Heterogeneous Macro and Financial Effects of ECB Asset Purchase Programs

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Introduction

- **Conventional measures**: policy rate adjustment
- **Unconventional measures**: ECB's asset purchasing programs
  - May 2009: SMP, CBPP1–2
  - January 2015: Large scale asset purchase program (APP)
  - March 2020: Pandemic emergency purchasing program (PEPP)

Introduction

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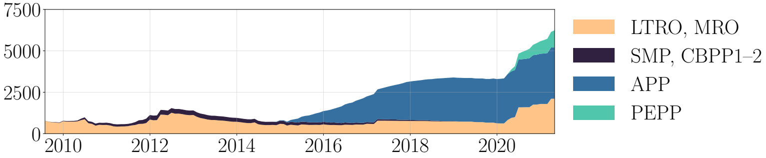
Figure: **Balance sheet European Central Bank (€ bn)**



ECB's balance sheet in 2020: €5,000,000,000,000;
over 50% of the Euro zone GDP

Our research

Focus

Effect of ECB's asset purchase programs on macroeconomy and financial markets.
→ Analyze effect over time of asset purchasing programs, focusing on heterogeneous effects across asset classes and countries

- **Findings**:
  - Heterogeneous effects in stock market (improved financial conditions)
  - Heterogeneous effects country-specific yields (flexible APPs)

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  - Bayesian structural vector autoregression (SVAR)
  - Global VAR (GVAR) framework for country effects

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  - Heterogeneous effects country-specific yields (flexible APPs)
- **Methods**:
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  - Global VAR (GVAR) framework for country effects
- **Identification** asset purchase shock:
  - Market surprises on central bank announcements and sign/zero restrictions

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Transmission mechanisms

- APP do not produce direct economic effects: work their way into economy via transmission channels
- Andrade et al. (2016), *ECB* propose three channels:

Transmission mechanisms

- APP do not produce direct economic effects: work their way into economy via transmission channels
- Andrade et al. (2016), *ECB* propose three channels:
  - **Portfolio rebalancing channel**: scarcity of assets
    $\rightarrow$ Decline in government bond yields, increase in stock prices
  - **Signaling channel**: announcements signal interest rates staying low
    $\rightarrow$ Stronger decline short-term interest rates
  - **Re-anchoring channel**: announcements help to guide inflation expectations and ensure price stability
    $\rightarrow$ Consumption increases and the risk premium declines

Heterogeneity in transmission mechanisms

- **Sectoral heterogeneity**
  - Portfolio rebalancing channel: all assets affected by lowering of borrowing costs
  - Event studies: short-term effects; value stocks more affected, banking sector more affected

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  - Financial market fragmentation in the Euro zone $\rightarrow$ challenging to conduct monetary policy
  - Evidence for heterogeneous transmission conventional and unconventional monetary policy on the (macro)economy (Georgiadis, 2015, EER; Burriel and Galesi, 2018, EER)
  - Evidence for asymmetric impact on government bonds of PEPP (Corradin et al., 2021, ECB)

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Our paper

Investigate heterogeneous transmission on financial markets and across countries

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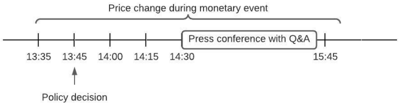
Data

Monthly data from July 2009–March 2021

3 identifying variables

- Interest rate: 3 month OIS EONIA*
- Stock prices: EURO STOXX 50*



* Source: EA-MPD; Euro Area Monetary Policy Event-Study Data Base (Altavilla et al., 2019; *JME*)

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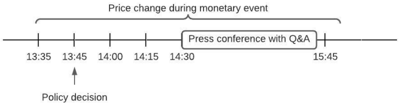
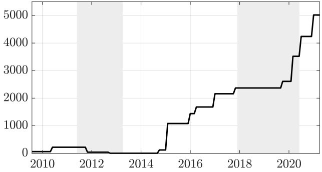


- Asset purchase volume announcement series



Cumulative announced volume.

* Source: EA-MPD; Euro Area Monetary Policy Event-Study Data Base (Altavilla et al., 2019; *JME*)

Data

Variables of interest:

- Output (real European GDP)
- Prices (Harmonized European CPI)
- 1 year European government bond yield
- 10 year European government bond yield
- MSCI index
- MSCI value-growth stocks ratio
- Risk premium high yields (BBB spread)
- European financial stress index (CISS)

Output; Prices	macroeconomy
1 year and 10 year government bond yields	government bonds
MSCI index; MSCI value-growth stocks ratio	stock market
Risk premium high yields (BBB spread)	corporate debt market
European financial stress index (CISS)	sovereign debt market

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} macroeconomy

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} stock market

- Risk premium high yields (BBB spread) } corporate debt market
- European financial stress index (CISS) } sovereign debt market

Additional

- Exchange rate
- Lending rates
- Industry-specific stock indices
- Country-specific data

Identification

Our proposal

Identification based on market surprises around policy announcement and a combination of sign and naturally imposed zero restrictions based on economic theory

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Identification based on market surprises around policy announcement and a combination of sign and naturally imposed zero restrictions based on economic theory

1. **Asset purchase shock**
   - Negative interest rate surprise
   - Positive stock price surprise

   } (*JK 2020*; Kerssenfischer, 2019, *DB*)
   - Increase in volume announced (Waele and Wieladek, 2016; *JME*)
   - Output and prices do not respond directly (Woodford, 2011; Beyer et al., 2017, *ECB*)

2. **Central bank information shock**
   (Jarociński and Karadi, 2020, AEJ; *JK 2020*)
   - Positive interest rate surprise
   - Positive stock price surprise

	AP shock	**CB info shock**
Output	0	0
Prices	0	0
Interest rate surprise	−	+
Stock price surprise	+	+
Ann. AP volume	+	

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Baseline VAR

Let $Y_t = \left(z_t', h_t', x_t'\right)'$.

- Reduced form VAR model akin *JK 2020*, $p = 2$ lags

$$\begin{pmatrix} z_t \\ h_t \\ x_t \end{pmatrix} = \begin{pmatrix} \mu_z \\ 0 \\ \mu_x \end{pmatrix} + \sum_{\ell=1}^{p} \begin{pmatrix} B_\ell^{zz} & B_\ell^{zh} & B_\ell^{zx} \\ 0 & 0 & 0 \\ B_\ell^{xz} & B_\ell^{xh} & B_\ell^{xx} \end{pmatrix} \begin{pmatrix} z_{t-\ell} \\ h_{t-\ell} \\ x_{t-\ell} \end{pmatrix} + \begin{pmatrix} u_t^z \\ u_t^h \\ u_t^x \end{pmatrix}, u_t \sim \mathcal{N}(0, \Sigma),$$

  - h_t: modeled as exogenous surprises
  - Estimate $(\mu, B_1, ..., B_p, \Sigma)$ in Bayesian fashion

z_t	Output
	Prices
h_t	EONIA 3m surprise
	STOXX 50 surprise
x_t	Announced AP volume
	1-year gvb yield
	10-year gvb yield
	MSCI index
	MSCI value-growth ratio
	BBB spread
	Sovereign CISS

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  - h_t: modeled as exogenous surprises
  - Estimate $(\mu, B_1, ..., B_p, \Sigma)$ in Bayesian fashion

- Gibbs sampling
  - Minnesota prior: $p(B, \Sigma) = p(B)p(\Sigma)$
    $\Sigma \sim \mathcal{IW}(S_0, v_0)$, $B \sim \mathcal{N}(B_0, V_0)$
  - Posterior:
    $\Sigma | B, Y \sim \mathcal{IW}(\overline{S}, \overline{v})$,
    $B | \Sigma, Y \sim \mathcal{N}(\overline{B}, \overline{V})$
  - 1,000 stable draws

z_t	Output
	Prices
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	BBB spread
	Sovereign CISS

Baseline VAR

- Recall: $Y_t = \left(z_t', \, h_t', \, x_t'\right)'$
- Structural VAR (**SVAR**)

$$A_0 Y_t = a + \sum_{\ell=1}^{p} A_\ell Y_{t-\ell} + \varepsilon_t, \qquad \varepsilon_t \sim \mathcal{N}(0, I_N).$$

  - Note that: $u_t = A_0^{-1} \varepsilon_t$

$\rightarrow$ need restrictions on A_0^{-1}

Identification methodology

- **Solution**: Generate $A_0^{-1} = \text{chol}(\widehat{\Sigma}) \times Q$ Details
    - Q: random orthogonal (rotation) matrix (Rubio-Ramirez et al., 2010, *RES*)
    - Importance sampling (Arias et al., 2018, *Ecta*)
- A_0^{-1} has to satisfy identifying restrictions

	AP shock	**CB info shock**
Output	0	0
Prices	0	0
EONIA 3-months surprise	$-$	$+$
STOXX 50 surprise	$+$	$+$
Announced AP volume	$+$	

- Calculate **impulse response functions** (IRFs)
    - Find a set of candidate IRFs
    - Calculate median and confidence bounds

GVAR framework

- Country-specific effects (Pesaran et al., 2004, *JBES*; Burriel and Galesi, 2018, *EER*)
- 8 countries: AUT, BEL, FRA, GER, ITA, NLD, PRT, SPN

GVAR framework

- Country-specific effects (Pesaran et al., 2004, *JBES*; Burriel and Galesi, 2018, *EER*)
- 8 countries: AUT, BEL, FRA, GER, ITA, NLD, PRT, SPN
- **VARX models for each country**:
  - Endogenous: 7 Country-specific variables: output, prices, 1 and 10y gov. bond, stock indices, value-growth spread, sovereign CISS
  - Exogenous: 1 Foreign-specific output based on trade-weights
  - Exogenous: 3 Euro zone variables: market surprises, AP announcement series
- **VARX model with European factors**:
  - Endogenous: 3 Euro zone (identification)
  - Exogenous: 7 GDP-weighted average of all countries' domestic variables

$\rightarrow$ **combined into one large model** (with spill-over effects) Details

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- Estimation: country-per-country
- Model captures complex dynamics well

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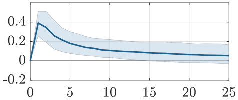
Macroeconomic variables

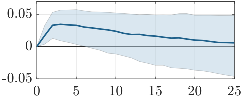
Responses to one-standard deviation shocks (+5% balance sheet volume). Median (solid line), 16–84th percentiles (grey area).

Asset purchase shock

Output



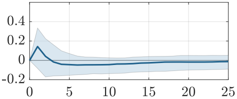
Prices



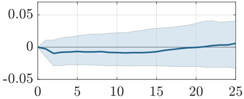
- **Output**: 41bp increase
- **Prices**: 3–4bp increase

CB information shock

Output



Prices



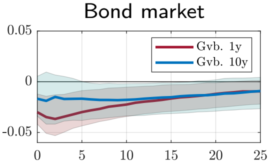
- **Output** and **prices**: negligible

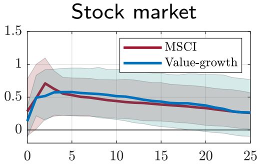
Asset purchase shock

- **Government bond yield 1 and 10 year**: $-$2-4 bp
  $\rightarrow$ Portfolio rebalancing channel and signaling channel
- **Stock prices**: +0.7% after 3 months
- **Value-growth**: +0.6% $\rightarrow$ firm heterogeneity
  $\rightarrow$ Portfolio rebalancing channel
- **Corporate debt (premium)**: $-$7 bp after 4 months
- **Sovereign stress index**:$-$0.5%
  $\rightarrow$ Re-anchoring channel

CB information shock

- Short-lived effect in financial markets





Euro area financial markets

Asset purchase shock

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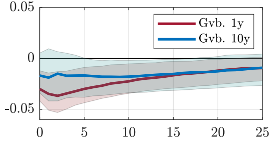
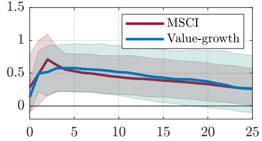
Bond market



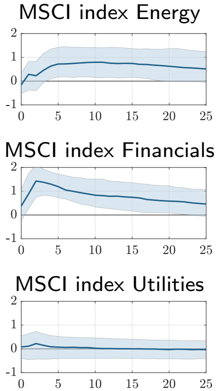
Stock market



- Results are robust to lag length VAR, prior hyper parameters, alternative identification
- Robust to prior rotation on matrix Q (Giacomini and Kitagawa, 2021, *Ecta*)

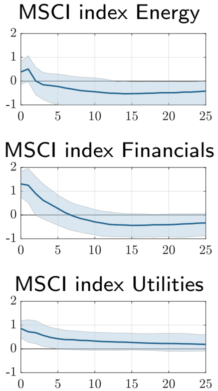
Heterogeneity in transmission on stocks

Asset purchase shock



- Energy: +0.9% after 3 months
- Financials: +1.4% after 3 months
- Utilities: no increase

CB information shock



- All increase → effect homogeneous

Heterogeneous effects across countries

8 European countries: Austria, Belgium, France, Germany, Italy, the Netherlands, Portugal and Spain

Asset purchase shock

- **Output (GDP)**: Southern European countries +30 bp, other countries +20 bp
- **Prices (CPI)**: small increase
- **Government bonds**: decrease, most for Southern European countries
- **Stocks**: +0.3–1.5%, no difference in value-growth per country
- **Debt markets**: Southern European sovereign debt markets reassured

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→ spill-over effects play a role, without spill-overs:

- Macroeconomic effects underestimated
- Financial effects overestimated

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Conclusion

- **Goal: investigate dynamic effect of asset purchase programs on financial markets**
- APPs stimulate the economy, decrease yields, increase stock prices and reassure debt markets

Conclusion

- **Goal: investigate dynamic effect of asset purchase programs on financial markets**
- APPs stimulate the economy, decrease yields, increase stock prices and reassure debt markets
- **Heterogeneity in transmission**
  - **Stock market**: value stocks more affected; financial stocks most
  - **Countries**: economy and yields of South European countries most positively affected, stocks of countries with high credit ratings most positively affected
- Empirical evidence for all three transmission channels:
  - Reduction in government bond yields: signaling channel
  - Increased stock prices: portfolio rebalance channel
  - Lagged reduction in risk premium on high yields: re-anchoring channel

Thank you!

- For country $i, i = 1, ..., 8$:

$$Y_{it} = c_i + \sum_{\ell=1}^{p_i} C_{i,\ell} Y_{i,t-\ell} + \sum_{\ell=0}^{q_i} \Lambda_{i,\ell} Y^*_{i,t-\ell} + \sum_{\ell=0}^{q_i} \Gamma_{i,\ell} X_{t-\ell} + u_{it}, \qquad (1)$$

with $Y^*_{it} = \sum_{j \neq i} w_{ij} Y_{jt}$, where $\sum_{j \neq i} w_{ij} = 1$ (trade weights).

- Common:

$$X_t = c_x + \sum_{\ell=1}^{p_x} \Psi_\ell X_{t-\ell} + \sum_{\ell=0}^{q_x} \Phi_\ell \widetilde{Y}_{t-\ell} + u_{xt}. \qquad (2)$$

with $\widetilde{Y}_t = \sum_j \widetilde{w}_j Y_{jt}$, where $\sum_j \widetilde{w}_j = 1$ (GDP weights).

- Combined, let $\mathcal{Y}_t = \begin{pmatrix} Y'_{1,t} & \dots & Y'_{N,t} & X'_t \end{pmatrix}'$:

$$H_0 \mathcal{Y}_t = h_0 + \sum_{\ell=1}^{\max_i (p_i)} H_\ell \mathcal{Y}_{t-\ell} + e_t. \qquad (3)$$

Back to GVAR framework

1. Draw Σ and B from its posterior distributions. Burn-in period: 5,000.

   If the model is stable, proceed with *Step 2*.
   Otherwise, consider a new draw until a stable model is found.

2. Construct the rotation matrix Q.

3. Calculate the candidate $A_0^{-1} = \text{chol}(\Sigma) \times Q$.

   If the sign restrictions are satisfied, calculate the weights $\omega \propto \frac{\left|\det(A_0)\right|^{-(2N+Np+2)}}{\text{vol}_Z(A_0, A_1, \ldots, A_p)}$, where $\text{vol}_Z(\cdot)$ denotes the volume element conditional on the zero restrictions defined as in Arias et al. (2018). Then proceed with *Step 4*.
   Otherwise, go back to *Step 2*. If the maximum number of Q draws is reached, go back to *Step 1*.

4. Repeat *Step 1* until *3* 1,000 times until we obtain $\widetilde{M}$ draws meeting the sign restrictions.

5. Calculate the normalized importance weights as $\widetilde{\omega}_j = \frac{\omega_j}{\sum_{j=1}^{\widetilde{M}} \omega_j}$, for $j = 1, ..., \widetilde{M}$.

6. Re-sample with replacement M^* times according to the specified importance weights $\widetilde{\omega}_j$ in *Step 5*. Calculate the corresponding impulse response functions.

Back to Methodology

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