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

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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

[Graph showing trends in inflation and inflation expectations from 2012 to 2020]
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
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
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.
Macroeconomic effects of UMP shocks:

- Single UMP shock, Corsetti, Duarte, and Mann (2018), Hachula, Piffer, and Rieth (2019),


- Normally UMP tools announced in the same time window
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
Outline

☐ A VAR for the Euro Area Economy

☐ Identification Strategy

☐ Estimation details & Results

☐ Policy implications and conclusions
A VAR for the euro area economy

- Model macro and financial variables through VAR:

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

- \( y_t \) 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

\[ u_t = H \varepsilon_t \quad (2) \]

- \( H \) is the impact matrix, \( \Sigma = HH' \)
How to identify the monetary policy shocks?


- **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)
How to identify the monetary policy shocks?


- **Heteroskedasticity**, Wright (2012)

- **Use of extraneous data:**
  - **This paper**: Internal instrument approach, Noh (2017), Paul (2019), Plagborg-Møller and Wolf (Forthcoming)
    - Augment endogenous variables with Proxies + Choleski decomposition
How to identify the monetary policy shocks?


- **Use of extraneous data:**
  - **This paper**: Internal instrument approach, Noh (2017), Paul (2019), Plagborg-Møller and Wolf (Forthcoming)
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- **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), 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:

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

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

- 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

\[ \Lambda^* = \begin{bmatrix}
\text{Target} & \text{Path} & \text{LTRO} & \text{QE} & \text{OIS1M} & \text{OIS3M} & \text{OIS6M} \\
* & 0 & 0 & 0 & \vdots & \vdots & \vdots \\
* & * & * & 0 & \vdots & \vdots & \vdots \\
* & * & * & * & \vdots & \vdots & \vdots \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
* & * & * & * & \vdots & \vdots & \vdots \\
\end{bmatrix} \]
The restrictions

\[ \Lambda^* = \begin{bmatrix}
  \text{Target} & \text{Path} & \text{LTRO} & \text{QE} \\
  * & 0 & 0 & 0 \\
  * & * & * & 0 \\
  * & * & * & * \\
  \vdots & \vdots & \vdots & \vdots \\
  * & * & * & * \\
\end{bmatrix}
\]

- **Unrestricted Target factor**
- **Target in MP event window,**
  - Cleanse the effects of conventional MP on remaining factors
The restrictions

$\Lambda^* = \begin{bmatrix}
\text{Target} & \text{Path} & \text{LTRO} & \text{QE} \\
* & 0 & 0 & 0 \\
* & * & * & 0 \\
* & * & * & * \\
: & : & : & : \\
: & : & : & : \\
* & * & * & * \\
\end{bmatrix}$

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

\[ \Lambda^* = \begin{bmatrix}
\text{Target} & \text{Path} & \text{LTRO} & \text{QE} \\
* & 0 & 0 & 0 \\
* & * & * & 0 \\
* & * & * & * \\
. & . & . & . \\
. & . & . & . \\
* & * & * & * 
\end{bmatrix} \begin{bmatrix}
\text{OIS1M} \\
\text{OIS3M} \\
\text{OIS6M} \\
. \\
. \\
. 
\end{bmatrix} \]

- Least percentage of explained variance before the Great Recession, in the spirit of Swanson (2019)
- QE influence long-end of the yield curve
Disentangling between information and forward guidance


- 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
MP Factors

Target

Information

Forward Guidance

LTRO

QE

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
- 50,000 draws, burn-in-sample = 25,000, ▶ 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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Have UMP been effective in increasing inflation?
The re-anchoring transmission channel

![Graphs showing the re-anchoring transmission channel for different economic indicators such as Target, Information, FG, LTRO, and QE over time.]
The re-anchoring transmission channel
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
References


References (cont.)

GEWEKE, J. (1992): “Evaluating the Accuracy of Sampling-Based Approaches to the Calculation of Posterior Moments,” in *Bayesian Statistics*.


References (cont.)


**NOH, E. (2017):** “Impulse-response analysis with proxy variables,” *Available at SSRN 3070401*.


**PLAGBORG-MØLLER, M., AND C. K. WOLF (Forthcoming):** “Local projections and VARs estimate the same impulse responses,” *Econometrica*.


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, 

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

\[ V_a := \text{cov} ((A_\ell)_{i,j}, (A_k)_{r,s} | \Sigma) = \begin{cases} \frac{\theta_1^2}{\ell \theta_2} \psi_j/(d-N-1), & j = s \quad \& \quad \ell = k \\ 0, & \text{otherwise} \end{cases} \quad (5) \]
The large Bayesian VAR

- Maximise of Marginal Data Density, closed-form solution
  - MDD: Function of the hyperparameters ($\theta$) 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 $\tilde{\Sigma}$

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

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

$$Q^* = \arg \min \frac{1}{T^*} \text{trace}(\mathcal{F}^* \mathcal{F}^*)$$

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 $Q$
Orthogonalised Factors and Loadings

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

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

- \( \tilde{F}_{k,t} = F_{k,t} - \hat{\beta}_k F_{t}^{\text{Target}} - \sum_{j=1}^{k-1} \gamma_j \tilde{F}_{j,t} \).

- Orthogonal Loadings, for \( i = 1, \cdots, 34 \)

\[
Z_{i,t} = \tilde{\Lambda}_i \tilde{F}_t + \nu_{i,t}, \quad \nu_{i,t} \sim \mathcal{N}(0, \omega_i^2), \tag{9}
\]
Factor loadings and the OIS term structure
## Factor loadings: Full data set

| Target Information FG LTRO QE |
|-----------------------------|----------------|----------------|----------------|----------------|
| 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           |
## Factor loadings: Full data set

<table>
<thead>
<tr>
<th>Gov. bond yields</th>
<th>Target</th>
<th>Information</th>
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<th>LTRO</th>
<th>QE</th>
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Autocorrelation and Partial autocorrelation functions
Convergence test

>p-values from the $\chi^2$-test of Geweke (1992)