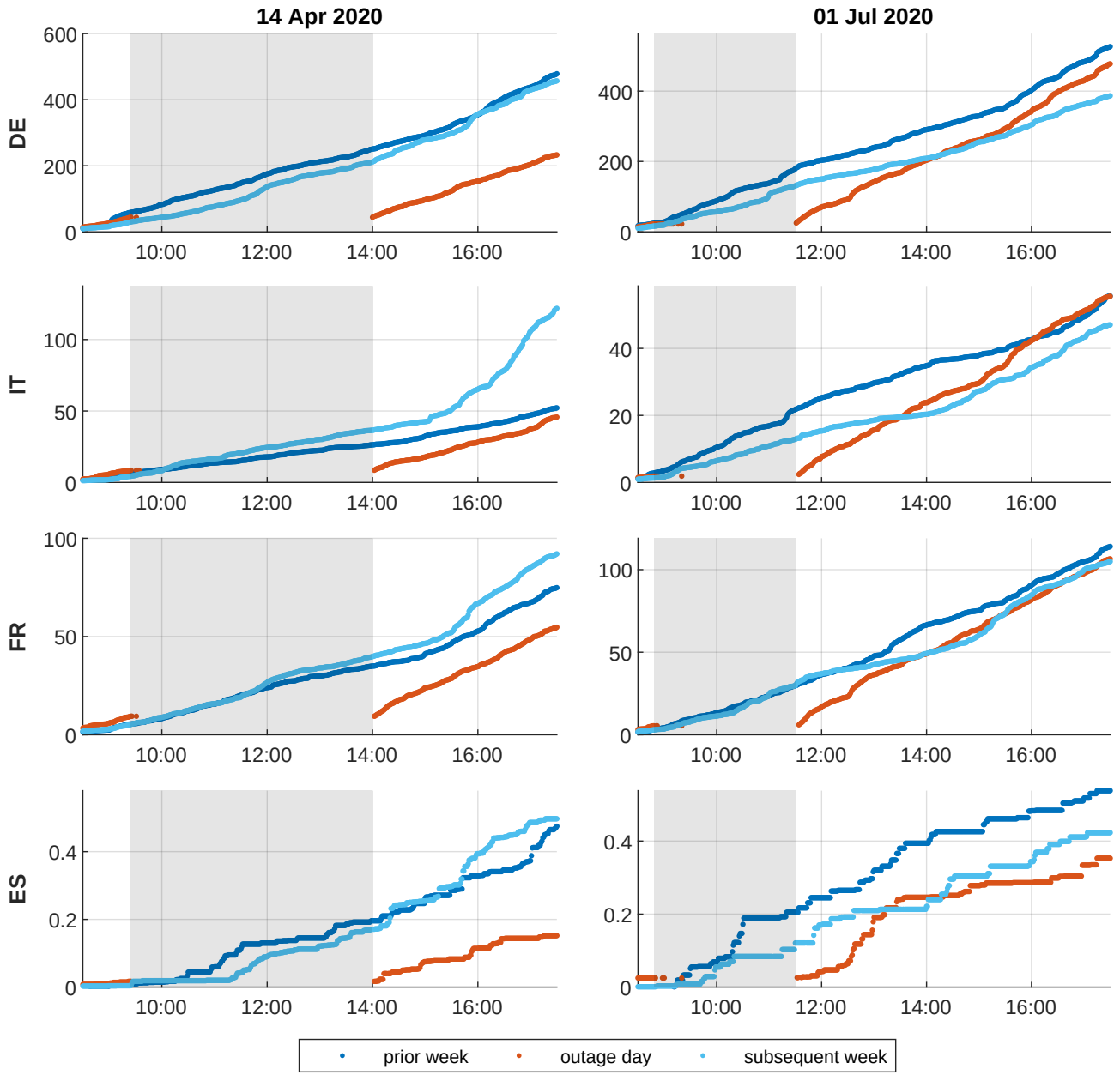
Shleifer, A. and R. W. Vishny (1997). The limits of arbitrage. *The Journal of Finance 52*(1), 35–55.

# References V

Svensson, L. E. (1994). Estimating and interpreting forward interest rates: Sweden 1992-1994. *National Bureau of Economic Research Working Paper No. 4871*.

Veldkamp, L. L. (2006). Information Markets and the Comovement of Asset Prices. *The Review of Economic Studies 73*(3), 823–845.

# Trading indeed stopped for all bond futures during 2020 Eurex outages

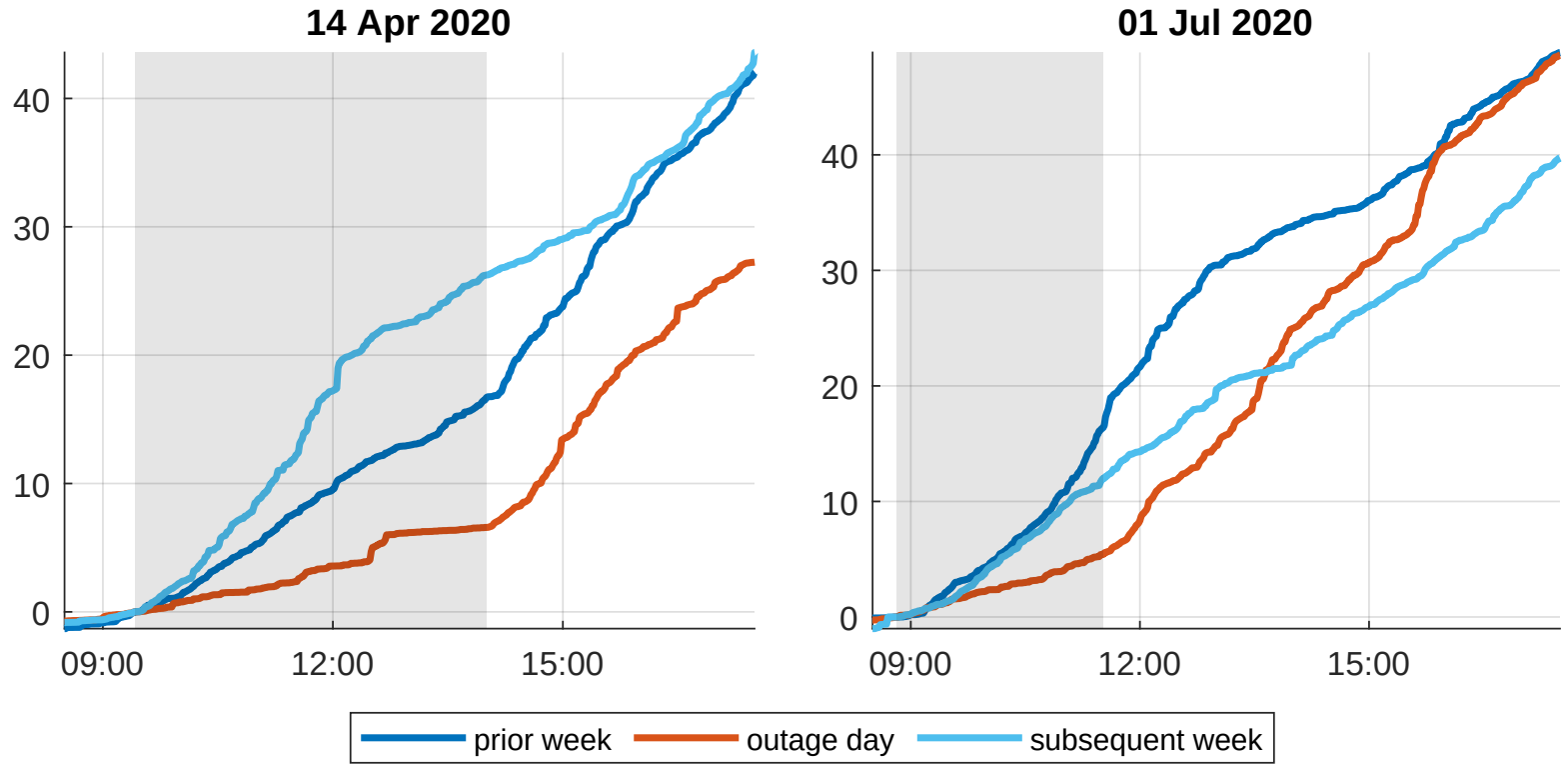



Cumulative trading volume in 10-year bond futures.

Number of traded front-end contracts in thousand.

Compare outage day with previous and subsequent week.

# Trading activity in cash EGBs drops




Cumulative trading volume on the cash market in all German, French, Italian and Spanish sovereign bonds (in billions of Euro, normalized to zero at the intraday time of the outage).

→ **similar** decline in DE/FR/IT/ES bonds, **stronger** decline in long-term bonds ($>$ 2.5y to maturity), see next slide

→ **stronger** decline in on-the-run bonds, see bond-level regression results

# Eurex outage effect on cash volumes across countries/maturities

jump back

estimate $log(1 + Volume_{cmt}) = \alpha + \gamma \times D_t + \beta \times FE + \epsilon_t$
for bonds of country $c$ in maturity-bucket $m$ and 30-minute interval $t$, $D_t = 1$ during outage

| | (1) Aggregate | (2) Maturities | (3) Countries |
|---|---|---|---|
| Outage | -3.11*** | | |
| Outage × <2.5y | | -1.07** | |
| Outage × 2.5-5.5y | | -3.70*** | |
| Outage × 5.5-10.5y | | -3.82*** | |
| Outage × >10.5y | | -3.84** | |
| Outage × DE | | | -2.78*** |
| Outage × FR | | | -3.36** |
| Outage × IT | | | -3.24*** |
| Outage × ES | | | -3.05** |
| FE Day | ✓ | ✓ | ✓ |
| FE Time | ✓ | ✓ | ✓ |
| FE Country | ✓ | ✓ | |
| FE Maturity Bucket | ✓ | | ✓ |
| Observations | 1440 | 1440 | 1440 |
| Adjusted $R^2$ | 0.325 | 0.336 | 0.324 |

Each column refers to a different regression, $Volume_{cmt}$ is the total trading volume in bonds of country $c$ and maturity bucket $m$ in the 30-minute time interval $t$. All explanatory variables are dummies: for time periods during Eurex outages, for different maturity buckets (bonds with less than 2.5 years to maturity serve as the baseline) or for different countries (Germany serves as the baseline). SEs are clustered at the daily level. *,**,*** indicate statistical significance at the 10%, 5% and 1% level, respectively.

# Eurex outage effect on cash volumes at bond level

jump back

estimate $log(1 + Volume_{it}) = \alpha + \gamma \times D_t \times BondCharacteristics + \beta \times FE + \epsilon_{it}$
for individual bonds $i$ and 60-minute intervals $t$, $D_t = 1$ during outage

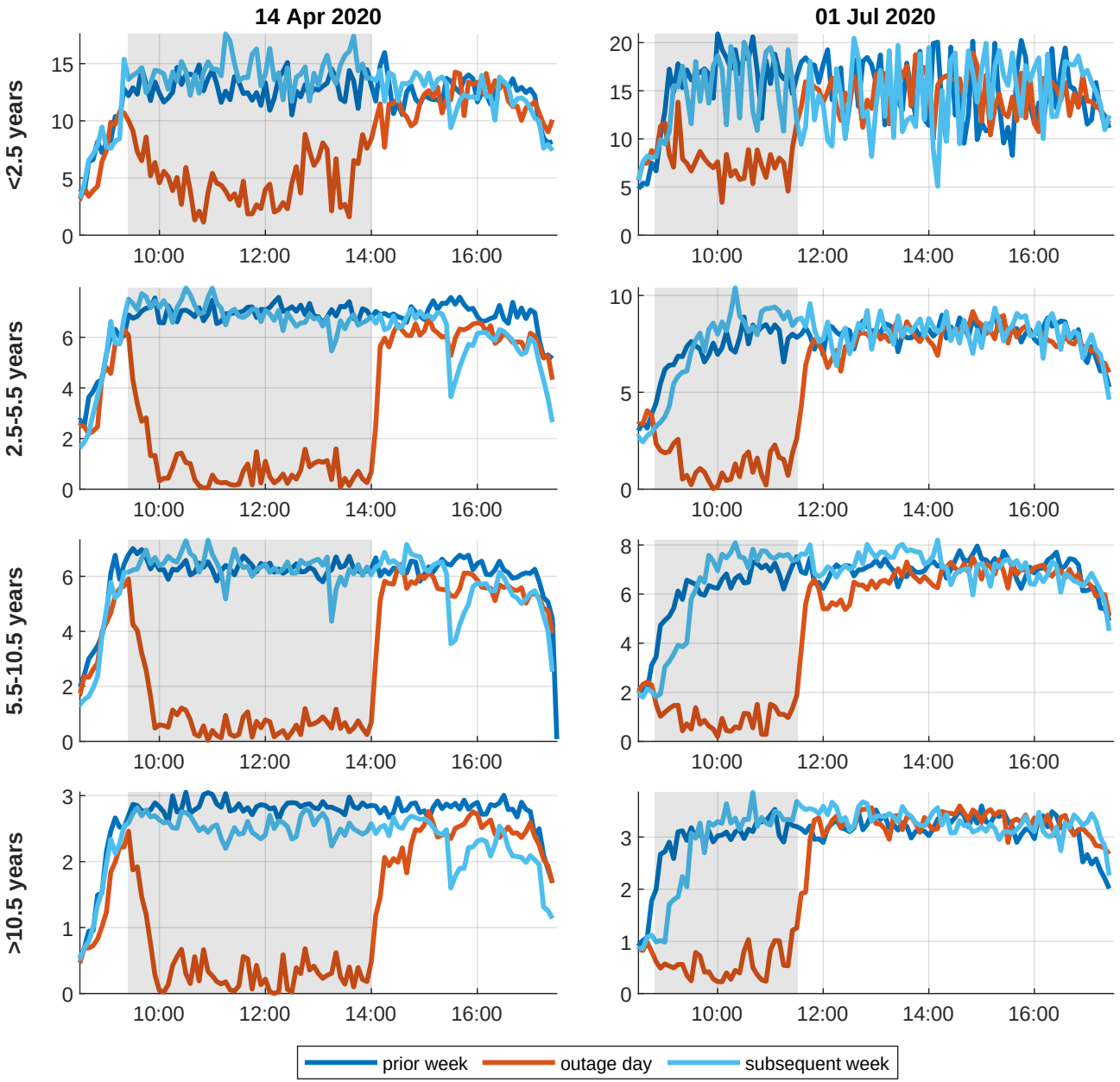
| | (1) | (2) |
|---|---|---|
| Outage | -3.14** | -3.65** |
| CTD | | 2.43*** |
| OTR | | 0.73* |
| Zero Coupon | | -1.10*** |
| log(Years to Maturity) | | 1.51*** |
| log(Years since Issuance) | | -1.13*** |
| Outage × CTD | | -1.32 |
| Outage × OTR | | -1.48** |
| Outage × Zero Coupon | | 0.68* |
| Outage × log(Years to Maturity) | | 0.08 |
| Outage × log(Years since Issuance) | | 0.31 |
| FE Day | ✓ | ✓ |
| FE Time | ✓ | ✓ |
| FE ISIN | ✓ | |
| FE Country | | ✓ |
| FE Maturity Bucket | | ✓ |
| Observations | 10752 | 10752 |
| Adjusted $R^2$ | 0.285 | 0.238 |

Each column refers to a different regression, $Volume_{it}$ is the transaction volume in a given bond $i$ in 1-hour intervals. To avoid compositional effects, we study a fixed set of 259 bonds throughout.

- usually, CTD and OTR bonds traded more frequently
- during the Eurex outage, trading in OTR bonds drops disproportionately

# Eurex outage effect on MTS liquidity across maturities

jump back




Instead of countries, compare MTS order book depth across maturity buckets:

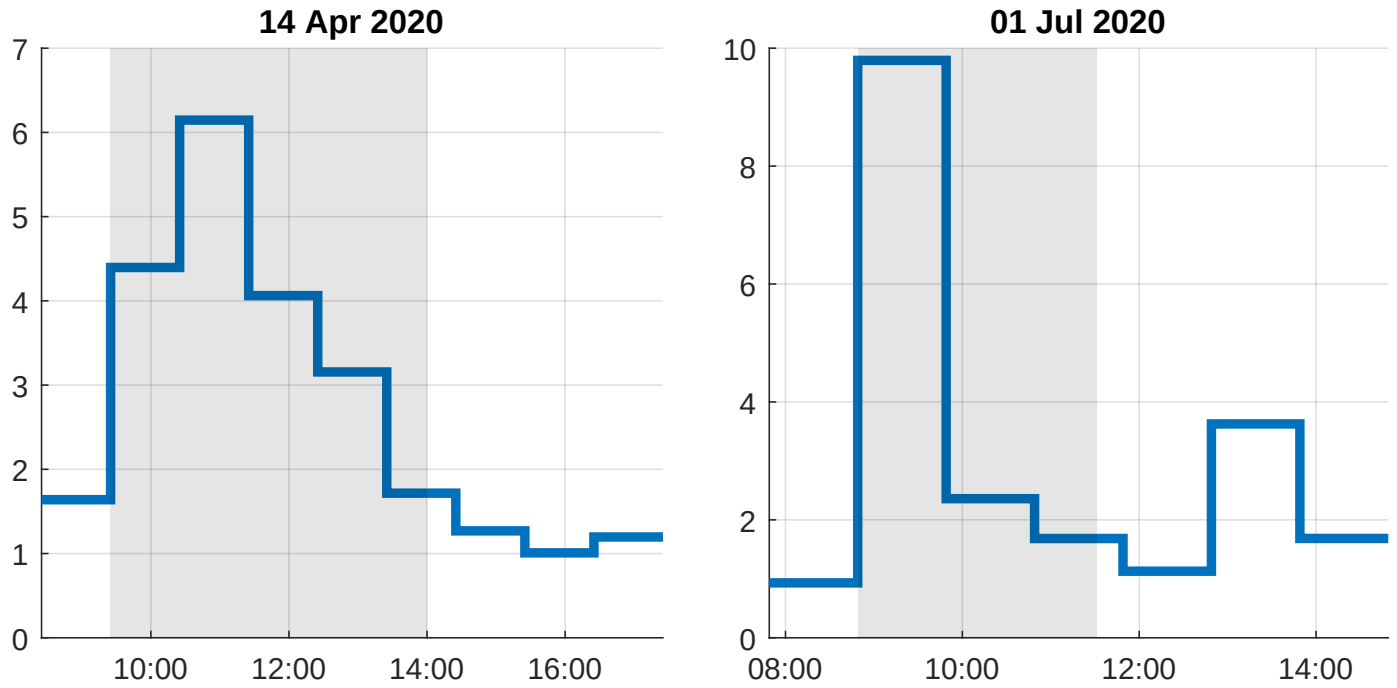
<2.5 years
2.5 - 5.5 years
5.5 - 10.5 years
>10.5 years

short-term bonds most ‘robust’

# Cash market pricing errors clearly linked to Eurex outage times

concern: pricing errors higher on outage days, for reasons other than Eurex?

- compute root mean squared pricing error as before
- but for one-hour intraday windows throughout the two outage days




answer: no

$\Rightarrow$ noise $\uparrow$ at outage start and $\downarrow$ at outage end

$\rightarrow$ intraday data is key, spike would not be visible in end-of-day prices

# Cash market pricing errors during Eurex outage

jump back

estimate $abs(PE_{it}) = \alpha + \gamma \times D_t \times Characteristics + \beta \times FE + \epsilon_{it}$ at transaction level

| | (1) | (2) | (3) |
|---|---|---|---|
| Outage | 1.25*** | 1.16*** | 1.75*** |
| log(Volume) | | -0.14 | -0.03** |
| CTD | | -0.33 | -0.20*** |
| OTR | | 0.26 | 0.26*** |
| Zero Coupon | | 0.03 | 0.09 |
| Years since Issuance | | 0.06* | 0.06 |
| Years to Maturity | | -0.08 | -0.03 |
| Outage × log(Volume) | | | -0.69*** |
| Outage × CTD | | | -1.02** |
| Outage × OTR | | | -0.59 |
| Outage × Zero Coupon | | | -0.06 |
| Outage × Years since Issuance | | | 0.02 |
| Outage × Years to Maturity | | | -0.15** |
| FE Minute | ✓ | ✓ | ✓ |
| FE ISIN | ✓ | | |
| Observations | 3381 | 3359 | 3359 |
| Adjusted $R^2$ | 0.115 | 0.126 | 0.223 |

The dependent variable is the absolute pricing error, i.e. the difference between the observed and fitted yield based on Svensson (1994). The sample spans all trades in one to ten year German bonds during the Eurex outages and during the same intraday window in the previous and subsequent week. Standard errors are clustered at the daily level. All regression include time-of-day fixed effects at the 15-minute frequency. *,**,*** indicate statistical significance at the 10%, 5% and 1% level, respectively.

usually: errors ↑ for small trades in short-term, OTR and non-CTD bonds

during Eurex outage: errors ↑ for small trades in short-term, non-CTD bonds

# Cash market pricing errors across venues

jump back

| | (1) Baseline | (2) Controlling for Volume |
|---|---|---|
| Outage × OTC bilateral | 1.97*** [0.40] | 1.37*** [0.17] |
| Outage × OTC via IDB | 0.14 [0.28] | 0.27 [0.27] |
| Outage × OTC via SI | 0.18 [0.25] | 0.30 [0.22] |
| Outage × electronic platforms | 0.91*** [0.17] | 0.50* [0.24] |
| Outage × regular exchange | 4.46*** [0.97] | 2.06 [1.37] |
| Outage × log(Volume) | | -0.59*** [0.07] |
| FE Minute | ✓ | ✓ |
| FE ISIN | ✓ | ✓ |
| Observations | 3084 | 3062 |
| Adjusted $R^2$ | 0.166 | 0.210 |

The dependent variable is the absolute pricing error, i.e. the difference between the observed and fitted yield based on Svensson (1994). The sample spans all trades in one to ten year German bonds during the Eurex outages and during the same intraday window in the previous and subsequent week. Standard errors are clustered at the daily level. All regression include time-of-day fixed effects at the 15-minute frequency. *,**,*** indicate statistical significance at the 10%, 5% and 1% level, respectively.

- errors ↑ for bilateral OTC trades
- and electronic platforms and regular exchanges ...

→ ... but due to smaller trade size

# Cash market pricing errors across investor segments

jump back

- most for C2C, somewhat for D2C, not for D2D (not shown)
- HHs incur losses; IFs, NBFIs and NFCs with gains
- dealers show minor mispricings only, and no consistent gains

| | absolute pricing error | | net pricing error | |
|---|---|---|---|---|
| | (1) Buy | (2) Sell | (3) Buy | (4) Sell |
| Outage × Bank Dealer | 0.40* [0.16] | 0.94** [0.26] | 0.10 [0.65] | -0.07 [0.21] |
| Outage × Bank Non-Dealer | 1.63** [0.45] | 1.50*** [0.31] | -0.03 [0.79] | -0.55 [0.75] |
| Outage × NBFI Dealer | -0.06 [0.24] | 0.36** [0.10] | 0.58 [0.80] | 0.03 [0.78] |
| Outage × NBFI Non-Dealer | 1.81 [0.96] | 0.41 [0.22] | 0.68* [0.29] | -0.16 [0.37] |
| Outage × Investment Fund | 0.95*** [0.22] | 3.55*** [0.45] | -0.32 [0.30] | -3.00*** [0.26] |
| Outage × ICPF | 0.33 [0.53] | -0.01 [0.77] | -0.16 [0.65] | -0.55 [0.86] |
| Outage × NFC | 2.28 [2.03] | 0.73 [0.68] | -1.93 [2.51] | -3.00*** [0.50] |
| Outage × Official | -0.02 [0.16] | 0.66 [0.41] | 0.05 [0.54] | 0.70** [0.22] |
| Outage × HHs | 4.14* [1.68] | 4.79*** [0.85] | -2.71** [0.95] | 5.64*** [1.02] |
| FE Minute | ✓ | ✓ | ✓ | ✓ |
| FE ISIN | ✓ | ✓ | ✓ | ✓ |
| Observations | 3085 | 3095 | 3085 | 3095 |
| Adjusted $R^2$ | 0.145 | 0.172 | 0.148 | 0.202 |

Effect of Eurex Outages on Absolute and Net Pricing Errors across Investor Types. The dependent variable is the transaction-level pricing error, in basis points of yield, in absolute (columns 1-2) or net terms (columns 3-4). Positive coefficients in column (3) imply that an investor type profits from the outage, buying bonds at a yield above fair value (price below fair value). Positive coefficients in column (4) imply that an investor type incurs losses during the outage, selling bonds at a yield above fair value (price below fair value). For brevity, the table shows results only for the outage dummy interaction terms.

# Previous Eurex outages provide robustness checks

## 10 other system-wide outages confirm our results

two outages in 2020 not unprecedented, ten other outages since 2008

- trading activity on cash market dropped each time
- as did liquidity on MTS
- larger effects for long-term bonds

## 2 partial outages highlight role of Bund futures

twice, Eurex went down except for 5y and 10y German bond futures
compared to system-wide outage, these partial outages have

- smaller overall effects on MTS liquidity
- particularly for 5-10y bonds

→ Bund futures as pricing benchmark for all EGBs

# Cash outages reduce trading activity, not market functioning

jump back

| | MTS 12 Jan 2010 8:00-10:35 | Bloomberg 17 Apr 2015 9:20-10:10 | FWB 27 May 2015 8:00-11:00 | Brokertec 11 Jan 2019 19:43-21:35 | MTS 26 Jul 2019 12:30-13:20 | Pooled |
|---|---|---|---|---|---|---|
| *Cash market* | | | | | | |
| Volume | -1.33*** [0.11] | -4.45*** [0.13] | -0.43* [0.10] | | -2.35* [0.69] | -1.46*** [0.44] |
| #Trades | -0.17*** [0.00] | -0.38 [0.17] | -0.08 [0.08] | | -0.28*** [0.01] | -0.17*** [0.05] |
| *Futures market* | | | | | | |
| Volume | 0.02 [0.03] | -0.25* [0.06] | -0.59 [0.50] | -0.23*** [0.01] | -0.55** [0.12] | -0.31* [0.17] |
| #Trades | 0.03 [0.05] | -0.15** [0.02] | -0.29 [0.26] | -0.16** [0.03] | -0.43* [0.14] | -0.17* [0.09] |
| Volatility | 0.09 [0.10] | -0.02 [0.03] | -0.44 [0.41] | -0.04 [0.02] | -0.11 [0.09] | -0.20 [0.19] |
| Amihud | 0.02** [0.00] | 0.03*** [0.00] | 0.09 [0.05] | -0.09 [0.15] | 0.07 [0.02] | 0.05* [0.03] |
| Roll | 0.02 [0.05] | 0.08* [0.02] | 0.15* [0.04] | -0.13 [0.14] | 0.05 [0.02] | 0.09** [0.03] |

- imperfect substitution between cash venues: aggregate activity ↓
- futures market barely affected: illiquidity ↑ .05 (Amihud) and .09 (Roll) std.dev.

# Implications for practitioners: data reliability

## When bond future prices become unavailable ...

- ... executable quotes for EGBs vanish
- ... indicative quotes for EGBs become stale
- ... as do quotes on interest rate swaps beyond $\sim$ 2y maturity

## Generous interpretation

$\rightarrow$ those quotes are tightly linked to bond future prices

## Less generous interpretation

$\rightarrow$ those quotes contain little inherent information

calculation methods behind quotes not disclosed, e.g. Bloomberg website describes quotes as "*a real-time composite based on executable and indicative quotes from multiple contributors [..] indicative of available consensus-forming prices, and designed for broad terminal use*"

we show: bond futures prices are vital input

# Implications for policy makers: costs and benefits of centralisation

## Future Market

- trading and clearing fully centralized on Eurex
- handful of highly liquid securities

$\Rightarrow$ central role for price discovery

$\times$ outage of Eurex a systemic risk

## Cash Market

- fragmented across competing trading venues, often without central clearing
- many quite illiquid bond issues

$\Rightarrow$ minor role for price discovery

$\checkmark$ robust to outage of individual venues

recent reform proposals:

- central clearing and all-to-all trading on cash market?
  see e.g. Duffie (2023) and U.S. Securities and Exchange Commission (2022)
- condense sovereign debt into handful of perpetual bonds?
  see e.g. John Cochrane (2015) for the US and Garriott et al. (2020) for Canada

# Size of Futures vs Cash Bond Market in Euro Area

jump back

| Country | Future Volume (billion €) | Cash Volume (billion €) | Ratio Future/Cash |
|---|---|---|---|
| Germany | 72,044 | 7,404 | 9.7 |
| France | 7,745 | 5,435 | 1.4 |
| Italy | 8,367 | 7,197 | 1.2 |
| Spain | 21 | 2,002 | .01 |

The bond future trading volumes correspond to the aggregate volume of all futures of a given country, from Eurex website. The cash market trading volumes are based on the European Secondary Bond Market Data Report by the International Capital Market Association (ICMA). All data refers to 2022.

# Cash market is relatively "fragmented" across instruments

jump back

1-4 futures vs. ∼100 bonds per country

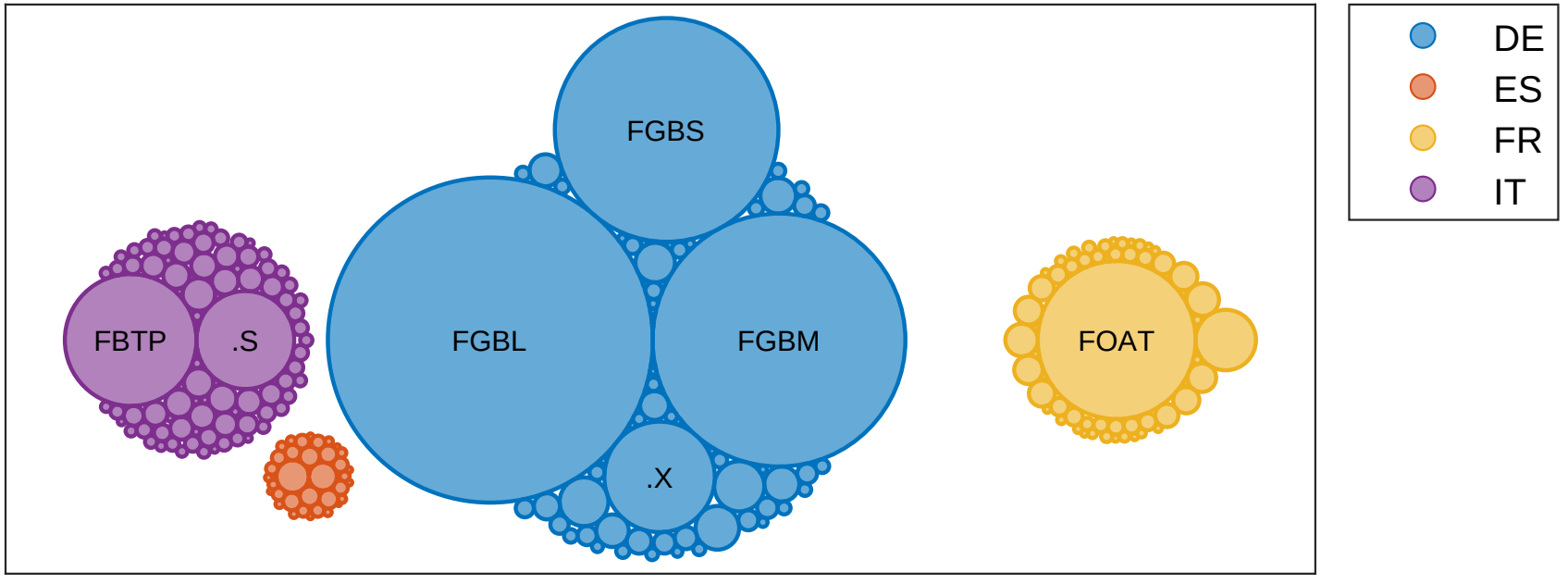
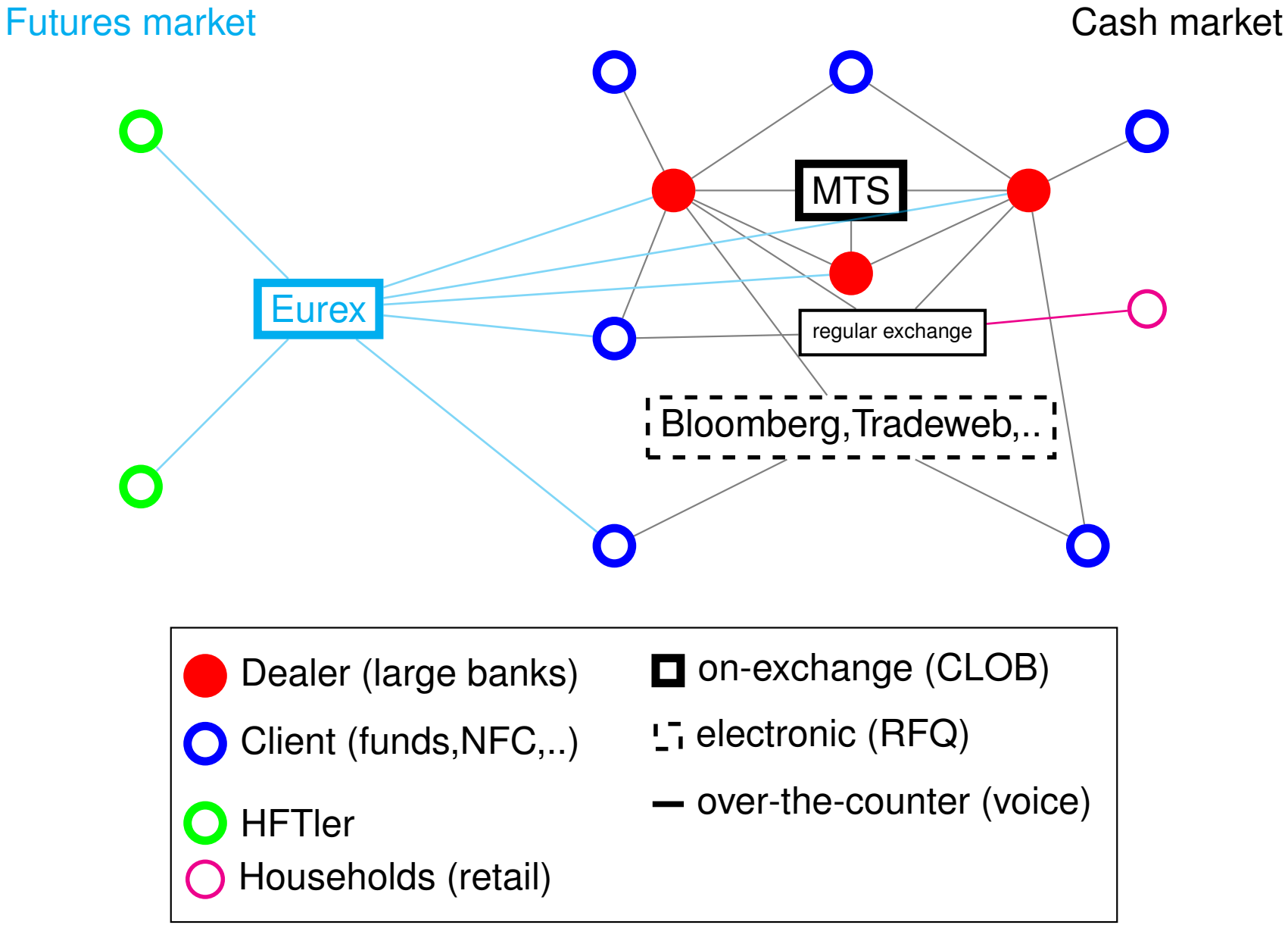



Figure: EGB Trading Volumes at the Instrument-Level. Each circle refers to an individual bond or bond future, with its size proportional to the notional trading volume. Bond futures are labelled, e.g. "FGBL" for the 10-year Bund future. Sample covers only plain-vanilla government bonds. See paper for details.

# Illustrative EGB Market Structure

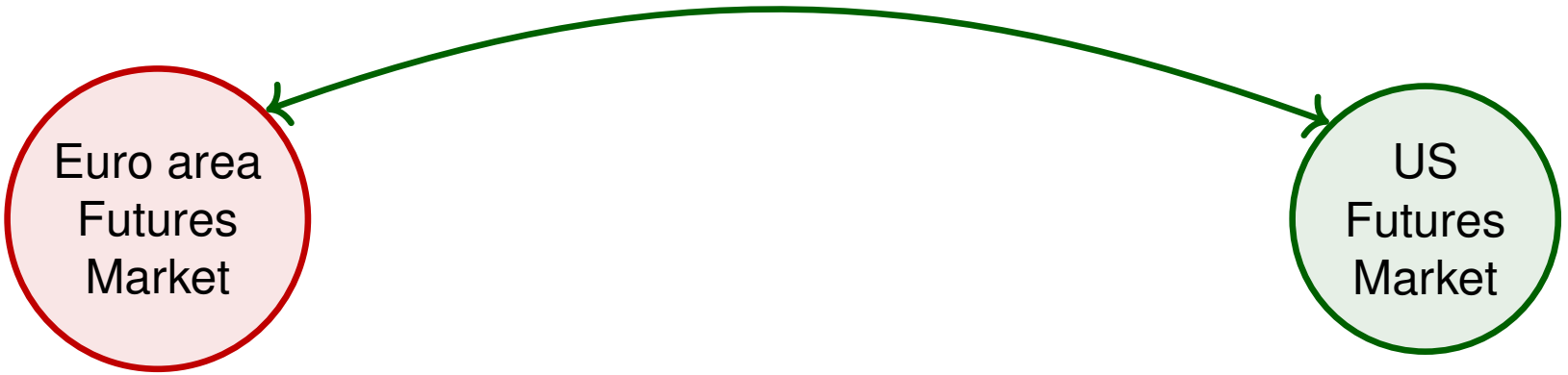
jump back



# US/EA Spillovers

jump back

do outages spill over between Eurex and CME?

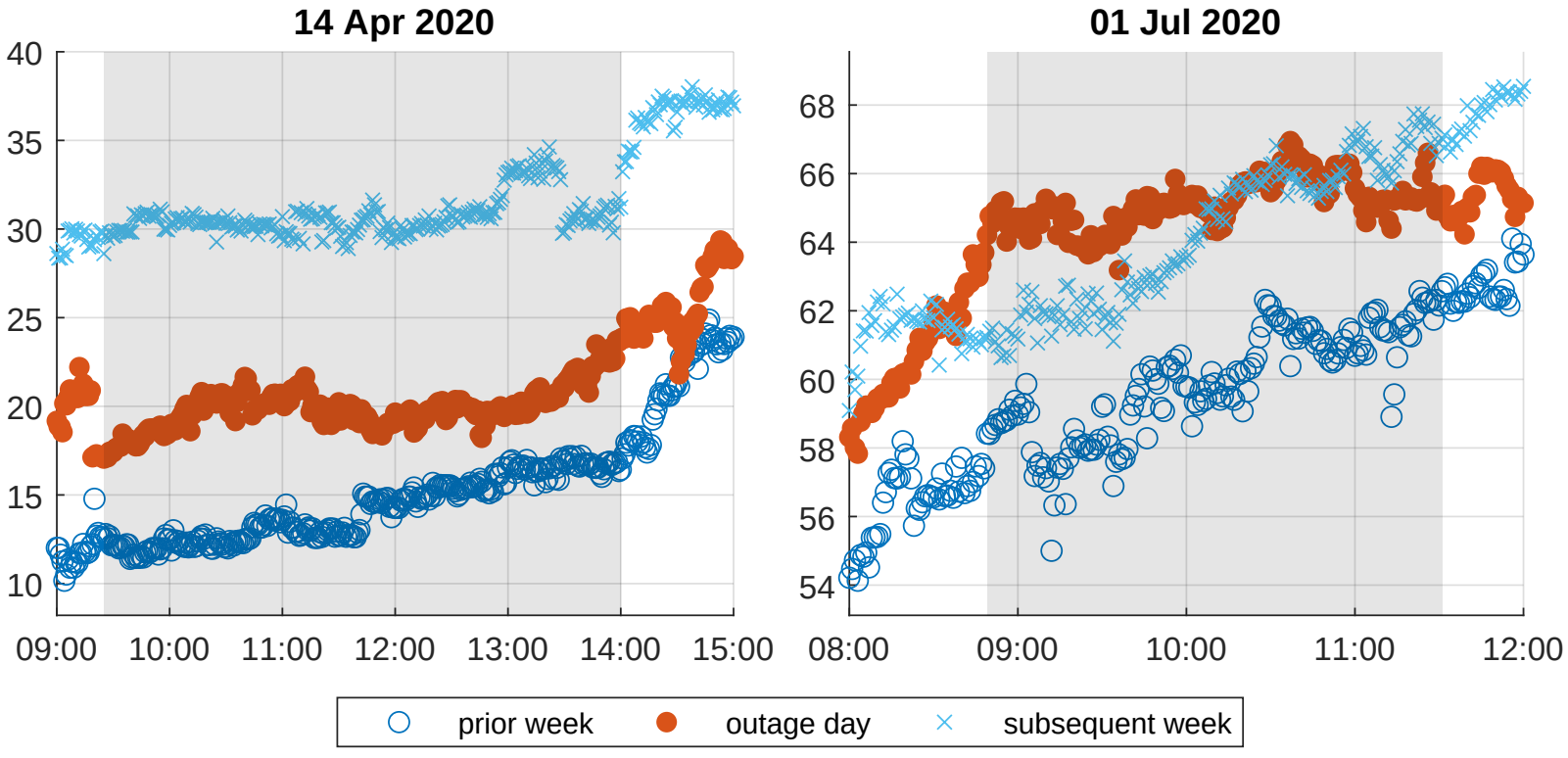



use Eurex outages to study EA→US

use CME/CBOT outages to study US→EA

- on 26 February 2019, the Chicago Mercantile Exchange (CME) was down from 7:39-10:45 p.m. US Eastern Time (see FT article)
- between 2006-2007, six outages on the Chicago Board of Trade (CBOT), predecessor of CME (Harding and Ma, 2010)

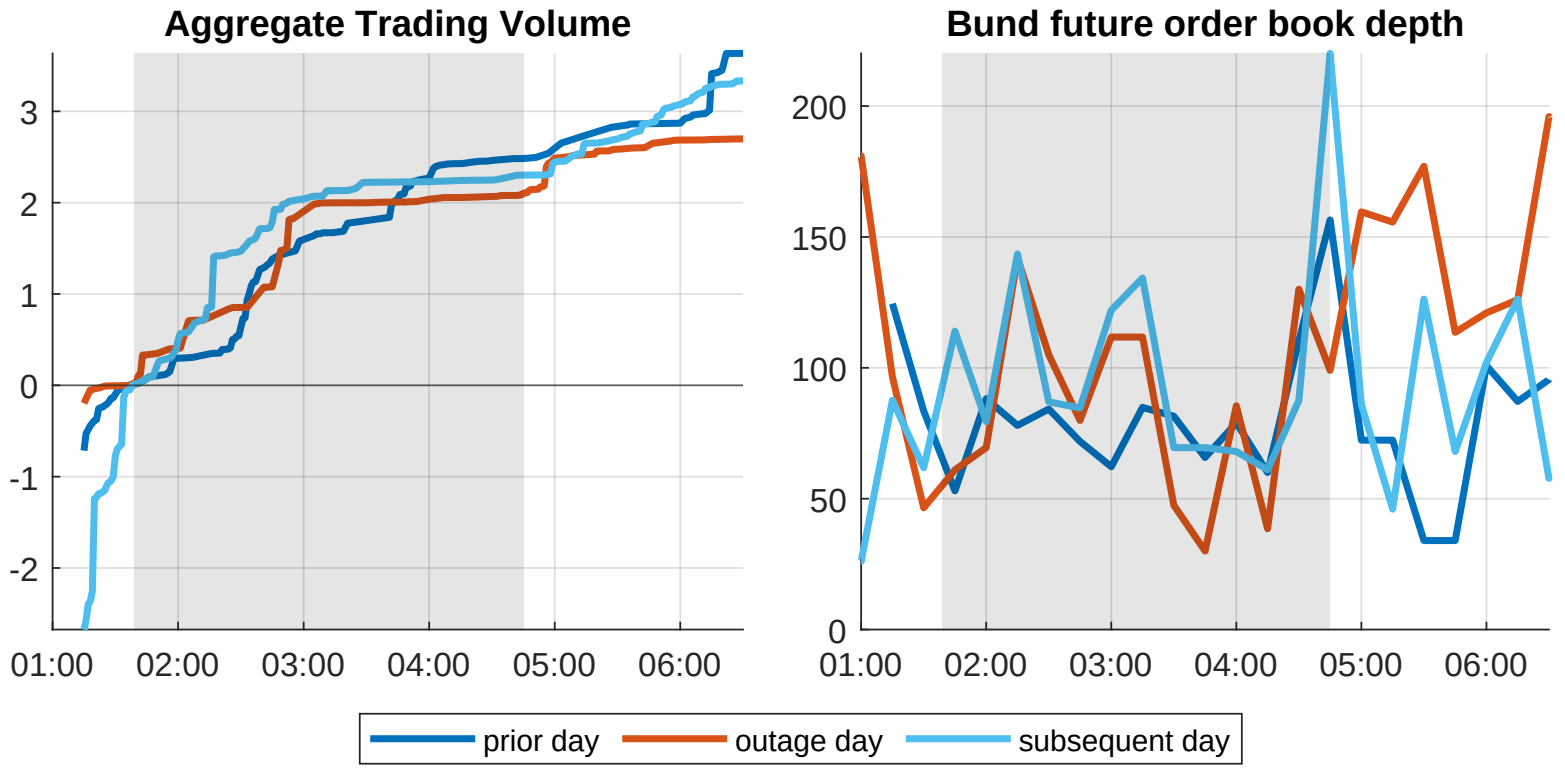
# Eurex outage has little impact on US Treasury futures




Order Book Depth of US Treasury Futures during Eurex outages. This figure shows the number of quoted contracts (in thousands) at the first 15 levels of both sides of the order book for 10-year Treasury futures. The grey area refers to the outage period on Eurex.

- small temporary drop in liquidity only for 1st outage
- maybe no surprise, but what about the other way around?
  We know US→ EA price spillovers very strong (see Boehm and Kroner, 2023)

# CME outage has little impact on Bund futures

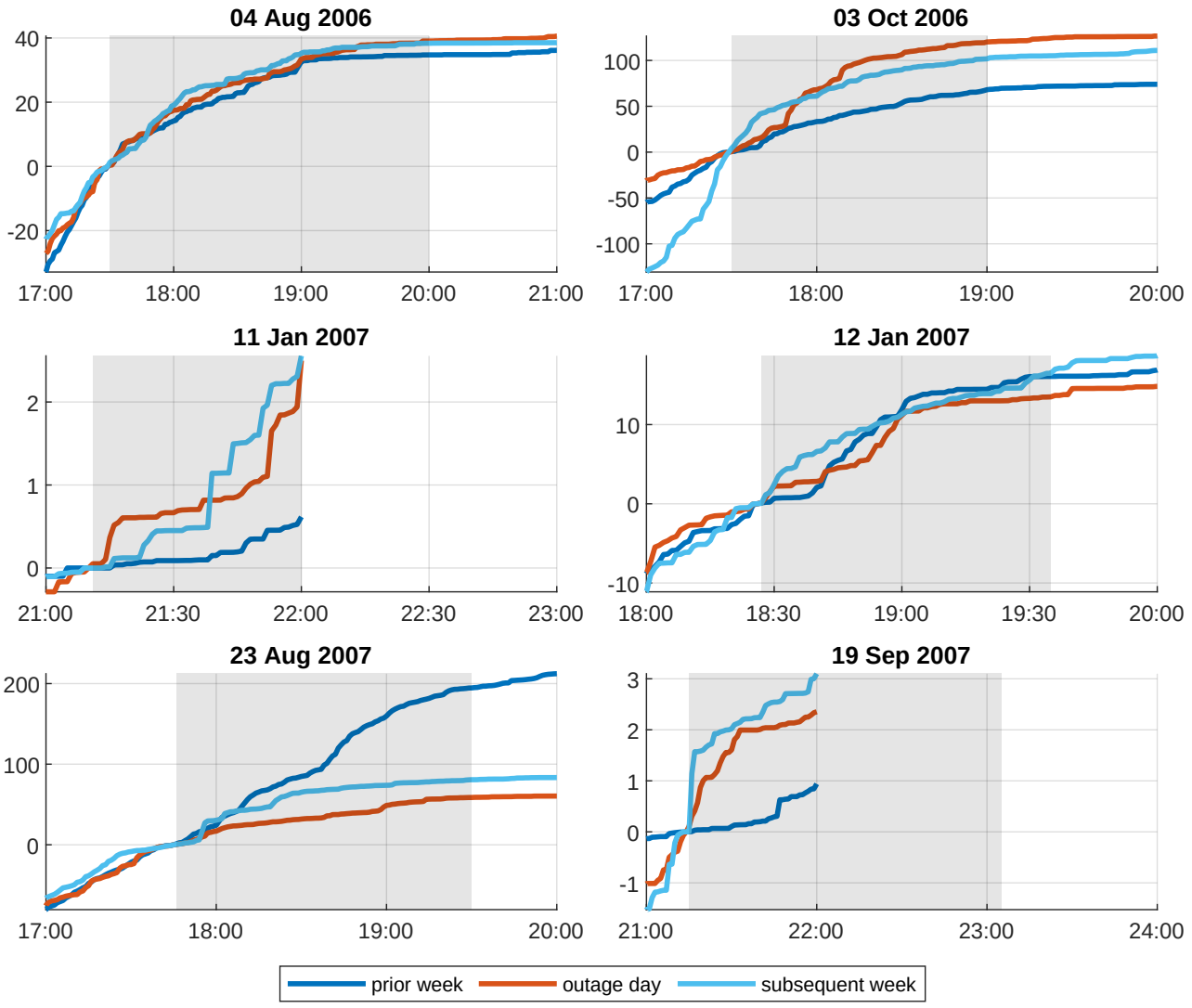



Eurex Activity during the CME Outage on 26 February 2019. The left panel shows the cumulative trading volume in all euro area bond futures on Eurex (in thousands of contracts, normalized to zero at the intraday time of the outage). The right panel shows the order book depth of 10-year German Bund futures (covering both sides of the first three levels of the order book; data comes from Bloomberg, since our Eurex order book data starts in April 2019). Red lines refer to the outage day, dark and light blue lines refer to the previous and subsequent day. In Central European Time, the outage occurred between 1:39 a.m. till 4:45 a.m. on 27 February 2019, marked by the grey area.

- no discernible decrease in Bund future liquidity
- due to timing of outage (very early morning)? No, see previous CBOT outages

# Previous CBOT outages also had little impact on Bund futures

jump back




No order book data for 2006-2007; look at cumulative trading volume of 10-year German bond futures around CBOT outages (in thousands of contracts, normalized to zero at the intraday time of the outage). Grey areas mark the outage times of CBOT.

No systematic effect

# Micro-level mechanism