Scarcity effects of QE: A transaction-level analysis in the Bund market

Kathi Schlepper
Deutsche Bundesbank

Heiko Hofer
Deutsche Bundesbank

Ryan Riordan
Queen's University

Andreas Schrimpf
Bank for International Settlements

Bank of Canada

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Outline

1. Motivation
2. Data
3. PSPP Programme
4. Price Impact
5. Liquidity Impact
6. Conclusions

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1 Motivation

2 Data

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Background

- The start of the PSPP programme caused uncertainty in European sovereign bond market.
- Surveys among market participants suggest most concerned about ability for participants to make markets, i.e. liquidity could be affected.
- MC study on Electronic Trading in Fixed Income Markets (2016) shows a decline in bid/ask spreads, but also highlights the risk that liquidity may have become less robust, i.e. fragile.
- Joint project between BIS and Bundesbank (and me;) to study how central bank bond purchases affect bond prices and liquidity.

Transmission channels

Signalling channel: price impact at the time of announcement. Investors instantaneously rebalance portfolios to reflect the new information.

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Portfolio re-balancing channel: frictions in markets cause relative scarcity. Investors slowly adjust portfolios and assets are not perfect substitutes. This leads to purchase (or flow effects) as assets are removed from the markets and slow investors adjust their portfolios.

Contribution to existing literature

Most papers focus on announcement effects:

- Altavilla et al (2015) study the effects of the ECB's PSPP
- Krishnamurthy et al (2015) analyze ECB's unconventional policies

Very few existing literature on security level:

- D'Amico and King (2013) investigate FED's QE programme
- Eser and Schwab (2016) on the impact of SMP programme

Main contributions:

- First paper using intra-day information on actual asset purchases
- Asset purchases represent repeated exogenous shocks that allows to study persistent effects on prices and liquidity
- Study the impact of QE on market liquidity conditions more broadly

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Data and markets

- Focus of analysis on German Bunds
- Asset purchases per ISIN since the start of the programme (Volume, price) with 1-minute time stamp
- MTS quote and trade data per ISIN with time stamp in seconds, quote data up to the third level of the order book
  $\Rightarrow$ Enables a precise identification of the impact of bond purchases
- Daily analysis: Time period from 09 March 2015 to 31 March 2016
- Intraday analysis: 10 September 2015 to 31 March 2016

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Dates

- Official announcement on 22 January 2015
  - Add PSPP to ABSPP and CBPP3 to a total purchase amount of 60 bn euro per month from March 2015 to at least September 2016.
  - Purchases are spread across national banks according to ECBs capital key, ECB also takes a part of initially 8%, since March 2016 10%.

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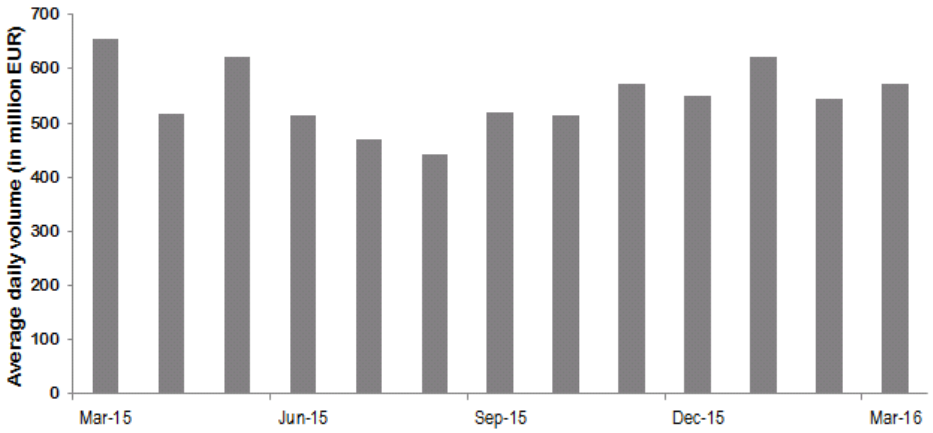
- Changes on 10 March 2016
  - Increase monthly purchases to 80 bn euro from April 2016 onwards
  - Deposit facility was decreased from -0.3 to -0.4%

Implementation

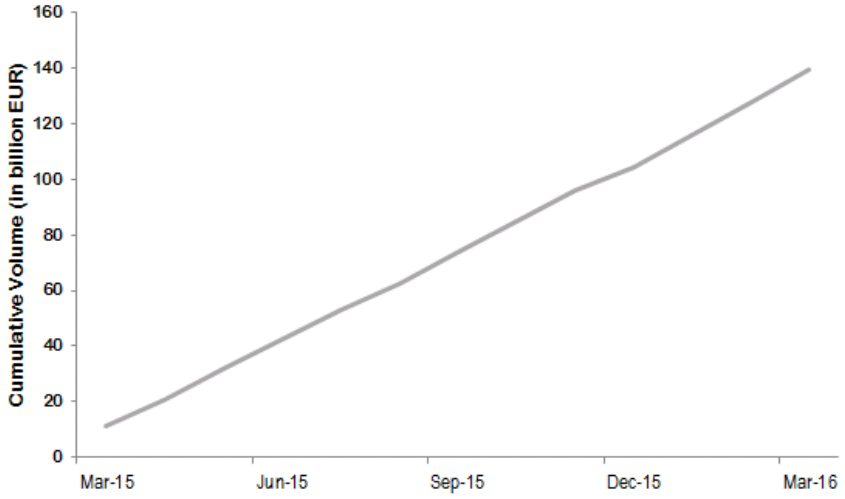
- Purchases only in secondary markets
- Maturity restriction: eligible securities must have a remaining maturity between 2 years and 30 years and 364 days
- Yield restriction: purchased bonds must have yields above the ECBs deposit facility
- Originally purchases of nominal and inflation-linked central government bonds; recognized agencies and EU supra-nationals were allowed, regional and local gov. bonds followed in Dec. 2015
- Central, regional and local gov. bonds only bought by the particular NCB and the ECB

Volume of German Securities Purchased under PSPP

Average daily purchase volume



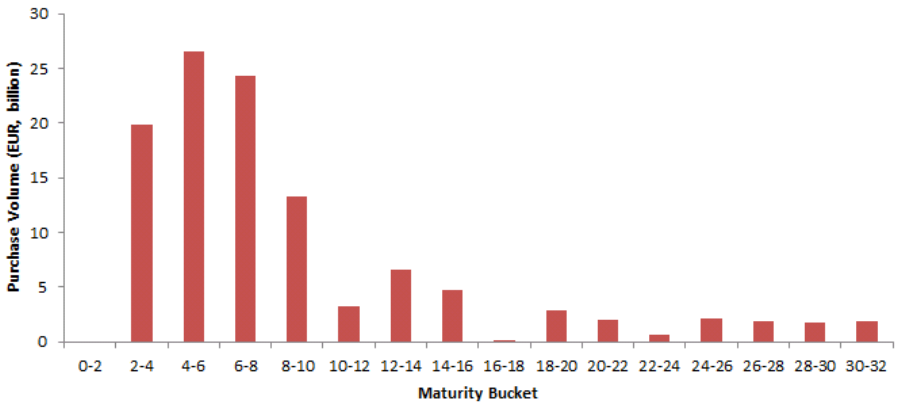
Cum. purchase volume



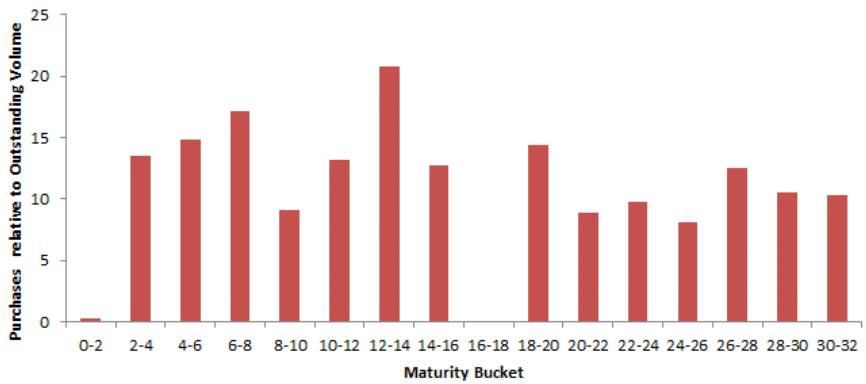
- Monthly volume (60 resp. 80 bn euro) only on average not every month, to account for seasonality
- Total purchased volume is steadily growing $\Rightarrow$ outstanding volume in the market is declining

Distribution of Asset Purchase Volume across Maturities

Purchased absolute volume



...relative to outstanding volume



- Absolute volume of purchases are concentrated in the lower maturities...
- ...proportional to outstanding volume

Implementation of Asset Purchases

	PSPP	**MTS** *(memo)*	**Ratio**
Mean ticket size (mEuro)	18.73	5.94	
Std. ticket size (in m Euro)	10.60	4.50	
Avg # purchases per bond–day	1.44	6.57	
# PSPP trades within best	4,232		92%
# PSPP trades better price	316		7%
# PSPP trades worse price	26		1%

Purchase Volume across Yield Curve Segments

	PSPP	**MTS**
Short term (0-3.5)	84.55	33.19
Medium term (3.5-7.5)	201.18	26.61
Long term (7.5-12.5)	103.04	25.27
Ultra long term (>12.5)	85.30	9.54

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Intraday analysis of price impact: methodology

- Estimate intraday price impact based on a VAR following Hasbrouck (1991)
- Use of 1-minute log price changes and central bank order flow in a bivariate autoregression framework
- Setup allows unambiguous identification of the price impact
- Determine the cumulative coefficient of the price change on the purchase amount for minutes 1 to 10

Vector Auto–Regression

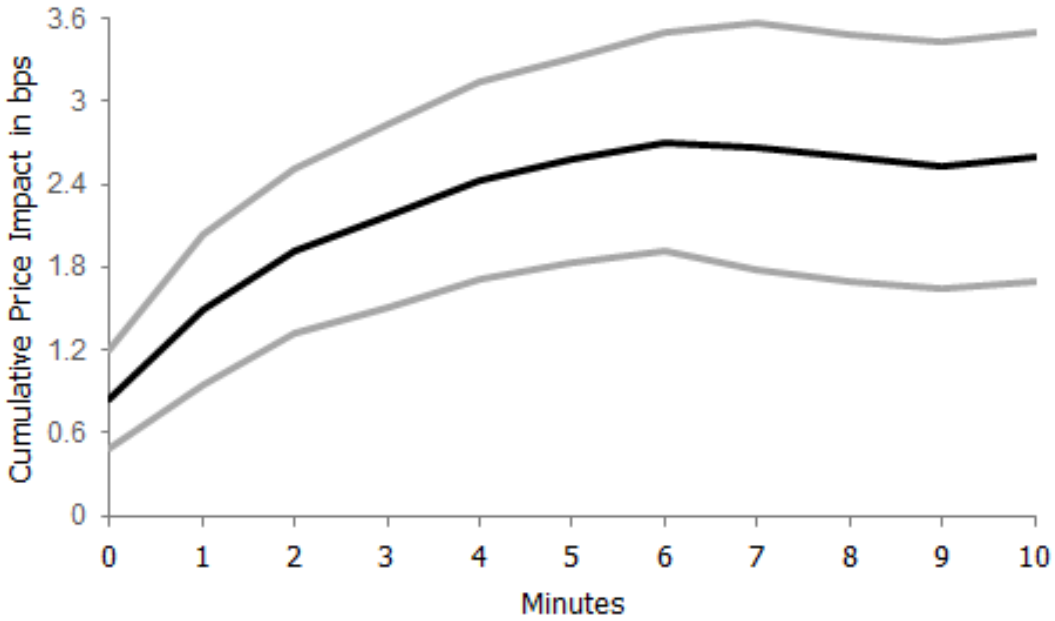
We estimate the following system:

$$r_t = a_0 + a_1 \cdot r_{t-1} + a_2 \cdot r_{t-2} + \ldots + a_{10} \cdot r_{t-10} + b_0 \cdot \Psi_t + b_1 \cdot \Psi_{t-1} + \ldots + b_{10} \cdot \Psi_{t-10} + \nu_{1t} \quad (1)$$

$$\Psi_t = c_0 + c_1 \cdot r_{t-1} + c_2 \cdot r_{t-2} + \ldots + c_{10} \cdot r_{t-10} + d_1 \cdot \Psi_{t-1} + \ldots + d_{10} \cdot \Psi_{t-10} + \nu_{2t}, \quad (2)$$

where $r_t = p_t - p_{t-1}$ denotes the (log) bond return and Ψ_t denotes the purchase volume of the central bank. Most of our interest lies in determining the cumulative price impact coefficient measured at 1-minute intervals and given by $\Lambda^{(N)} = \Sigma_{i=0}^{N} \widehat{b}_i$.

Intraday analysis of price impact: results

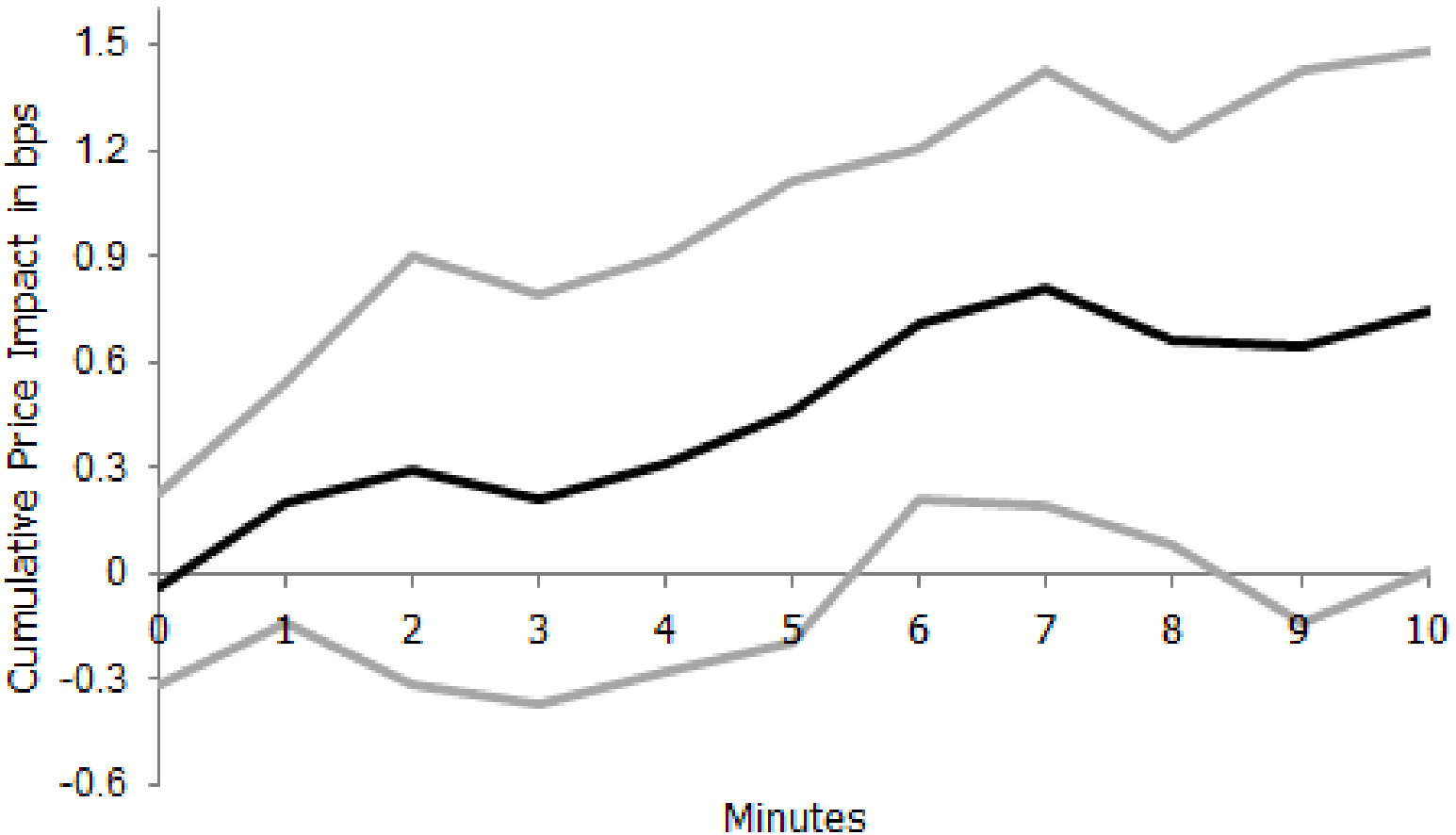


- Prices adjust to new equilibrium price with the 6 minutes after purchase
- Transactions are reflected in the wider inter-dealer market quickly $\Rightarrow$ dealers seem to update their quotes in the MTS market relatively quickly

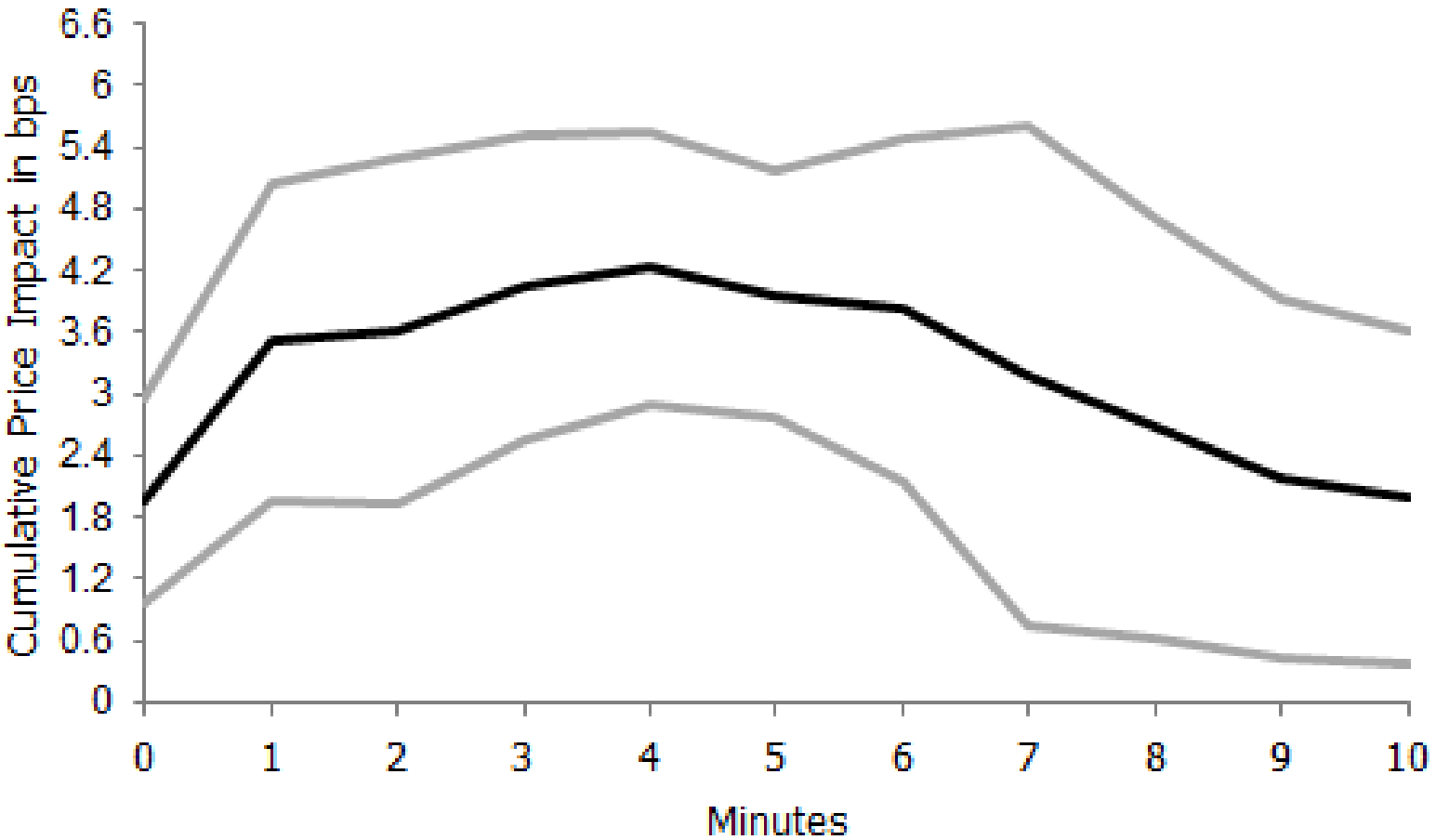
Intraday Price Impact

Minute post purch.	Coef. PSPP flow	Cum. Price Impact	CSR t-stat
0	0.54	0.54	3.98
1	0.34	0.88	3.75
2	0.20	1.07	3.54
3	0.36	1.43	4.27
4	0.22	1.65	4.78
5	-0.02	1.62	4.46
10	-0.01	1.49	3.66

Intraday analysis of price impact: maturity buckets (short–term)



Intraday analysis of price impact: maturity buckets (ultra long–term)



Daily analysis of price impact: methodology

- Diff-in-diff panel regression of price change on purchase dummy (interacted with the purchase amount in EUR million)

$$r_{i,t} = \alpha_i + \beta \cdot \Psi_{i,t} + \delta \cdot Controls_{(i),t} + \epsilon_{i,t}, \tag{3}$$

- Control variables:
  - Time-series controls: market volatility, yield-spread, purchases in 2016, end-of-year and announcement effects
  - Bond-specific controls: eligibility, purchases on the previous day, maturity

Daily analysis of price impact: results

- Positive impact of PSPP purchases on prices relative to not purchased bonds
- Impact of pure purchase signal ranges between 1.14 and 3.07 Bps
- Impact of purchase amount ranges between 2.19 and 6.10 Bps
- Important control variables:
  - Announcements of changes in PSPP (-)
  - Purchases in 2016 (+)
  - Previous purchase (-)
- Results suggest that purchase effects are detectable beyond initial impact after a couple of minutes

$\Rightarrow$ Suggest a quantitatively significant scarcity channel of QE transmission

Daily Price Impact

	Panel A: Purchases			
	(1)	(2)	(3)	(4)
Ψ	1.139*	1.261	2.893***	3.074***
	(0.683)	(0.796)	(0.977)	(1.001)
Vix	2.704***	2.705***	2.704***	2.704***
	(0.465)	(0.465)	(0.465)	(0.465)
	Panel B: Amounts			
	(1)	(2)	(3)	(4)
Ψ	2.189**	2.284**	4.188***	6.097***
	(1.025)	(1.097)	(1.296)	(1.696)
Vix	2.702***	2.703***	2.701***	2.700***
	(0.465)	(0.464)	(0.464)	(0.464)

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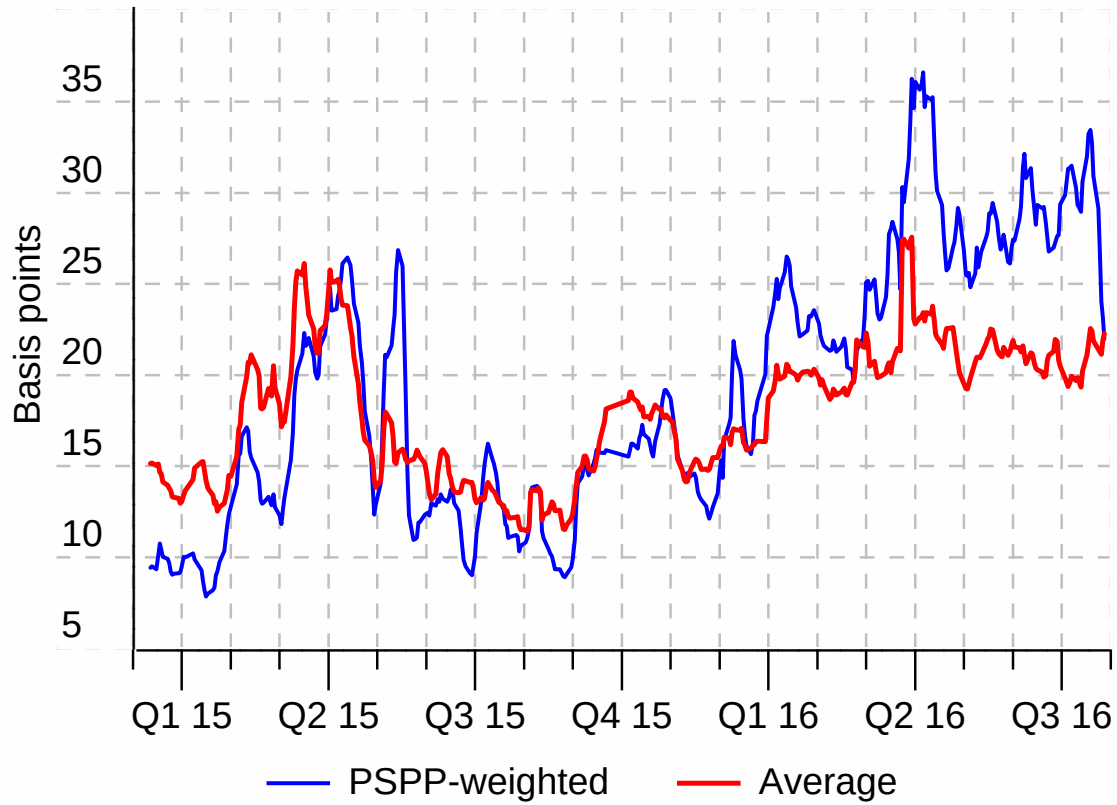
Bund Market Liquidity

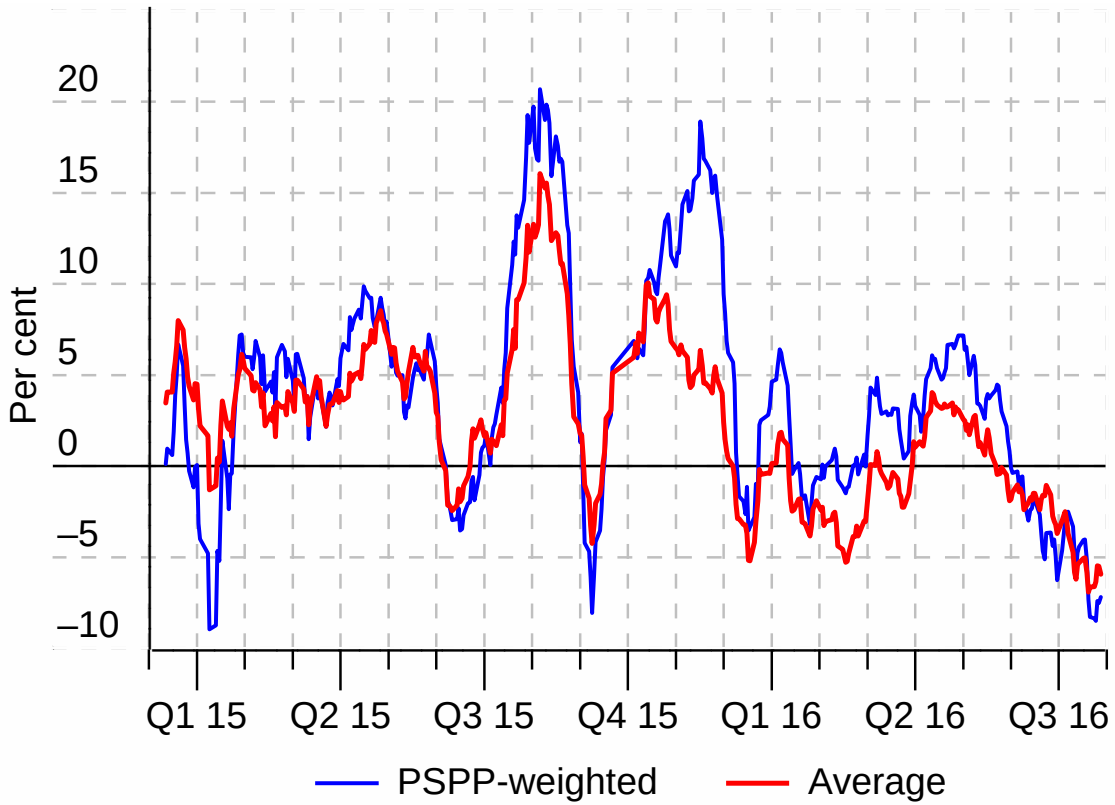
Liquidity measures constructed from MTS order book data

- Relative Bid ask spread
- Top–of–book depth
- First three levels of depth
- Order book imbalance

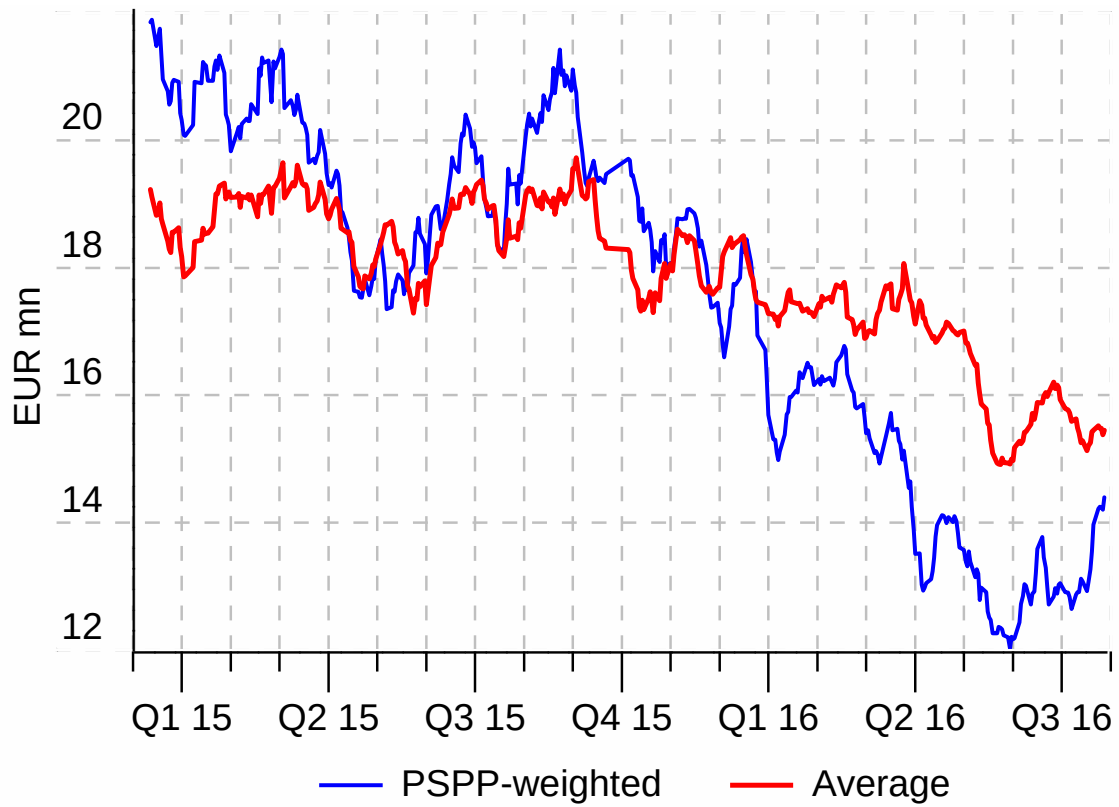
Relative Bid–Ask Spread on MTS



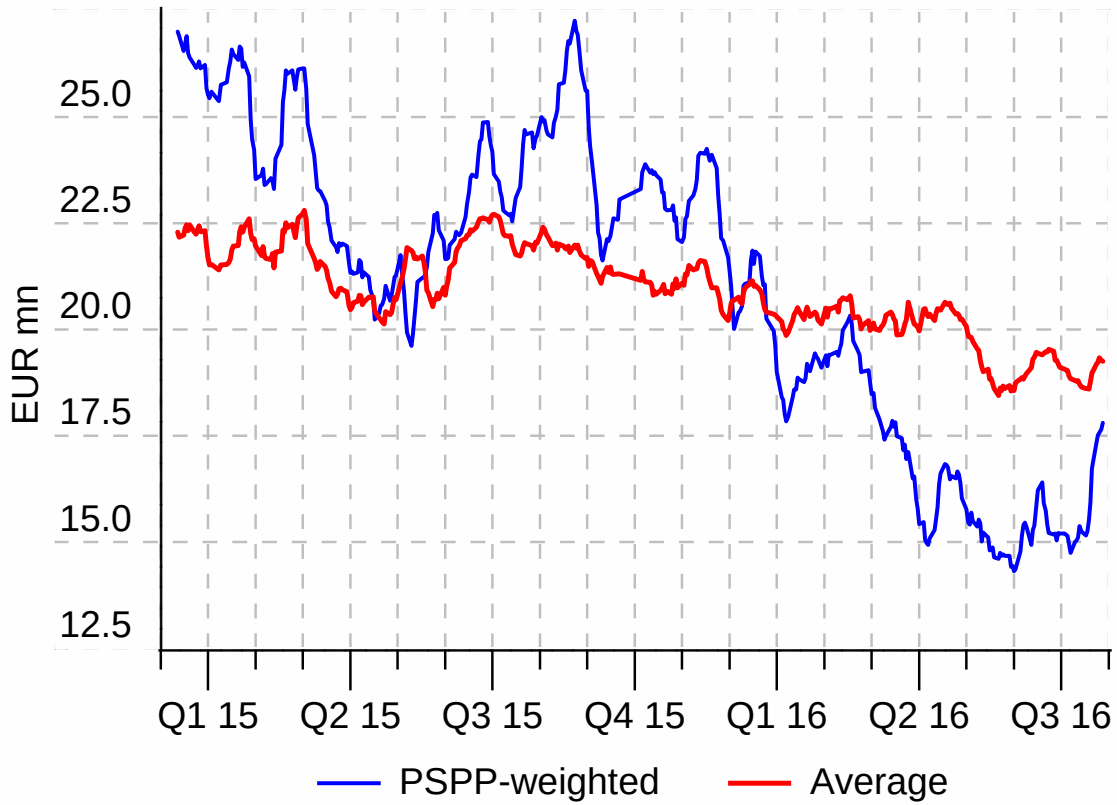
Order Book Imbalance on MTS



Top of Book Depth on MTS



Top–3 Book Depth on MTS



Bund Market Liquidity

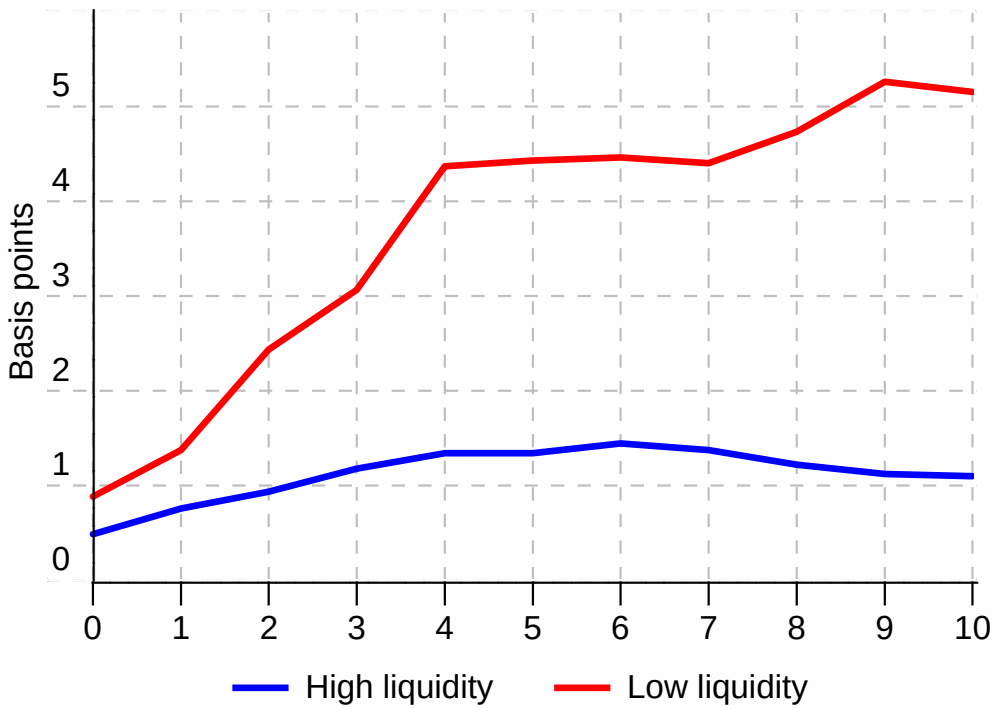
Liquidity (on MTS) is worse now than at the start of the programme.

- Liquidity appears to have worsened
- Spreads have widened
- Depth has decreased
- Decrease correlates with purchase volumes in those maturities

Intraday analysis of price impact in stress periods

Do purchases have a larger price impact during episodes of strained liquidity?

- Liquid market regime: relative bid-ask spread $>$ mean spread per bond
- Illiquid market regime: relative bid-ask spread $<$ mean spread per bond
  $\Rightarrow$ prices adjust to central bank purchases slower in illiquid markets than in liquid markets.



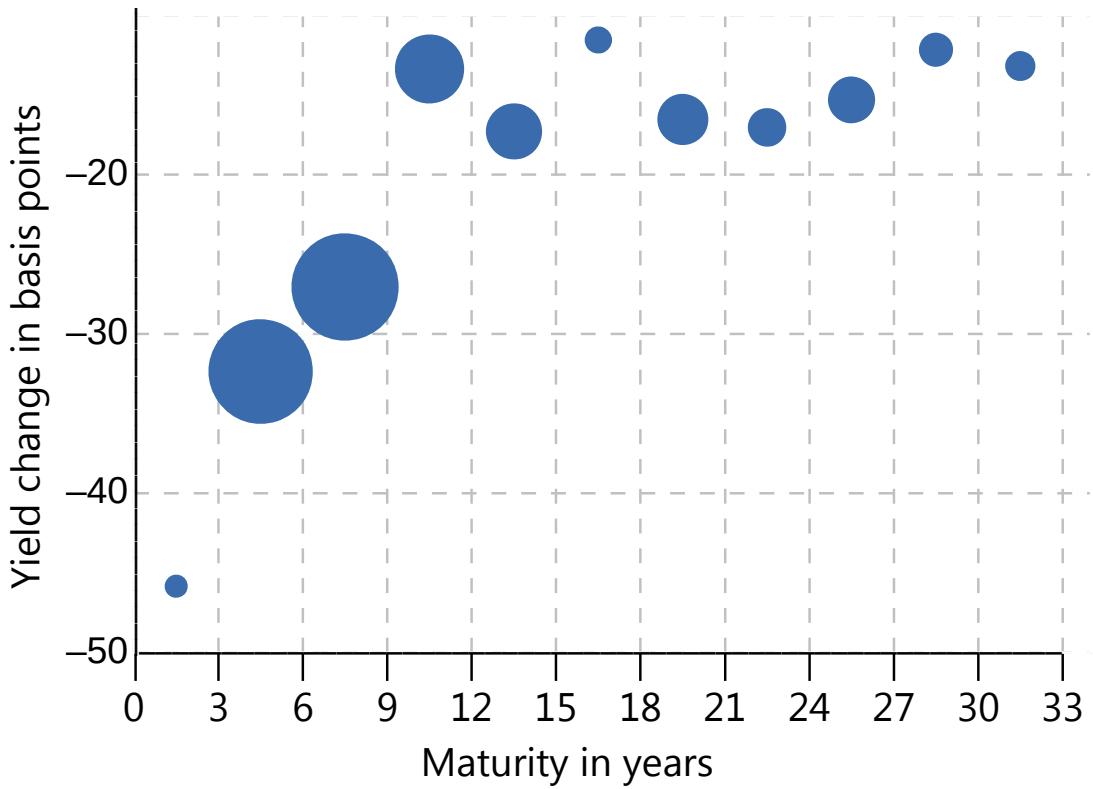
Daily analysis of price impact in stress periods

- Daily price impacts are larger when liquidity is low.
- Low liquidity days: price impacts are between 3 and 7 basis points.

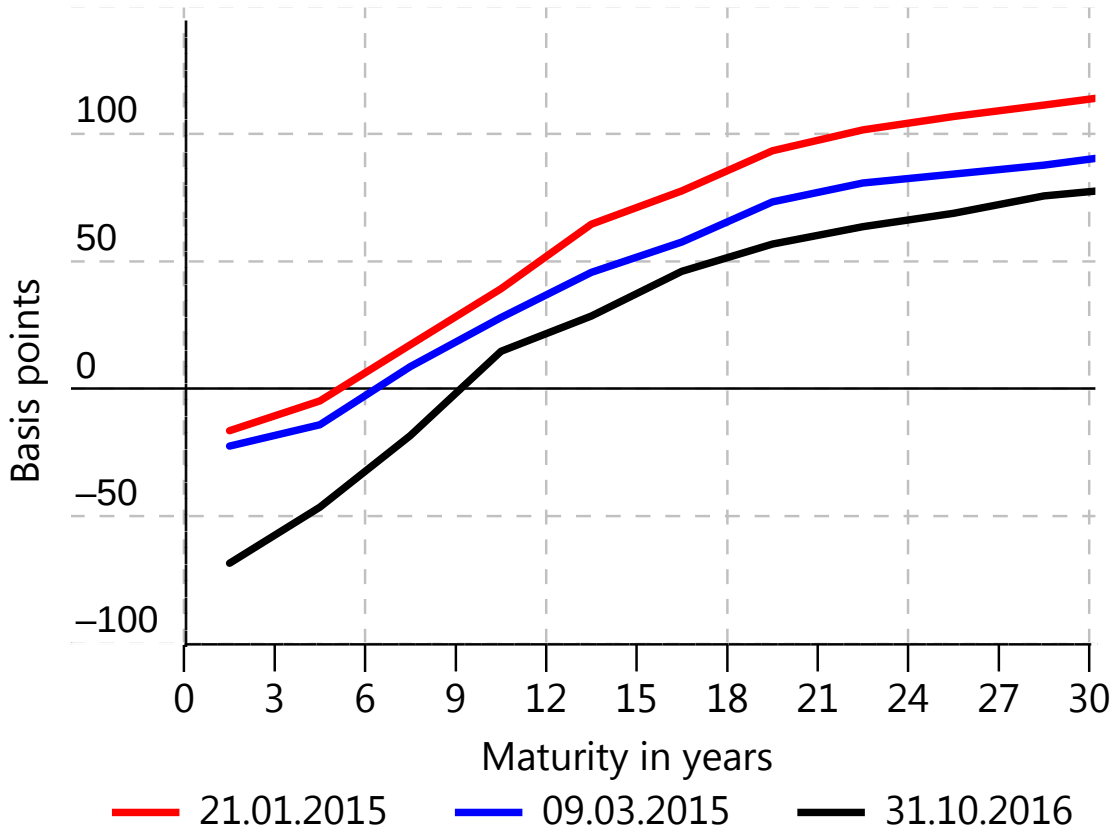
  $\Rightarrow$ 2.5 times higher than average in terms of purchase signal

  $\Rightarrow$ 50% higher price impact than average in terms of purchase amount
- High liquidity days: impacts are around zero and insignificant

Are the effects permanent?



Signalling or Rebalancing?



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Conclusions

1. Bundesbank asset purchases have a direct impact on bond prices in the wholesale market.
   - Average price impact of 4 basis points (per EUR 100 million)
   - Market settles on new equilibrium price about 5 to 10 min after the trade

   $\Rightarrow$ Despite the transparency of the PSPP programme it has a sizeable (and permanent?) price impacts on Bunds.

   $\Rightarrow$ QE policies do not just work via a signalling channel, but scarcity (portfolio re-balancing) effects are important, too.

2. Liquidity has been affected negatively with wide–reaching effects.

3. Price impacts are greater in periods of strained liquidity conditions.

Extra slides