Does Monetary Policy Influence the Uncertainty of Financial Markets?

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Introduction

What do we do?

- Investigate the effects of monetary policy **(MP)** on **financial market uncertainty** in the Euro area.
- Study this question for different **asset classes, countries, and dimensions of MP**.
- Look at the **dynamic** effects of MP shocks (exogenous changes) on uncertainty.

What do we do?

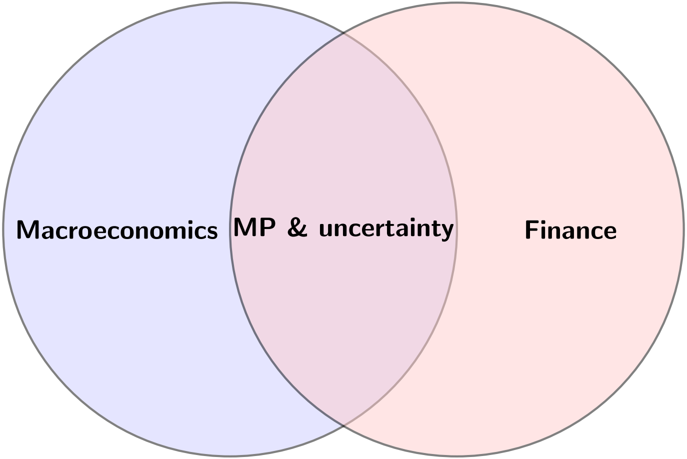
- Use a term structure model (Nelson and Siegel, 1987; Diebold and Li, 2006) and HF variations in yields to recover (i.e. **identify**) exogenous changes in MP.
- Dissociate shocks into **three different structural dimensions**: shocks to level, slope and curvature (cfr. Inoue and Rossi, 2021).
- Propose a stochastic volatility model accounting for the presence of MP shocks.

Research Questions

- Does monetary policy influence the uncertainty dynamics of financial assets?
- Are there differences across countries (asset classes) within the Euro area?
- Are there differences according to the type of monetary policies?

Monetary policy and financial uncertainty

A macro-finance research question



Why do we care?

Macro point of view

- **Uncertainty** is important to explain business cycles (Bloom, 2009; Bachmann et al., 2013; Jurado et al., 2015; Ludvigson et al., 2021).
- Monetary policy matters in shaping **aggregate** fluctuations in uncertainty (Bekaert et al., 2013; Mumtaz and Theodoridis, 2020) of **macro fundamentals**.
- Structural macroeconomic models focus on **financial conditions and endogenous risk** in real economic cycles.

Why do we care?

Finance point of view

- **MP matters for asset pricing**: impact on the yield curve and risk premia Kuttner (2001); Rigobon and Sack (2004); Bernanke and Kuttner (2005); Gürkaynak et al. (2005); Wright (2012).
- Understanding the interactions between monetary policy and asset volatility is essential from a **financial stability** point of view.
- Potential implications for portfolio and risk management practices?

Literature

A. Monetary Policy and Financial Markets

- Extensively studied by Eichenbaum and Evans (1995); Kuttner (2001); Bernanke and Kuttner (2005); Gürkaynak et al. (2005) and others.
- Importance heightened post-Great Financial Crisis and in a zero lower bound environment.

Gaps

- Those studies focus on mean effects of monetary policy **(first-order effects)**.
- Limited understanding of how monetary policy affects uncertainty **(second-order effects)** surrounding asset prices.

Literature

B. Monetary policy, uncertainty and business cycles

- A substantial body of literature (Bloom, 2009; Schaal, 2012; Bachmann et al., 2013; Jurado et al., 2015; Baker et al., 2016) examines the impact of uncertainty on real business cycles.
- Studies focusing on the interaction between MP & uncertainty are less numerous (Bekaert et al., 2013; Mumtaz and Theodoridis, 2020).

Gaps

- Various measures of **(macroeconomic)** uncertainty captured at aggregated level.
- No specific focus on: (i) financial markets, (ii) heterogeneity and (iii) multidimensionality of MP.

Literature

C. Empirical finance

- Existing research on the effects of MP on **US stock market volatility**: Bomfim (2003); Farka (2009); Chuliá et al. (2010); Kurov (2010); Gospodinov and Jamali (2012).
- **Main findings:** positive relationship between unexpected change (surprise) in target funds rate and volatility.

Gaps

- Financial uncertainty limited to stocks.
- Focus solely on **the effects at impact**.
- Different econometric frameworks: GARCH (intraday) or regression analysis with realized volatility.

Contributions

- Analyze the role of monetary policy in driving financial market uncertainty in Euro Area (cfr. A,B).
- Treat uncertainty at the asset level (i.e. disaggregated) as **stochastic** and dependent on monetary policy (cfr. A,C).
- Propose an econometric framework to capture different dimensions of MP shocks (surprises) and quantify their dynamics effects on asset uncertainty (cfr. B,C).

Methodology

Methodology: two pillars

I. Identification of Monetary Policy Shocks

- High-frequency data around policy announcements.
- Adapt the methodology of Inoue and Rossi (2021) to capture multiple dimensions of monetary policy.

II. Stochastic Volatility Model

- Incorporate covariates to measure endogenous uncertainty.
- Model specification includes changes in term structure factors (level, slope, and curvature).

I.Identification of Monetary Policy Shocks

The functional approach of Inoue and Rossi (2021)

- Shocks are defined by changes in a **function**: the yield curve $y_t(\tau)$.

- Relying on Nelson and Siegel (1987); Diebold and Li (2006) $y_t(\tau)$ dynamics evolves according to:

$$y_t(\tau) = \beta_{1,t} + \beta_{2,t}\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau}\right) + \beta_{3,t}\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau}\right), \quad (1)$$

  where $\beta_t = (\beta_{1,t}, \beta_{2,t}, \beta_{3,t})'$ denotes respectively level, slope and curvature factors.

I.Identification of Monetary Policy Shocks

Illustration: Yield curve over time

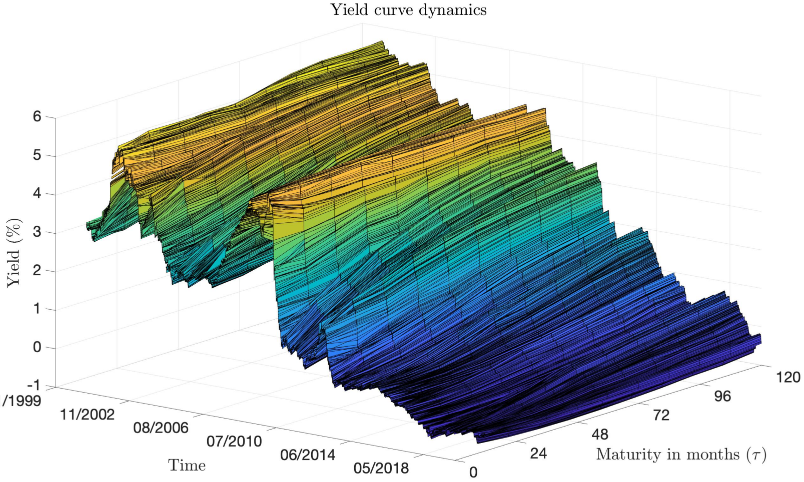


Figure: Yield curve dynamics

I.Identification of Monetary Policy Shocks

The functional approach of Inoue and Rossi (2021)

- MP shocks are defined as the shifts in the yield curve ($\Delta y_t(\tau)$) observed on **monetary policy announcements days** d_t:

$$\varepsilon_t^{MP} = \Delta y_t(\tau).d_t, \tag{2}$$

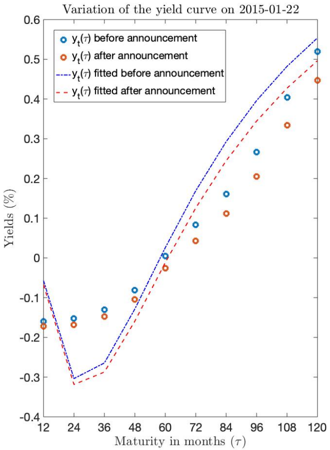
$$= \Delta\beta_{1,t}^d + \Delta\beta_{2,t}^d \left(\frac{1 - e^{-\lambda\tau}}{\lambda\tau}\right) + \Delta\beta_{3,t}^d \left(\frac{1 - e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau}\right), \tag{3}$$

  where $\Delta\beta_{j,t}$ are changes in factors induced by a MP shock at time t.

- Potential issue: At a daily frequency, $\Delta\beta_{j,t}$ and $y_t(\tau)$ can be explained by other things than MP phenomena.

I. Identification of Monetary Policy shocks

Illustrative example: first QE announcement 22/01/15



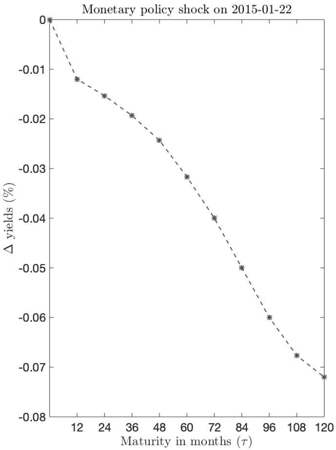


Figure: Functional MP shock of Inoue and Rossi (2021) on first QE announcement.

I.Identification of Monetary Policy Shocks

Exploiting HF data of Altavilla et al. (2019)

- Instead of observing $y_t(\tau)$ on **a daily window**, we observe directly **high-frequency reactions** of yields $\Delta y_t^{hf}(\tau)$ captured around monetary policy announcements for different maturity.

- $\Delta y_t^{hf}(\tau)$ captured within monetary policy announcement episodes $\rightarrow$ solely the response of yields to monetary policy shocks.

I.Identification of Monetary Policy Shocks

Illustration: HF variations of the yield curve

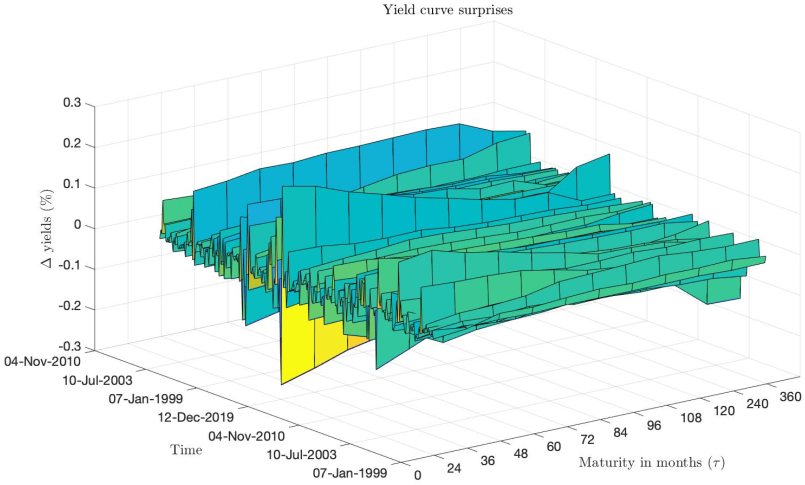


Figure: HF variations in yields $\Delta y_t(\tau)$ from Altavilla et al. (2019)

I.Identification of Monetary Policy Shocks

Analogy between our approach and Inoue and Rossi (2021)

- Considering that $\Delta y_t^{hf}(\tau) = \frac{\partial y_t(\tau)}{\partial \varepsilon_t^{MP}}$ and following (1), we can write explicitly:

$$\begin{aligned}
\Delta y_t^{hf}(\tau) &= \frac{\partial y_t(\tau)}{\partial \varepsilon_t^{MP}}, && (4)\\
&= \frac{\partial y_t(\tau)}{\partial \beta_t} . \frac{\partial \beta_t}{\partial \varepsilon_t^{MP}}, && (5)\\
&= \Delta\beta_{1,t}^{hf} + \Delta\beta_{2,t}^{hf}\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau}\right) + \Delta\beta_{3,t}^{hf}\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau}\right). && (6)
\end{aligned}$$

I.Identification of Monetary Policy Shocks

Comparison

Figure: Components of the shocks $\Delta\beta_t^{HF}$ using HF surprises of Altavilla et al. (2019).

I.Identification of Monetary Policy Shocks

Comparison

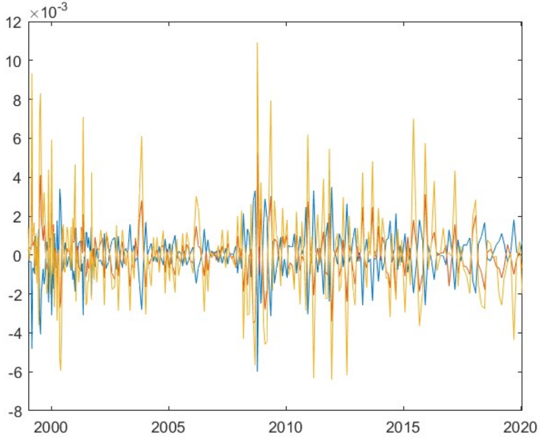


Figure: Components of the shocks $\Delta\beta_t^d$. Replication of Inoue and Rossi (2021).

I.Identification of Monetary Policy shocks

Comparison: scatter plots

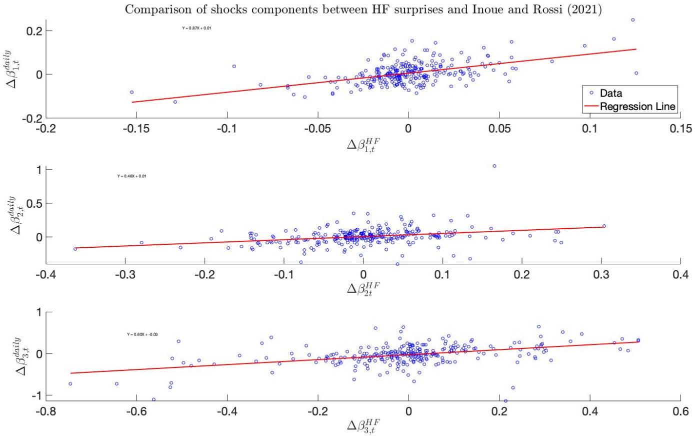


Figure: Scatter plots of shocks component (y-axis: components of Inoue and Rossi (2021); x-axis: HF identification

II. Stochastic Volatility Model

- Let X_t be a particular (or a linear combination of) component(s) of $\Delta\beta_{j,t}$. Taking those ones as covariates, we follow Ulm and Hambuckers (2022)

$$
\begin{aligned}
r_t &= \sigma_t \xi_t, & \xi_t &\sim \mathcal{N}(0,1), && (7)\\
\sigma_t^2 &= \exp\{h_t + \theta X_t + \rho \log(r_{t-1}^2)\}, &&&& (8)\\
h_t &= \mu_h + \phi(h_{t-1} - \mu_h) + \nu_t, & \nu_t &\sim \mathcal{N}(0,\omega^2) && (9)
\end{aligned}
$$

where r_t denotes daily log-returns, σ_t^2 time-varying volatility and h_t the volatility state.

II. Stochastic Volatility Model

- This model is an extension of Omori et al. (2007).
- The parameter(s) in θ is (are) the volatility response(s) at impact of particular shocks component(s) in X_t.
- The inclusion of $\rho \log(r_{t-1}^2)$ is tractable for computing the effects of X_t at multiple horizons $h = 0, 1, ..., H$ on $\log(\sigma_{t+h}^2)$:

$$\Phi^h = \mathbb{E}_t(\log \sigma_{t+h}^2 | X_{t,i} = 1) - \mathbb{E}_t(\log \sigma_{t+h}^2 | X_{t,i} = 0) \quad (10)$$

$$= \rho^h \theta \quad (11)$$

II. Stochastic Volatility model

Estimation

- Rely on Omori et al. (2007) to approximate the model in a linear fashion.
- This enables to use the Kalman filter to get the conditional density of the state h_t.
- Estimation of (posterior) parameters (ρ, θ) and the volatility state (h_t) is done via MCMC algorithms (Bayesian methods).

Data

Data

- **HF surprises of the yield curve:** surprises in German bond yields Altavilla et al. (2019).
- **Exchange rates:** EUR/USD,EUR/GBP,EUR/CHF and EUR/JPY.
- **Stock indices**: indices from different countries such as France,Belgium or Spain (CAC40, BEL20, IBEXX35).
- **Governement and Corporate Bond Indices:** e.g. iBoxx EUR Liquid Sovereigns Index, ICE BofA Euro Corporate Index.

Early results

Early results

EUR\USD

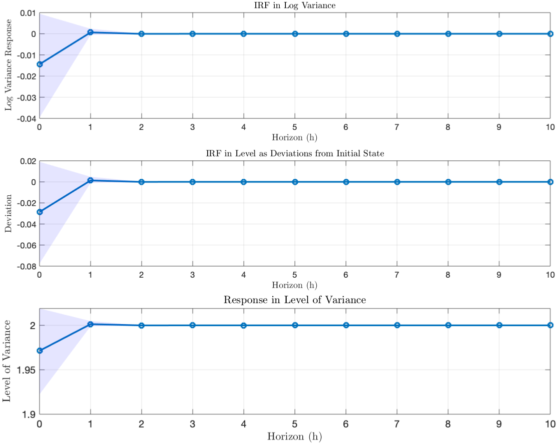


Figure: Uncertainty response of EUR\USD to MP shocks (X_t as sum of all components).

Early results

EUR\GBP

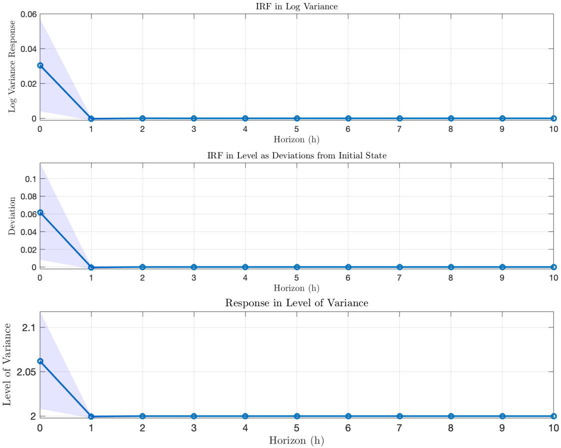


Figure: Uncertainty response of EUR\GBP to MP shocks (X_t as sum of all components).

Early results

EUR\CHF

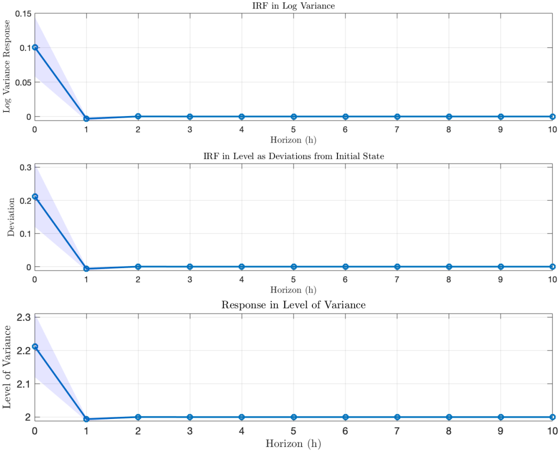


Figure: Uncertainty response of EUR\CHF to MP shocks (X_t as sum of all components).

Early results
EUR\JPY

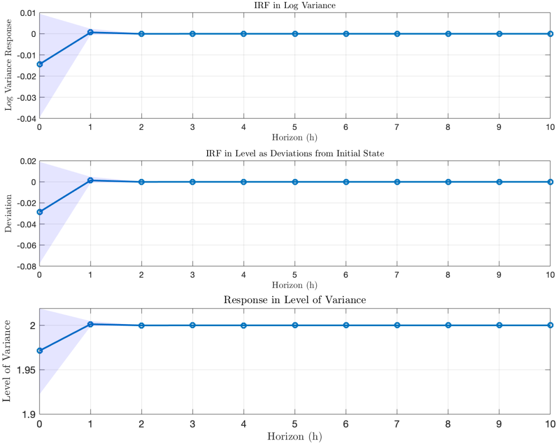


Figure: Uncertainty response of EUR\JPY to MP shocks (X_t as sum of all components).

Early results

First conclusions

- Effects mainly at impact, no persistence (small ρ)$\rightarrow$ why?.
- Significant results **do not contradict a positive** relationship between MP and financial uncertainty.
- Similar to Bomfim (2003); Farka (2009); Chuliá et al. (2010) and other studies in empirical finance literature (C).

Thank you!

References I

Carlo Altavilla, Luca Brugnolini, Refet S Gürkaynak, Roberto Motto, and Giuseppe Ragusa. Measuring euro area monetary policy. *Journal of Monetary Economics*, 108:162–179, 2019.

Rüdiger Bachmann, Steffen Elstner, and Eric R Sims. Uncertainty and economic activity: Evidence from business survey data. *American Economic Journal: Macroeconomics*, 5(2): 217–49, 2013.

Scott Baker, Nicholas Bloom, and Steven Davis. Measuring economic policy uncertainty. *The Quarterly Journal of Economics*, 131(4):1593–1636, 2016.

Geert Bekaert, Marie Hoerova, and Marco Lo Duca. Risk, uncertainty and monetary policy. *Journal of Monetary Economics*, 60(7):771–788, 2013.

Ben S Bernanke and Kenneth N Kuttner. What explains the stock market's reaction to federal reserve policy? *The Journal of finance*, 60(3):1221–1257, 2005.

Nicholas Bloom. The impact of uncertainty shocks. *Econometrica*, 77(3):623–685, 2009.

Antulio N Bomfim. Pre-announcement effects, news effects, and volatility: Monetary policy and the stock market. *Journal of Banking & Finance*, 27(1):133–151, 2003.

Helena Chuliá, Martin Martens, and Dick van Dijk. Asymmetric effects of federal funds target rate changes on s&p100 stock returns, volatilities and correlations. *Journal of Banking & Finance*, 34(4):834–839, 2010.

Francis X Diebold and Canlin Li. Forecasting the term structure of government bond yields. *Journal of econometrics*, 130(2):337–364, 2006.

References II

Martin Eichenbaum and Charles L Evans. Some empirical evidence on the effects of shocks to monetary policy on exchange rates. *The Quarterly Journal of Economics*, 110(4):975–1009, 1995.

Mira Farka. The effect of monetary policy shocks on stock prices accounting for endogeneity and omitted variable biases. *Review of Financial Economics*, 18(1):47–55, 2009.

Nikolay Gospodinov and Ibrahim Jamali. The effects of federal funds rate surprises on s&p 500 volatility and volatility risk premium. *Journal of Empirical Finance*, 19(4):497–510, 2012.

Refet S Gürkaynak, Brian Sack, and Eric Swanson. Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements. *International Journal of Central Banking*, 1(1), May 2005.

Atsushi Inoue and Barbara Rossi. A new approach to measuring economic policy shocks, with an application to conventional and unconventional monetary policy. *Quantitative Economics*, 12(4):1085–1138, 2021.

Kyle Jurado, Sydney C Ludvigson, and Serena Ng. Measuring uncertainty. *American Economic Review*, 105(3):1177–1216, 2015.

Alexander Kurov. Investor sentiment and the stock market's reaction to monetary policy. *journal of Banking & Finance*, 34(1):139–149, 2010.

Kenneth N Kuttner. Monetary policy surprises and interest rates: Evidence from the fed funds futures market. *Journal of monetary economics*, 47(3):523–544, 2001.

References III

Sydney C. Ludvigson, Sai Ma, and Serena Ng. Uncertainty and business cycles: Exogenous impulse or endogenous response? *American Economic Journal: Macroeconomics*, 13(4): 369–410, October 2021.

Haroon Mumtaz and Konstantinos Theodoridis. Dynamic effects of monetary policy shocks on macroeconomic volatility. *Journal of Monetary Economics*, 114:262–282, 2020.

Charles R Nelson and Andrew F Siegel. Parsimonious modeling of yield curves. *Journal of business*, pages 473–489, 1987.

Y. Omori, S. Chib, N. Shephard, and J. Nakajima. Stochastic volatility with leverage: Fast and efficient likelihood inference. *Journal of Econometrics*, 140(2):425–449, 2007.

Roberto Rigobon and Brian Sack. The impact of monetary policy on asset prices. *Journal of Monetary Economics*, 51(8):1553–1575, 2004.

Edouard Schaal. Uncertainty, productivity and unemployment in the great recession. *Federal Reserve Bank of Minneapolis, mimeo*, 2012.

Maren Ulm and Julien Hambuckers. Do interest rate differentials drive the volatility of exchange rates? evidence from an extended stochastic volatility model. *Journal of Empirical Finance*, 65:125–148, 2022.

Jonathan H Wright. What does monetary policy do to long-term interest rates at the zero lower bound? *The Economic Journal*, 122(564):F447–F466, 2012.