Disentangling the effects of multidimensional monetary policy on inflation and inflation expectations in the euro area

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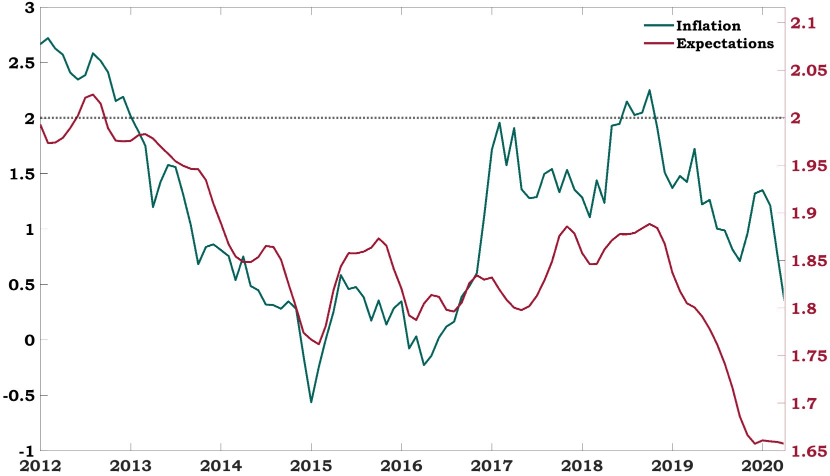
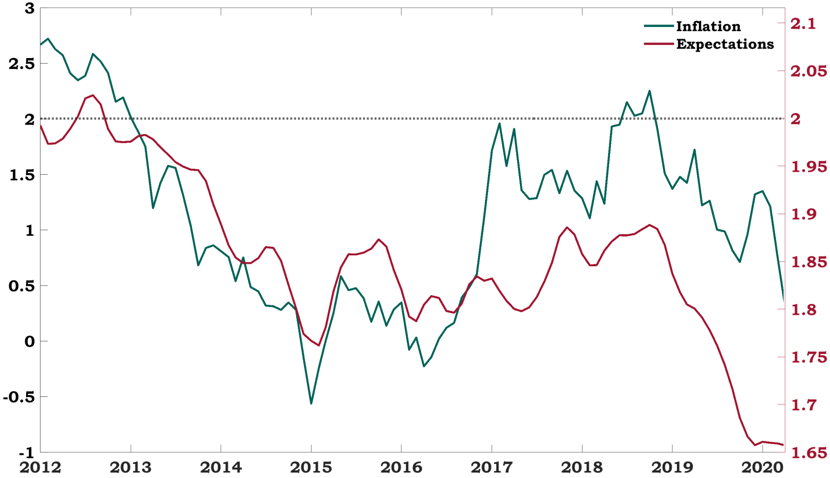
Research Question

What is the effectiveness of the ECB's monetary policy toolkit for achieving price stability and anchoring inflation expectations?

Inflation and inflation expectations in the euro area

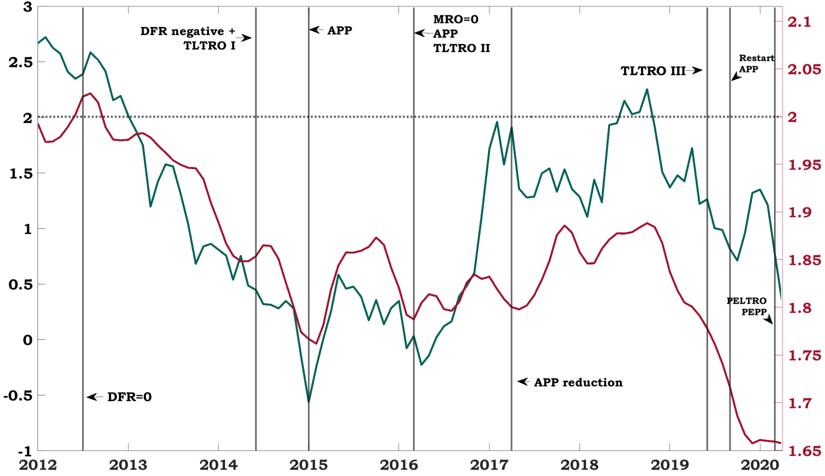


Inflation and inflation expectations in the euro area

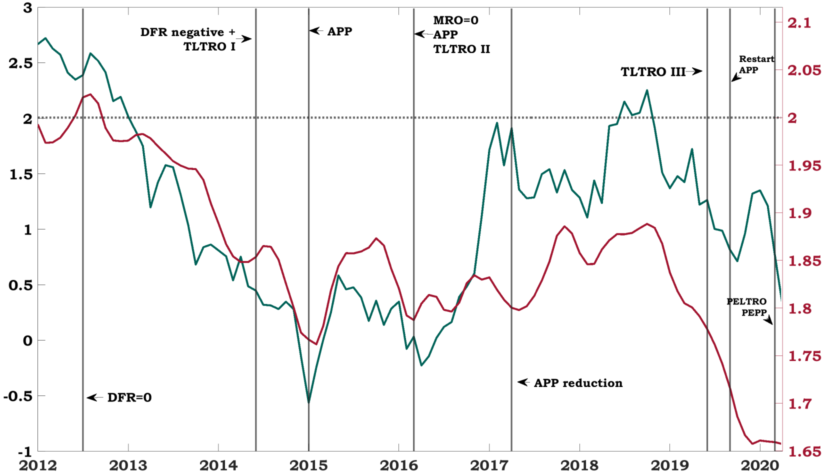


- Inflation and expectations lower than *close but below 2%* target

Inflation and inflation expectations in the euro area



Inflation and inflation expectations in the euro area



- What is the effectiveness of each tool to influence inflation and expectations?

This paper

- Novel high-frequency identification of shocks related to conventional, unconventional (forward guidance, LTRO, QE) and communication tools
- Assess the effectiveness of several tools for increasing inflation and for anchoring inflation expectations
- Forecaster's vs consumer's short-term inflation expectations

Sneak peak...

- *Re-anchored inflation expectations channel*: Long-term inflation expectations of professional forecasters increase in response to forward guidance and QE
- Inflation increases and remains significantly high for over one year after a forward guidance shock
- *ECB's information effect*: Inflation, interest rate, and expectations decrease
- Short-term inflation expectations of consumers and forecasters react in opposite directions to QE shocks

Related Literature

- Macroeconomic effects of UMP shocks:
  - Single UMP shock, Corsetti, Duarte, and Mann (2018), Hachula, Piffer, and Rieth (2019),
  - Isolate one or block of UMP policies, Campbell et al. (2012), Boeckx, Dossche, and Peersman (2017), Gambetti and Musso (2017), Jarociński and Karadi (2020), Andrade and Ferroni (2020), among many others
  - Normally UMP tools announced in the same time window

Related Literature

- High-frequency identification of monetary policy shocks, Gürkaynak, Sack, and Swanson (2005), Nakamura and Steinsson (2018), Rogers, Scotti, and Wright (2018), Swanson (2019), Altavilla et al. (2019), among many others
  - Different types of shocks with respect to the yield curve term structure
  - Multidimensional monetary policy: Target, path, balance sheet

Outline

- A VAR for the Euro Area Economy
- Identification Strategy
- Estimation details & Results
- Policy implications and conclusions

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A VAR for the euro area economy

- Model macro and financial variables through VAR:

$$y_t = c + A_1 y_{t-1} + \cdots + A_p y_{t-p} + u_t, \quad u_t \sim \mathcal{N}(0, \Sigma) \qquad (1)$$

- y_t is a $N \times 1$ vector of data, A_i are matrices of parameters for $i = 1, \cdots, p$, and u_t are the reduced-form errors
- Large Bayesian VAR à la Giannone, Lenza, and Primiceri (2015), Details
- Bridge between structural and reduced-form VAR

$$u_t = H\varepsilon_t \qquad (2)$$

- H is the impact matrix, $\Sigma = HH'$

How to identify the monetary policy shocks?

- Sign restrictions, Andrade and Ferroni (2020), Jarociński and Karadi (2020), Gambetti and Musso (2017)
- Heteroskedasticity, Wright (2012)
- Use of extraneous data:
  - Proxy VAR, Stock and Watson (2012, 2018), Mertens and Ravn (2013)
  - Internal instrument approach, Noh (2017), Paul (2019), Plagborg-Møller and Wolf (Forthcoming)

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  - **This paper:** Internal instrument approach, Noh (2017), Paul (2019), Plagborg-Møller and Wolf (Forthcoming)
    - Augment endogenous variables with Proxies + Choleski decomposition
- How to obtain monetary policy proxies?

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Monetary Policy in the euro area

- ECB's monetary policy decisions: Press release (13:45 CET), Press conference (14:30-15:30 CET), Monetary Policy Event Window (13:45-15:30 CET)
  - Since 2016 UMP is communicated in the press release window
- Euro Area Monetary Policy Event-Study Data Base (EA-MPD), EA-MPD Altavilla et al. (2019)
  - Target, path and balance sheet components in monetary policy event window
  - January 2002 - February 2020, 199 governing council meetings
  - $Z = 199 \times 34$ matrix of asset and bond surprises from the EA-MPD: OIS, sovereign bond yields, stock market prices indices, exchange rates

A factor model for MP announcements

- The matrix of surprises Z evolves as a factor model:

$$Z = F\Lambda' + \xi, \quad \xi \sim \mathcal{N}(0, R) \tag{3}$$

- Factors, F is $T^* \times r$; loadings, Λ is $34 \times r$ and $T^* = 199$ are dates of governing council meetings,
  - Set r=4, 58% of explained variance scree plot

- Identification problem: $F^* = FQ$ and $\Lambda^* = \Lambda Q$ observationally equivalent, where Q is a rotation matrix

- Find a rotation matrix Q with economic meaning

The restrictions

$$\Lambda^* = \begin{array}{cc} \begin{array}{cccc} \text{Target} & \text{Path} & \text{LTRO} & \text{QE} \end{array} & \\ \begin{bmatrix} * & 0 & 0 & 0 \\ * & * & * & 0 \\ * & * & * & * \\ \vdots & \vdots & \vdots & \vdots \\ * & * & * & * \end{bmatrix} & \begin{array}{c} \text{OIS1M} \\ \text{OIS3M} \\ \text{OIS6M} \\ \vdots \\ \end{array} \end{array}$$

The restrictions

$$\Lambda^* = \begin{array}{c} \\ \\ \end{array}\left[\begin{array}{cccc} \text{Target} & \text{Path} & \text{LTRO} & \text{QE} \\ * & 0 & 0 & 0 \\ * & * & * & 0 \\ * & * & * & * \\ \vdots & \vdots & \vdots & \vdots \\ * & * & * & * \end{array}\right] \begin{array}{c} \\ \text{OIS1M} \\ \text{OIS3M} \\ \text{OIS6M} \\ \vdots \\ \\ \end{array}$$

- Unrestricted Target factor
- Target in MP event window, Press release vs MP window
  - Cleanse the effects of conventional MP on remaining factors

The restrictions

$$
\Lambda^* = \begin{array}{c} \\ \left[\begin{array}{cccc} \text{Target} & \text{Path} & \text{LTRO} & \text{QE} \\ * & 0 & 0 & 0 \\ * & * & * & 0 \\ * & * & * & * \\ \vdots & \vdots & \vdots & \vdots \\ * & * & * & * \end{array}\right] \end{array} \begin{array}{c} \\ \text{OIS1M} \\ \text{OIS3M} \\ \text{OIS6M} \\ \vdots \\ \\ \end{array}
$$

- Forward guidance implemented to influence medium- to long-term horizons

The restrictions

$$\Lambda^* = \begin{array}{cl} \begin{array}{cccc} \text{Target} & \text{Path} & \text{LTRO} & \text{QE} \end{array} & \\ \left[\begin{array}{cccc} * & 0 & 0 & 0 \\ * & * & * & 0 \\ * & * & * & * \\ \vdots & \vdots & \vdots & \vdots \\ * & * & * & * \end{array}\right] & \begin{array}{l} \text{OIS1M} \\ \text{OIS3M} \\ \text{OIS6M} \\ \vdots \\ \end{array} \end{array}$$

- Least percentage of explained variance before the Great Recession, in the spirit of Swanson (2019)
- QE influence long-end of the yield curve

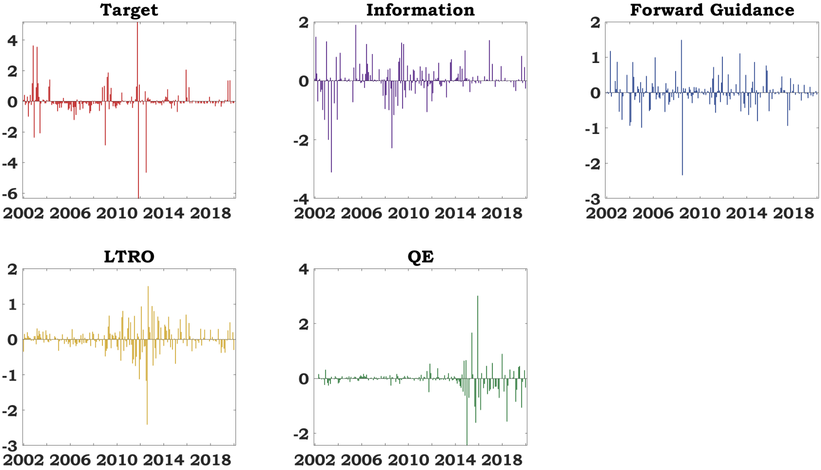
Finding a Rotation

Disentangling between information and forward guidance

- Information (forward guidance) shocks: interest rates and stock market indices positively (negatively) correlated , Andrade and Ferroni (2020), Jarociński and Karadi (2020)
  - Information factor: observations of path factor such that STOXX50 and OIS-5Y positively commove
  - Forward guidance factor: observations of path factor such that STOXX50 and OIS-5Y negatively commove

Orthogonal factors

MP Factors



▸ Loadings: OIS ▸ Loadings: all variables

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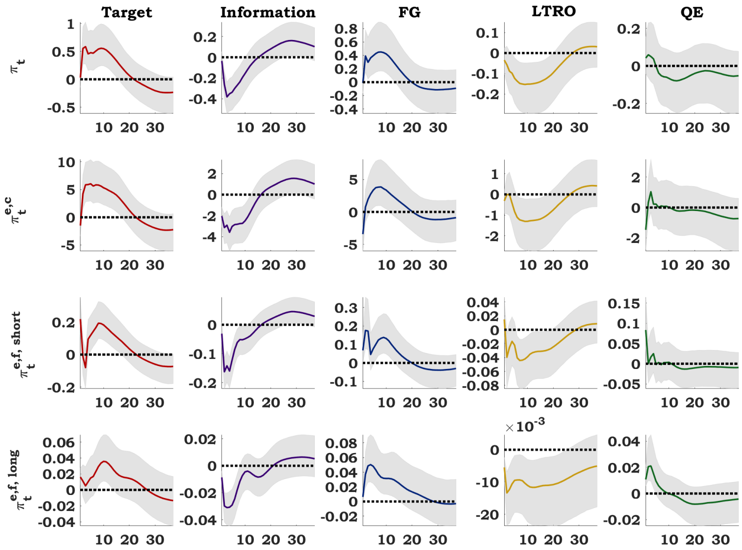
Data

- 20 monthly macroeconomic and financial variables
  - Output, Inflation, exchange rate, interest rates, stock market, spreads...
  - Short-term expectations: Consumers (European Commission) and forecasters (Eurozone Barometer)
  - Long-term expectations: Survey of Professional Forecasters (ECB)
- Year-over-Year transformations when applicable

Estimation details

- Model with $p = 3$ lags, ACF& PACF
- 50000 draws, burn-in-sample=25000, Geweke test
- Shocks normalisation:
  - Target: 25 basis points decrease in EURIBOR 1M
  - Information: 15 basis points decrease in 2Y yield
  - FG: 15 basis points decrease in 2Y yield
  - LTRO: 10 basis points decrease in spread between 10Y Italian and German sovereign bond yields
  - QE: 10 basis points decrease in 10Y yield

Have UMP been effective in increasing inflation?



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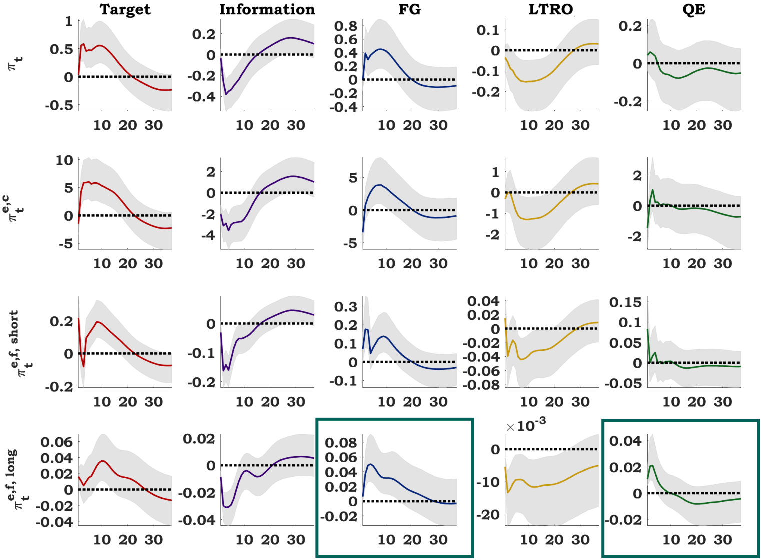

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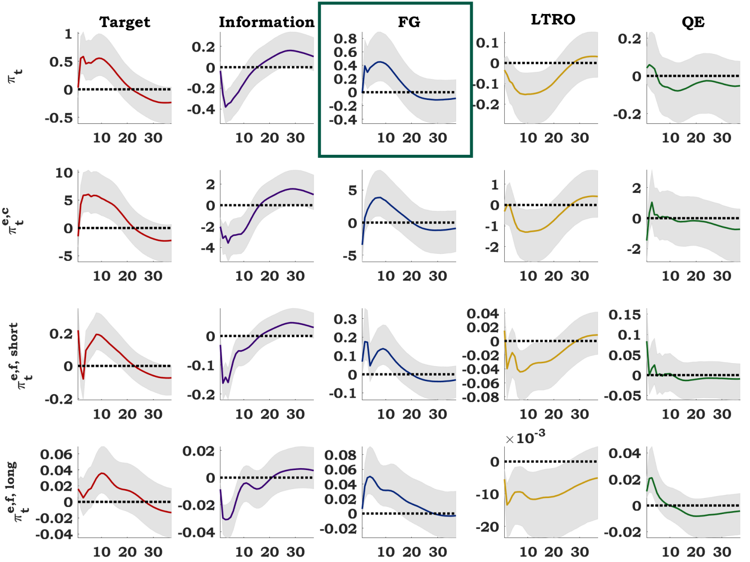

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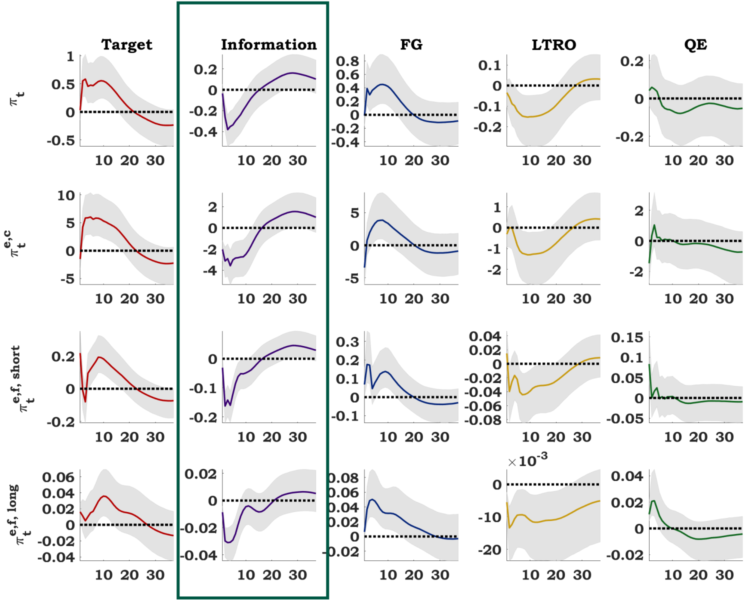

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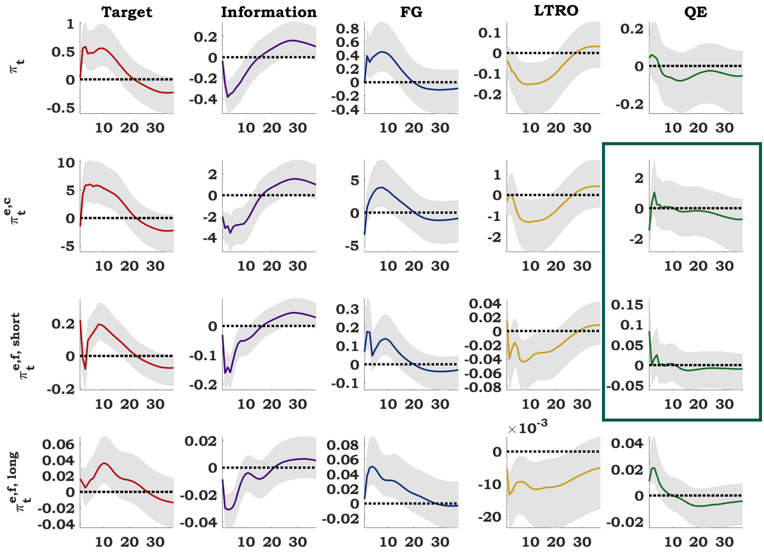
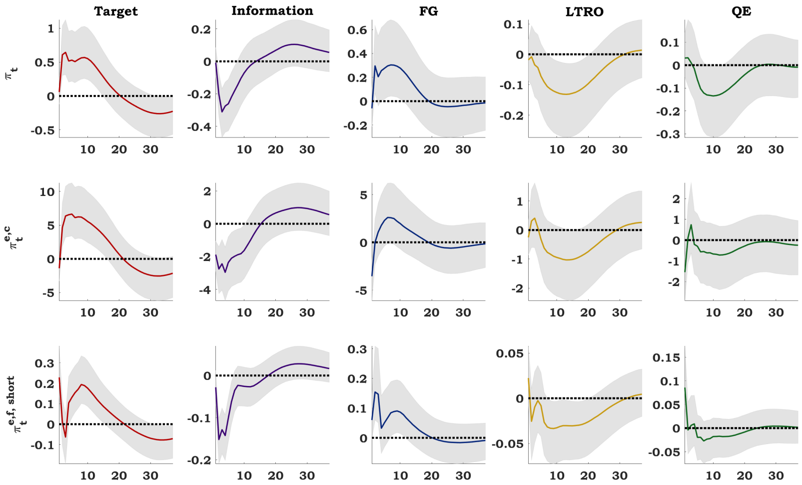


The re-anchoring transmission channel



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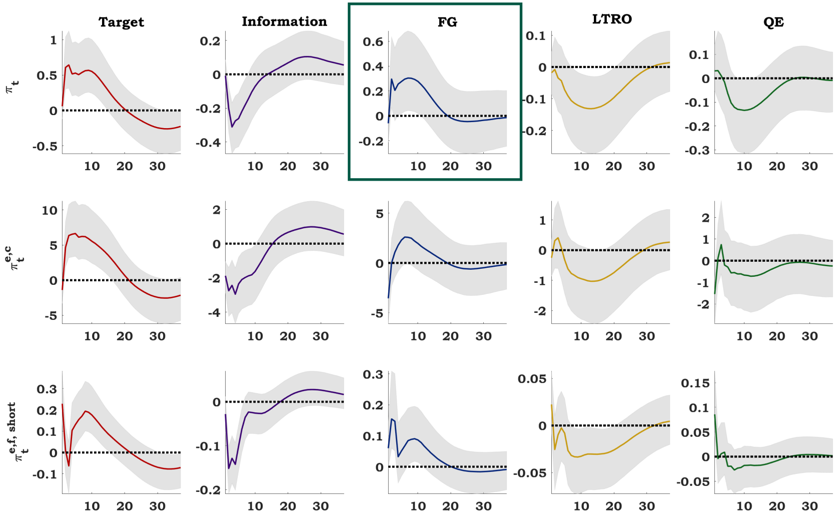

Conclusions & policy implications

- Re-anchored inflation expectations after QE and forward guidance
- Consumers and forecasters have opposite reaction to QE
  - Possible misinterpretation of MP decisions
  - Tailor-made communication strategies for several agents in the economy
- Power of inflation expectations for monetary policy transmission
  - Inflation expectations as a policy tool, Coibion et al. (2020)

Thank you!

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You can access the latest version of the paper here

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The priors

$$\Sigma \sim iW(\Psi, d)$$
$$\text{vec}(A)|\Sigma \sim \mathcal{N}(a, \Sigma \otimes \Omega)$$

- Minnesota, sum-of-coefficients and single-unit-root, priors

$$\underline{A} := \mathbb{E}[(A_\ell)_{i,j}|\Sigma] = \begin{cases} \delta_i, & i = j \quad \& \quad \ell = 1 \\ 0 & \text{otherwise} \end{cases} \tag{4}$$

$$V_a := \text{cov}\left((A_\ell)_{i,j}, (A_k)_{r,s}|\Sigma\right) = \begin{cases} \frac{\theta_1^2}{\ell^{\theta_2}} \frac{\Sigma_{i,r}}{\psi_j/(d-N-1)} & j = s \quad \& \quad \ell = k \\ 0 & \text{otherwise.} \end{cases} \tag{5}$$

back

The large Bayesian VAR

- Maximise of Marginal Data Density, closed-form solution
  - MDD: Function of the hyperparameters (θ) of the prior
  - Optimal shrinkage degree
- Uncertainty about hyperparameters: Hierarchical model
  - Gamma priors for hyperparameters
  - Draws through a Metropolis-Hastings algorithm
- Sample large BVAR parameters $\alpha = \text{vec}(\tilde{A})$ and $\tilde{\Sigma}$

$$\alpha|\theta, \Sigma, \tilde{Y} \sim \mathcal{N}\left(\tilde{\alpha}, \tilde{V}_\alpha\right) \tag{6}$$

$$\Sigma|\theta, \tilde{Y} \sim iW\left(\tilde{\Psi}, \tilde{T} - p + d\right) \tag{7}$$

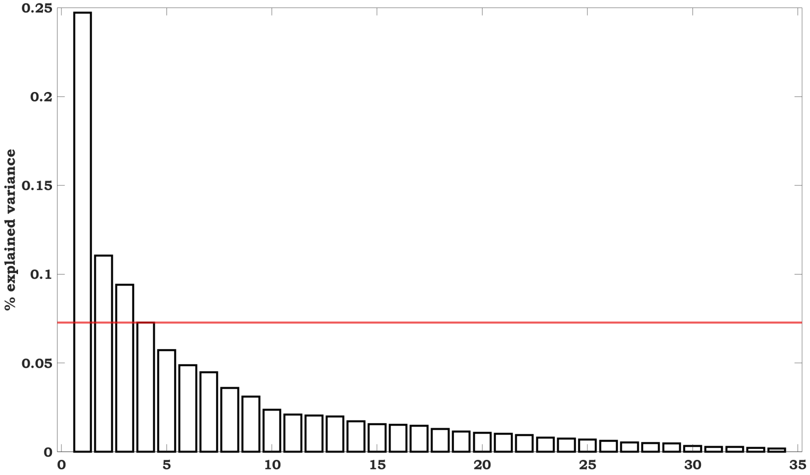
back

The EA-MPD

- The Euro Area Monetary Policy Event-Study Data Base (EA-MPD), Altavilla et al. (2019)
  - Surprises of Overnight index swaps (OIS), Government Bond Yields, Stock Market indices, Exchange Rates.
  - Difference between median quote 10 mins before and 10 mins after a window
  - Surprises for three windows: Press release, press conference and monetary policy event

shocks

Scree plot



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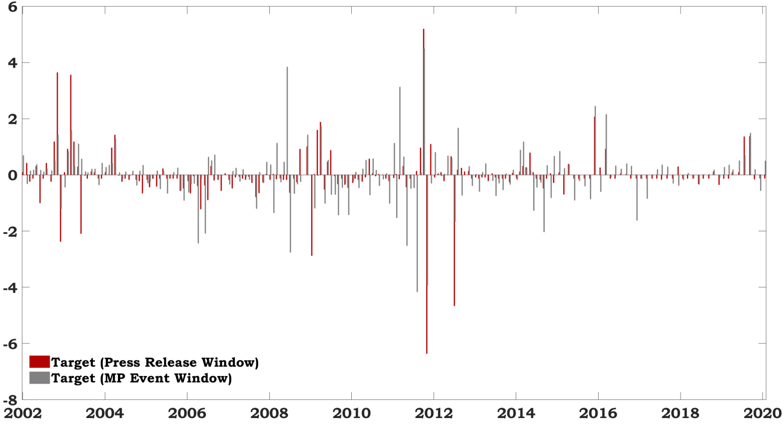
Target factors



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Finding a rotation matrix

- Principal components as initial estimator
- $\mathcal{F}^*$ last two factors from $F^* = FQ$, related to LTRO and QE
- I minimise the following problem for the pre-crisis period: Jan 2002 - August 2008:

$$Q^* = \arg\min \frac{1}{T^*} \operatorname{trace}(\mathcal{F}^{*\prime}\mathcal{F}^*)$$
$$\text{s.t.}$$
$$Q'Q = I_r$$
$$\Lambda_{OIS1M,\bullet} Q_{\bullet,2} = 0, \quad \Lambda_{OIS1M,\bullet} Q_{\bullet,3} = 0 \quad \Lambda_{OIS1M,\bullet} Q_{\bullet,4} = 0$$
$$\Lambda_{OIS3M,\bullet} Q_{\bullet,5} = 0$$

- where $Q_{\bullet,i}$ and $Q_{i,\bullet}$ correspond to the i-th column of Q

back

Orthogonalised Factors and Loadings

- Orthogonal Factors: $\tilde{F}_{k,t}$, $k = \{\text{information, forward guidance, LTRO, QE}\}$

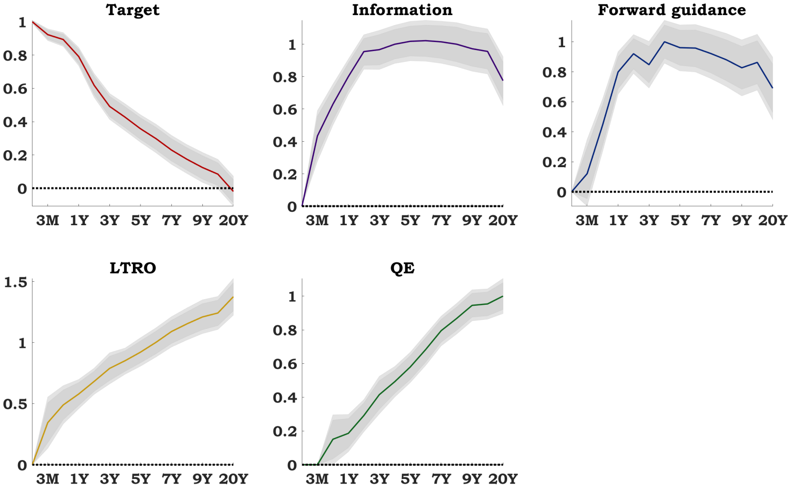
$$F_{k,t} = \beta_k F_t^{Target} + \sum_{j=1}^{k-1} \gamma_j \tilde{F}_{j,t} + e_{k,t}, \quad e_{k,t} \sim \mathcal{N}(0, \sigma_k^2), \tag{8}$$

- $\tilde{F}_{k,t} = F_{k,t} - \hat{\beta}_k F_t^{Target} - \sum_{j=1}^{k-1} \gamma_j \tilde{F}_{j,t}$.
- Orthogonal Loadings, for $i = 1, \cdots, 34$

$$Z_{i,t} = \tilde{\Lambda}_i \tilde{F}_t + v_{i,t}, \quad v_{i,t} \sim \mathcal{N}(0, \omega_i^2), \tag{9}$$

back

Factor loadings and the OIS term structure



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Factor loadings: Full data set

Table: Factor Loadings

		Target	Information	FG	LTRO	QE
OIS	OIS1M	1.00	0.00	0.00	0.00	0.00
	OIS3M	0.92	0.43	0.12	0.34	0.00
	OIS6M	0.89	0.63	0.44	0.49	0.15
	OIS1Y	0.79	0.80	0.80	0.58	0.19
	OIS2Y	0.62	0.95	0.92	0.68	0.29
	OIS3Y	0.49	0.97	0.85	0.79	0.42
	OIS4Y	0.43	1.00	1.00	0.85	0.49
	OIS5Y	0.36	1.02	0.96	0.92	0.58
	OIS6Y	0.30	1.02	0.96	1.00	0.68
	OIS7Y	0.23	1.01	0.92	1.09	0.79
	OIS8Y	0.17	1.00	0.88	1.15	0.87
	OIS9Y	0.12	0.97	0.83	1.21	0.95
	OIS10Y	0.08	0.96	0.86	1.24	0.95
	OIS20Y	-0.02	0.78	0.69	1.38	1.00

back

Factor loadings: Full data set

		Target	Information	FG	LTRO	QE
Gov. bond yields	DE3M	0.64	-0.03	-0.01	-0.12	0.05
	DE6M	0.70	0.41	0.31	0.32	0.13
	DE1Y	0.74	0.67	0.77	0.57	0.19
	DE2Y	0.51	0.88	1.01	0.72	0.34
	DE5Y	0.28	0.96	0.93	1.00	0.60
	DE10Y	0.02	0.87	0.73	1.29	1.16
	FR2Y	0.52	0.86	0.92	0.65	0.38
	FR5Y	0.37	0.91	0.89	0.58	0.79
	FR10Y	0.12	0.83	0.67	0.57	1.41
	IT2Y	0.31	0.62	0.92	-0.96	0.84
	IT5Y	0.25	0.57	0.82	-1.16	1.07
	IT10Y	0.13	0.45	0.49	-1.16	1.40
	ES2Y	0.39	0.73	1.06	-0.43	0.57
	ES5Y	0.26	0.77	0.94	-0.80	0.96
	ES10Y	0.21	0.58	0.64	-0.95	1.30
Stock Market	STOXX50	-0.35	0.58	-0.09	0.98	-1.18
	SX7E	-0.18	0.35	-0.11	1.53	-0.71
Exchange rates	EURUSD	0.16	-0.24	-0.26	1.22	0.95
	EURGBP	0.21	-0.09	-0.31	1.14	0.93
	EURJPY	0.18	0.05	-0.22	1.29	1.01

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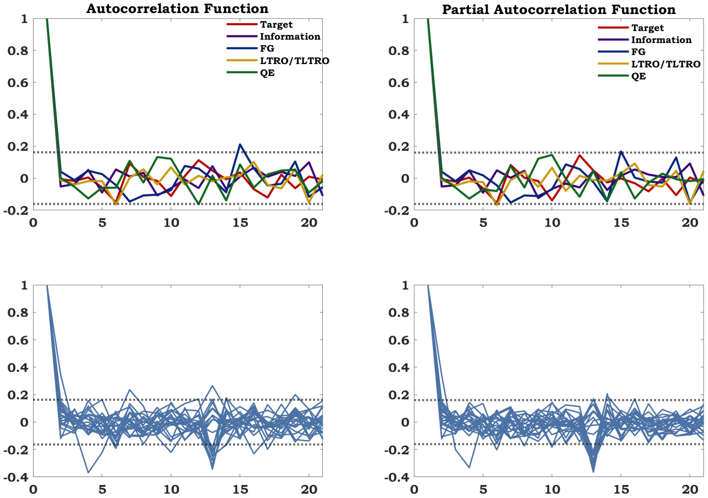
Autocorrelation and Partial autocorrelation functions



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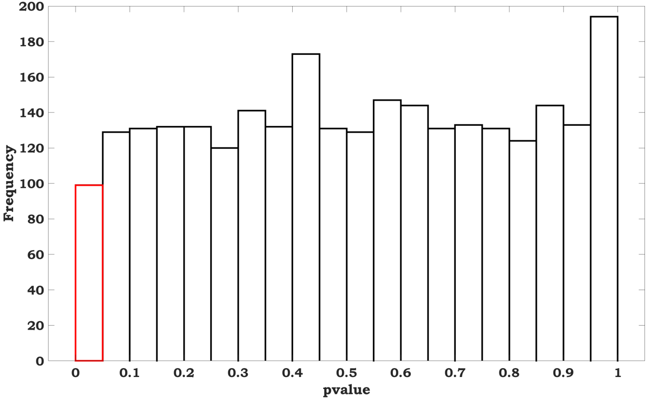
Convergence test



- p-values from the χ^2-test of Geweke (1992) back