What drives euro area financial markets? The role of US spillovers and global risk[*]

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Abstract

Understanding euro area financial market dynamics requires looking beyond borders. We introduce a novel Bayesian structural VAR model designed to jointly estimate the main drivers of euro area financial asset prices on a daily basis. The model explicitly accounts for transatlantic spillovers and the distinctive influence of the United States, particularly through its monetary policy and its role as a safe haven during periods of heightened risk aversion. The results show that euro area financial markets are influenced by a complex interplay of domestic factors, US influences, and global risk shocks, which can either amplify or mitigate financial dynamics at home. These significant spillovers can pose substantial challenges for monetary policy, particularly amidst economic and monetary policy divergence.

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1 Introduction

Monetary policy makers closely monitor daily fluctuations in financial asset prices such as bond yields, stock prices and exchange rates in search for signals on the underlying expected dynamics of the economy. Asset prices contain a rich set of information; they react in real time to economic news and hint at how markets assess the effect of recent news or policy decisions on growth and inflation.

At the same time, extracting information from asset prices in real time is challenging; economic shocks do not occur in isolation and can steer asset prices in different directions, blurring their signalling content. Euro area financial markets are also largely driven by international factors, which adds to the complexity. Two particularly important sources of global impulses have been documented in the literature.

First, many studies have documented the importance of US monetary policy spillovers (Bruno and Shin, 2015; Dedola et al., 2017; Ca'Zorzi et al., 2023; Jarociński, 2022; Buch et al., 2019), reflecting the central role of US monetary policy in steering the global financial cycle (Miranda-Agrippino and Rey, 2020; Gourinchas and Rey, 2022) and the dominant role of the US dollar in the international monetary system (Maggiori et al., 2019; Ilzetzki et al., 2019; Boz et al., 2022). US developments affect economic conditions abroad through various channels, including demand, the exchange rate and financial linkages. As a result not only US monetary policy shocks but also news about the US economy can influence global financial markets (Albuquerque and Vega, 2009; Pinchetti and Szczepaniak, 2023).

Second, global financial markets are vulnerable to sudden shifts in global risk sentiment, as shown by the global financial crisis of 2008 and the outbreak of the COVID-19 pandemic in 2020. During such episodes, global investors typically rotate from risky into safe assets amid heightened global risk aversion, which affects the pricing of financial assets globally (Baele et al., 2020; Ahmed, 2023). The safe haven status of US dollar-denominated assets implies that the US dollar and US Treasury yields are particularly susceptible to shifts in global risk sentiment (Habib and Stracca, 2012; Fatum and Yamamoto, 2016; Georgiadis et al., 2024; Bodenstein et al., 2023), which in turn can affect asset pricing in the euro area.

To gauge the driving forces behind euro area financial markets, it is important to jointly account for the effects of these two types of shocks – US-specific shocks and global risk shocks. The academic literature so far has mostly evaluated these in isolation. This leaves open the question of their relative importance, which is key to understand the policy implications of a given change in financial conditions. For instance, a decline in euro area interest rates is likely to exert very different effects depending on whether it reflects a domestic monetary policy easing, negative macroeconomic news, spillovers from US monetary policy accommodation, or heightened global risk aversion.[1] Disentangling these different drivers of financial market movements in a simultaneous way is therefore an important endeavour for monetary policy makers and central bankers at large.

To address this challenge, this paper proposes a parsimonious unified framework that allows separating daily movements of key euro area financial variables into their underlying drivers, while accounting for the unique role of the US in shaping global financial market dynamics. The primary goal of the model is to provide a real-time evaluation of what steers key euro area asset prices on a daily basis. We stand out from prior research by explicitly considering international channels[2] and integrating various driving factors in one common framework[3], which allows us to untangle their relative importance. In addition, our approach departs from the high frequency literature identifying monetary policy shocks in a narrow time interval around monetary policy announcements (e.g. Jarociński and Karadi, 2020), in that we identify euro area and US shocks on a continuous, daily basis, aligning with the frequency at which market participants adjust their perception of the macroeconomic and policy outlook. This broader approach has the benefit of capturing anticipation effects of monetary policy, which play a pivotal role in the transmission of monetary policy to financial conditions (Cao et al., 2013). It also allows capturing

[1] The fact that shock-dependence matters for the interpretation of changes in asset prices has been documented in the literature on exchange rate pass-through (Forbes et al., 2018), for instance, but it applies to financial asset prices more generally.

[2] For example, Matheson and Stavrev (2014) estimate a daily BVAR model for US yields and stock prices based on sign restrictions exploiting cross-asset price movements. Compared to them, we extend the model to a two-country euro area/US framework including not only bond yields and equity prices but also the bilateral USD/EUR exchange rate. Additionally, we build on the role of US dollar-denominated assets as safe haven assets for global investors to identify a new important source of daily market movements; the so-called "global risk" factor.

[3] For example, Ca'Zorzi et al. (2023) compare the international transmission of euro area and US monetary policy shocks relying on "pure" monetary policy shocks which are identified in a narrow time window and purged for central bank information effects following Jarociński and Karadi (2020). Our paper differs by simultaneously identifying macro, monetary policy and global risk shocks, which provide a more comprehensive picture of the relative importance of monetary policy shocks in driving financial markets.

changes in the perception of market investors on the monetary policy stance which happen on non-meeting days (Jayawickrema and Swanson, 2021; Bauer and Swanson, 2023). Our identification leads to an interpretation of monetary policy shocks that is broader and more general than in the standard high frequency literature, in essence capturing the continuous repricing by markets of monetary policy expectations, similar to Cieslak and Pang (2021). Despite these differences, however, we find that our estimated monetary policy shocks co-move significantly with estimates from the high-frequency literature on the days when a monetary policy announcement takes place. We also find that realizations of our monetary policy shocks are significantly larger on monetary policy meeting days than on non-meeting days.

In a first step, we set up a Bayesian Vector Autoregression (BVAR) model at daily frequency that identifies five different drivers of asset price fluctuations: euro area and US monetary policy, euro area and US domestic macro news, and global risk. We rely on an identification approach based on sign and magnitude restrictions following Arias et al. (2018), exploiting the information content of daily co-movements in risk-free yields, equity prices and the US dollar-euro exchange rate. The key novelty is that we explicitly allow for simultaneous spillovers between the euro area and the US and account for the potential importance of global risk in driving financial markets on both sides of the Atlantic. This contrasts our approach from the literature on international spillovers of monetary policy shocks that leverages high frequency information in proxy-SVARs (Degasperi et al., 2024; Miranda-Agrippino and Nenova, 2022) or by a combination of high frequency policy proxies and traditional sign restrictions (Cesa-Bianchi and Sokol, 2022). In particular, Cesa-Bianchi and Sokol (2022) disentangle domestic and foreign dynamics by ruling out spillovers from the domestic to the foreign economy with zero restrictions, whereas we allow for simultaneous international spillovers by imposing softer magnitude restrictions. This offers a complementary perspective on the identification of international spillovers and cross-country shocks. We extensively test the performance of our model by benchmarking its interpretation of daily financial market movements against our knowledge of clear narrative events, and by comparing the estimated structural shocks with other established standards from the literature. In a second step, we use our set of daily shocks as econometric instruments in a monthly proxy structural VAR model, following Gertler and Karadi (2015), Mertens and Ravn (2013), Stock and Watson (2012), and particularly Caldara and Herbst (2019). We use this monthly model to assess how daily financial dynamics carry over to the real economy, and to illustrate why it matters to differentiate between different drivers of financial variables in the first place.

Two sets of results are worth highlighting. First, to grasp the daily shifts in the set of key financial variables that we consider, it is essential to account for the US influence and the impact of global risk. Our results show that spillovers from the US and changes in global risk aversion can explain close to half of the average variation in selected asset prices in the euro area. This large effect of foreign forces might pose challenges for domestic policy makers. At times, these spillover effects might align with the intended direction set by domestic monetary policy. But there might be instances when these spillovers push asset prices in the opposite direction, and policymakers are faced with the decision to counteract these or not. While US spillovers explain a large part of dynamics in euro area financial markets, euro area shocks are found less relevant for US financial markets. Instead, shifts in global risk sentiment determine a larger part of the US financial market dynamics, consistent with its safe haven role.

The second key finding is that daily movements in financial markets provide valuable information about broader, longer-term expectations for economic growth and inflation. Our proxy VAR results show that the way financial markets affect the overall economy can vary significantly based on the combination of factors driving their developments. This implies that for policymakers, breaking down signals from daily financial market indicators is particularly relevant; it provides a crucial signal on expected core economic trends and insights into how monetary policy is being transmitted to the real economy.

The remainder of the paper proceeds as follows. The next section explains the setup of the daily Bayesian VAR model, the data and the sign restriction identification scheme, while subsection 2.5 empirically evaluates the validity of the model set-up. Section 3 reviews the main empirical results, focusing on the factors driving euro area financial markets since the inception of the euro with particular attention to cross-Atlantic spillovers and global risk shocks. It then assesses the transmission of the identified shocks to the real economy using a proxy VAR model which is described in Section 4. Section 5 concludes.

2 Identifying daily drivers of euro area asset prices

2.1 A daily two-country structural VAR model

In order to analyse the drivers of euro area financial markets, we set up a two-country Structural Vector Autoregression model (SVAR) containing key asset price data for the euro area and the US, which we estimate using Bayesian methods. The underlying drivers of daily changes in these euro area and US asset prices are identified using sign restrictions exploiting cross-asset price movements on the day of the shock. Using these models to analyse interactions at daily frequency offers a number of benefits to circumvent some of the well-documented limitations of shock identification with low-frequency macroeconomic data. In particular, due to the rich data environment, the estimation can rely on rather minimalistic prior assumptions.

Following the notation of Rubio-Ramirez et al. (2010), the structural form of the VAR is given by:

$$y_t' A_0 = x_t' A_+ + \varepsilon_t' \tag{2.1}$$

Here, y_t is an $n \times 1$ vector of endogenous variables and x_t is an $(np+k) \times 1$ vector which collects all pre-determined variables, that is, p lags of the endogenous variables and k exogenous and deterministic variables. The conformable matrices A_0 and A_+ capture the contemporaneous co-movement between endogenous variables and the VAR parameters of the pre-determined variables, respectively. The corresponding reduced form is given by

$$y_t' = x_t' B + u_t' \tag{2.2}$$

where, $B = A_+ A_0^{-1}$ and $u_t = \varepsilon_t' A_0^{-1}$ with $E[u_t u_t'] = \Sigma = (A_0' A_0)^{-1}$. For an orthonormal $n \times n$ rotation matrix, Q, (A_0, A_+) can alternatively be expressed as the observationally equivalent $(A_0 Q, A_+ Q)$. Since the set of possible orthogonal matrices is infinite, there exists an infinite number of structural models that give rise to the same observable data.[4] However, given a specific Q, there exists a one-to-one mapping between reduced and structural form. Given the Cholesky-factorisation[5] of the covariance matrix of the residuals, we can write the reduced form in terms of the underlying structural shocks and

[4] Because $B = A_+ A_0^{-1} = A_+ Q \cdot Q^{-1} A_0^{-1}$ and $\Sigma = A_0 Q \cdot Q^{-1} A_0^{-1} \ \forall \ Q \in \mathcal{O}_n$.

[5] Or any other decomposition h for which is holds that $h(\Sigma)' h(\Sigma) = \Sigma$ (Arias et al., 2018).

the rotation matrix Q (Arias et al., 2018):

$$y_t' = x_t'B + \varepsilon_t'Q'\text{chol}(\Sigma) \tag{2.3}$$

Since B and Σ are exactly identified and Q uniquely links these to a valid structural model, Q can be used as a parsimonious way to carry theoretical restrictions on the structural parameters that are independent of the reduced form. In particular, these restrictions can be expressed as a Bayesian prior over Q that assigns zero probability mass to parts of the parameter space where the restrictions do not hold. This forms the basis for identification. Statistics, such as impulse response functions or historical decompositions can be computed in a standard way. In general, however, this identification will not be unique and the imposed sign restrictions will yield a set of models that is plausible under these sign restrictions.

2.2 Priors and Estimation

In the empirical exercises, we follow Arias et al. (2018) and impose a conjugate normal-inverse-Wishart prior on the reduced form parameters as well as a uniform prior on the rotation matrix, Q. The joint prior is hence given by

$$p(B, \Sigma, Q) = P(B, \Sigma) \cdot P(Q). \tag{2.4}$$

Together with a normal likelihood this parametrisation gives rise to a so-called normal-generalised-normal posterior distribution over the structural parameters (A_0, A_+) conditional on the restrictions imposed. Because $p(B, \Sigma \mid Y_T)$ is itself a proper posterior density, i.e. $p(B, \Sigma \mid Y_T) \propto p(B, \Sigma) \cdot p(Y_T \mid B, \Sigma)$, and because Q is not informative about the reduced form, i.e. the reduced from is unaffected by the choice of restrictions, this posterior is given by

$$p(B, \Sigma, Q \mid Y_T) \propto p(Q) \cdot p(B, \Sigma) \cdot p(Y_T \mid B, \Sigma). \tag{2.5}$$

In the empirical application, estimation is implemented with Algorithm 1 of Arias et al. (2018) which yields i.i.d. draws from the normal-generalised-normal posterior conditional on the set of sign restrictions. In doing so, we do not restrict the set of (A_0, A_+)

itself but the contemporaneous impulse response functions. Each iteration, we draw a naive candidate for the impulse response function which we repeatedly rotate with draws of Q. If the rotated impulse response function conforms to our sign restrictions, we retain the draw, otherwise we discard it.

2.3 Data

Our set of variables comprises the 10-year euro area Overnight Index Swap (OIS), the EUROSTOXX price index, the US S&P 500 and the bilateral euro-US dollar exchange rate, as well as the spread between the 10-year euro OIS rate and 10-year US Treasury yield.[6] We use the 10-year euro area OIS rate and US Treasury yield, as they are the main references for long-term risk-free rates in both jurisdictions.[7,8] Including long-term rates in the model, as opposed to short-term rates, allows for a broader definition of monetary policy shocks and might better capture shifts in risk sentiment. Regarding monetary policy shocks, using the 10-year yield allows capturing not only conventional monetary policy – which mostly affects the yield curve at short to medium maturities – but also unconventional measures such as those deployed by the Fed following the Global Financial Crisis. Large-scale asset purchases have been shown to indeed exert a larger impact at longer maturities by compressing term premia.[9] In addition, focusing on longer-term risk-free rates is instrumental to identify the global risk shock, as flight to safety episodes primarily affect investors' appetite for risk-free bonds against riskier assets, and the US Treasury market is the largest provider of safe, US dollar-denominated assets globally. Cieslak and Povala (2015) and Cieslak and Pang (2021) have shown that risk premium shocks more strongly affect longer maturities of US Treasury bonds, moving

[6] The yield and spread variables enter the model in first difference, while stock prices and the exchange rate are in log-difference. All variables are at business day frequency.

[7] The swap rate is the fixed rate which banks engaging in swap contracts agree to pay in exchange for receiving the average overnight interest rate for the duration of the swap. Unlike an unsecured interbank loan, in which the lender is exposed to the full credit risk of the borrower, a swap contract is settled in notional amounts, namely without involving a physical exchange of principals, and thus it is considered near risk-free.

[8] An alternative would be to use the 10-year German Bund as a measure of the long-term risk-free rate. However, given that the 10-year OIS and 10-year German Bund are tightly correlated over time, estimating the model with the 10-year German Bund instead of the 10-year OIS leaves the results largely unaffected.

[9] The downward pressures on the term premium stem from the central bank extracting duration risk from the market, which is the well-documented duration channel of asset purchases. For an empirical assessment of the duration channel of ECB asset purchases based on a term structure model, see Eser et al. (2023).

10-year yields more than twice as strongly as 2-year yields. The model is estimated over the period January 1999 – December 2023, including 4 lags of the dependent variables.[10]

2.4 Shock identification

Shock identification is achieved by way of imposing sign restrictions as in Arias et al. (2018). Our approach consists of imposing sign restrictions on daily cross-asset price movements, motivated by the intuition often portrayed in market commentaries that these co-movements reveal information about the underlying drivers of financial markets. For instance, bond yields and stock prices typically co-move positively in response to news about the economy and negatively in response to news related to monetary policy. This intuition finds strong empirical support (Rigobon and Sack, 2003; Rigobon and Sack, 2004; Matheson and Stavrev, 2014), and has been formalised in several papers that identify the contribution of monetary policy or growth shocks to yield and stock price reactions around monetary policy announcements.[11] The imposed sign restrictions are also in line with well-established closed and open economy structural model dynamics, such as those described in Bernanke et al. (1999) and Christiano et al. (2014) for the domestic shocks, and Gali and Monacelli (2005), Dedola and Lombardo (2012) and Dedola et al. (2013) for the cross-country spillovers.

A crucial departure from the literature using higher frequency asset price dynamics for shock identification lies in our broader framework, and this along two dimensions. First, we do not confine the estimates to a specific narrow time window surrounding particular announcements, but instead allow shock identification in "continuous time". This is consistent with the observation that market-moving news, which influence perceptions on monetary policy or the growth outlook, unfold virtually every day. Nuances in monetary policy communication which move financial markets often occur outside of these narrow time frames (Bauer and Swanson, 2023; Jayawickrema and Swanson, 2021), for example.

[10]While our main interest is on the most recent years, we include the pre-crisis sample as a way to benchmark post-crisis developments vis-à-vis "normal" times.

[11]For example, Jarociński and Karadi (2020) use high-frequency co-movement of interest rates and stock prices around policy announcements to disentangle monetary policy surprises from central bank information shocks. Andrade and Ferroni (2021) use co-movements between yields and inflation expectations to disentangle "Odyssean" monetary policy signals from "Delphic" monetary policy surprises (Campbell et al., 2012). Cieslak and Schrimpf (2019) use co-movements between stock prices and bond yields at different maturities to decompose asset price fluctuations into monetary policy surprises, information (or growth) surprises and risk shocks.

A second departure from this literature is that we identify multiple shocks jointly, which is a key contribution as it allows us to compare the relative importance of the key driving factors, while taking a consistent approach to identification.[12]

Table 1 summarises the structural shock identification scheme via sign restrictions on the contemporaneous impulse response functions. A "+" and "-" denote an increase or decrease, respectively, in the variable following a specific shock, while empty fields leave that response unrestricted. All restrictions are imposed on impact, reflecting the fact that markets typically react to news within the same day.

[Table 1 roughly intended here.]

As shown in Table 1, monetary policy shocks differ from macro shocks through the implied co-movement between yields and stock prices; a restrictive monetary policy shock drives yields up and equity prices down, while a positive macro shock increases yields and equity prices (Matheson and Stavrev, 2014; Altavilla et al., 2019; Cieslak and Schrimpf, 2019; Jarociński and Karadi, 2020). Both shocks are assumed to affect the exchange rate similarly, with higher domestic interest rates leading, ceteris paribus, to an appreciation of the domestic currency (Engel, 2014; Ca'Zorzi et al., 2023). We leave the effect of a domestic shock on foreign equity prices unrestricted as the effect is a priori ambiguous.[13]

Second, we allow for instantaneous spillovers between the euro area and the US, which requires to properly control for the country of origin. We address this issue by assuming that a domestic shock has a larger effect on the domestic variable than on the foreign variable. In practice, we apply this magnitude restriction through the spread between euro area and US yields. For example, a monetary policy tightening in the US might put upward pressures on US and euro area yields, but as the spread of euro area over US rates declines, US yields will react more strongly. This contrasts our approach from Cesa-Bianchi and Sokol (2022) who rule out direct spillovers from the domestic to the foreign economy by means of stricter zero restrictions.

Finally, a global risk shock causes investors to re-allocate their holdings of risky versus safe assets, which causes equity prices and bond yields to move in the same direction.

[12] For shocks other than the monetary policy shocks, such as the global risk or macro shocks, defining a narrow window around a specific event for identification is more challenging and arguably more arbitrary.

[13] News about the domestic macroeconomic outlook may drive a re-allocation from domestic risky assets into foreign risky assets, which all else equal would exert opposite effects on domestic and foreign equity prices. On the other hand, positive domestic news on the economy can lift foreign equity prices through the demand channel.

For example, higher risk aversion will reduce appetite for risky assets (Baele et al., 2020) while causing inflows into safe assets. During episodes of heightened global risk, investors flee into US dollar-denominated assets as these are considered liquid and safe (Farhi and Gabaix, 2016; Jiang et al., 2021), which holds in particular for US Treasury bonds in that they embed a convenience yield (Krishnamurthy and Vissing-Jorgensen, 2012; Du et al., 2018). Due to the higher liquidity and safety of US Treasuries, we assume that Treasury rates will fall more strongly than euro area yields upon a worsening in global risk sentiment, which causes the euro area-US rate spread to decline. In addition, the US dollar is assumed to appreciate vis-à-vis the euro exchange rate, reflecting the role of the US dollar as safe haven currency (Georgiadis et al., 2024), and the US economy providing insurance in times of global stress (Gourinchas and Rey, 2022).

Interpretation of the structural shocks. Our choice to identify the structural shocks in "continuous time" by relying on co-movements in asset prices has implications for the interpretation of the shocks. We identify the structural shocks through the lens of financial markets, with the shocks capturing changes in the interpretation of market participants of daily news on the macroeconomic outlook, global risk and monetary policy, as captured by changes in asset pricing. This implies that we attain a wider definition of the structural shocks than part of the literature does. For example, compared to the studies using high-frequency monetary policy shock identification during narrow time windows (e.g. Jarociński and Karadi, 2020), our monetary policy shocks capture changes in the *perception* of market participants of the monetary policy stance, similar to Cieslak and Pang (2021). These will include shifts in interest rates on days of monetary policy meetings and speeches, but also shifts caused by news that induce market participants to re-price their monetary policy expectations. This could happen following important data releases when monetary policy is data dependent, for example. As such, our monetary policy shocks encompass a broader range of innovations beyond those directly stemming from surprises in monetary policy decisions or communication, as we identify these shocks through asset price movements. Similarly, the global risk shock captures market reactions to events that cause investors to price in increased risk aversion, by shifting towards risk-free assets and safe US dollar-denominated assets. For each day, typically a multitude of shocks is identified.

There are advantages to our identification approach. For example, compared to the literature exploiting market movements over narrow time windows around monetary policy events, there are two main differences. First, our approach is not restricted to days of monetary policy announcements but we allow for monetary surprises to occur any day. This is consistent with the findings of Jayawickrema and Swanson (2021) and Bauer and Swanson (2023), who have underlined the importance of broadening the time window to a wider set of events in order to accurately pin down monetary policy surprises and central bank information effects. Particularly when monetary policy takes a data-driven approach, markets might re-assess the expected stance of monetary policy more frequently. Second, because we do not restrict the time window to specific events, our approach also allows capturing in full anticipation effects that materialise ahead of the actual policy announcement through nuances in monetary policy communication on non-monetary policy meeting days such as in speeches. These anticipation effects are an important channel of monetary policy transmission, as shown by Cao et al. (2013) who uses surveys, newspaper articles and internet searches to show that announcements for various rounds of LSAPs in the US were largely expected. Our results, discussed below, confirm that monetary policy announcements are typically largely anticipated by market participants – and our framework effectively categorizes these as monetary policy shocks.[14] Moreover, we find that realisations of monetary policy shocks are significantly larger on monetary policy meeting days than on non-meeting days which reflects our broader definition of monetary policy shocks.[15]

Despite these conceptual differences, we find that our monetary policy shocks co-move strongly with estimates from the high-frequency literature on announcement days. To illustrate the validity and information content of the shocks retrieved from our daily SVAR, we project onto them the high-frequency surprises in OIS rates across the term structure, using the changes in OIS rates around ECB announcements from the EA Monetary Policy Database of Altavilla et al. (2019).

For each high-frequency change hf in the OIS rate at maturity τ recorded on an-

[14] In particular, our results suggest that, once accounting for anticipation effects, there is no evidence that the marginal impact of LSAP programmes on long-term interest rates has declined over time. This finding is in line with the evidence provided by Carlson et al. (2020), Cahill et al. (2013), and Cao et al. (2013). Cahill et al. (2013) show that, after controlling for pre-announcement market expectations, the yield impact of the Fed's asset purchases has not reduced over time.

[15] See Figure A.1 in the online appendix.

nouncement day t, we run the following univariate regression, where $\varepsilon^{(i)}$ is the i'th shock in the daily SVAR:

$$hf_{\tau,t} = \alpha^{(i)} + \beta_{\tau}^{(i)} \varepsilon_t^{(i)} + \nu_{\tau,t}^{(i)} \tag{2.6}$$

[Figure 1 roughly intended here.]

Figure 1 shows that the shocks from the daily SVAR have significant explanatory power for high-frequency movements in financial market variables around policy announcements. We find that our monetary policy shock explains a significant share of the variation in OIS rates around policy announcements – around 40% beyond the four-year mark. Since our shocks are identified using a fairly long risk-free rate and estimated on a sample which includes a long period of unconventional monetary policy with short-term interest rates near the effective lower bound, it is expected that they co-move most with surprises at medium- to long-term maturities. Point estimates of the parameter β are statistically significant (at the 5%-level) and sizable with a one-standard-deviation monetary policy shock increasing OIS surprises by about 2.5 basis points (compared to a standard deviation of around 5 basis points for most OIS surprises).

Possible extensions to our framework. While our baseline specification is rather parsimonious, it could be extended to capture additional drivers of euro area financial conditions, such as sovereign or corporate credit risk. Additionally, one could consider yields at other maturities as a way to capture different dimensions of monetary policy (e.g. negative interest rate policy versus rate forward guidance versus the ECB's asset purchase programme).[16] [17] While changing the specification of the model may enrich the interpretation of monetary policy factors, the results remain largely unaffected.[18] For our global risk shock, this implies that in essence, a simple framework that rests on two

[16]In practice, empirically disentangling the different monetary policy instruments in one single framework proves challenging. Rostagno et al. (2021) propose an approach that overcomes this challenge based on combining yield curve identification with a large macro BVAR.

[17]One important implication of using long-term yields is that the estimated monetary policy shock spans multiple dimensions in line with the target, path and QE factors from the literature. The online appendix provides a cross-check of our estimated monetary policy shock against the Target, Path, and QE instruments from Miranda-Agrippino and Nenova (2022). The results indicate that our monetary policy shock loads positively on all three factors and can therefore be interpreted as spanning multiple monetary policy dimensions. See Figure B.15 and subsequent.

[18]The online appendix provides robustness checks of alternative model specifications, for example using sovereign yields.

types of assets – risk-free bonds and equity – in combination with a safe haven currency such as the US dollar seems sufficient to pin down the "flight-to-safety" component.

2.5 Model interpretation and validation

We check the validity of our identification strategy in two ways. First, we inspect the estimated shocks and compare them to alternative empirical measures over time (Section 2.5.1). Second, we review the shock decomposition over a selection of significant market events for which we have a strong prior knowledge on the dominant factor driving market developments over that specific event (Section 2.5.2).

2.5.1 Economic interpretation of the identified drivers.

Monetary policy shocks. An inspection of the estimated euro area and US monetary policy shocks shows that over periods when the ECB and the Fed have been most active in deploying unconventional policy measures[19], large realisations of the shocks coincide with important monetary policy announcements (Figure 2). For example, large shocks for the euro area come with the first Asset Purchase Programme (APP) announcement in early 2015, its subsequent recalibrations and the announcement of the Pandemic Emergency Purchase Programme (PEPP) at the onset of the pandemic. For the US, the largest negative monetary policy shock during that time frame occured on the day of the first Large-Scale Asset Purchase (LSAP) announcement in November 2008. We also inspect other policy announcements and find a significant contribution of monetary policy shocks in shaping financial conditions on these days. Overall, this indicates that our approach effectively captures key monetary policy announcements.[20]

[Figure 2 roughly intended here.]

[19]We focus on (i) 2014-2020 for the euro area, covering the adoption of negative interest rate policy (NIRP) and the Asset Purchase Programme (APP) announcement and the measures taken in response to the COVID-19 pandemic such as the Pandemic Emergency Purchase Programme (PEPP); and (ii) the period 2008-2012 for the US, during which the various Large-Scale Asset Purchase (LSAP) Programmes were announced. The choice to focus on this specific period is arbitrary; also beyond this time frame important monetary policy shocks are well captured.

[20]These findings are consistent with the literature documenting a strong asset price reaction around large-scale asset purchase announcements. For the euro area, see Altavilla et al. (2021) and Andrade et al. (2016). For the US, see Vissing-Jorgensen and Krishnamurthy (2011) and Gagnon et al. (2011).

Macro shocks. We assess the euro area and US macro shocks by comparing them with the Citigroup Economic Surprise Index ("CESI"), a measure of macroeconomic surprises commonly used by market analysts.[21] As our identification of the macro shock aims at capturing news that affect the market perception of the macroeconomic outlook, the estimated macro shocks should exhibit some degree of co-movement with actual macro surprises. In fact the comparison shows that both measures strongly co-move over the estimated sample for both the euro area and the US.[22] It also shows that the correlation tends to vary over time. In particular, the identified macro factor disconnects at times from actual macro surprises with some persistence. There are two possible explanations for this. First, while the CESI index is an aggregation of all different macro releases, market participants might be inclined to give more attention to specific news at specific periods of time. Second, the disconnect between actual macro surprises and the market perception of the macro outlook as estimated in our model is also consistent with the tendency of markets to over- or under-react to news about the state of the economy in bouts of optimism or pessimism, as in Benhabib et al. (2016). Alternatively, it might be that under imperfect information market investors take into account a wider set of economic indicators than pure data releases when forming their expectations about the state of the economy and the central bank's reaction to it, as suggested by Pastor and Veronesi (2009).

Global risk shock. To assess how well we capture shifts in global risk, we compare our estimated shock series to alternative risk measures: the US and euro area indices of stock market volatility (VIX and VSTOXX, respectively), the euro area "CISS" index of systemic stress (Hollo et al., 2012) and the global economic uncertainty measure of Bobasu et al. (2024), as plotted in Figure 3. Our global risk factor, which aims at capturing episodes of shifting risk aversion and flight to quality, strongly co-moves with these alternative risk measures, exhibiting spikes during episodes of market turmoil such as the 2008 Lehman collapse or at the start of the COVID-19 pandemic in early 2020. We also find evidence that the euro area sovereign debt crisis was accompanied by a surge

[21] The CESI is defined as a weighted historical standard deviation of data surprises (actual releases versus the Bloomberg median survey) and is calculated daily in a rolling three-month window. The weights of the economic indicators are derived from relative high-frequency spot foreign exchange impacts of 1 standard deviation data surprises adjusted to include a time decay feature so as to replicate the contained memory of markets.

[22] See Figure A.3 in the online appendix.

in global risk aversion with investors moving out of euro-denominated assets toward US-denominated assets in an attempt to reduce their exposure to redenomination risk.[23] Our global risk factor – being two-sided – tracks symmetrically both adverse and benign risk sentiment episodes. We find, for example, that at times when the euro area economy was on a recovery track, such as in the mid-2000s or over 2015-2018, the risk environment was especially favourable, which may have further supported the recovery.

[Figure 3 roughly intended here.]

2.5.2 Event study evidence

As a second test of validation, we study the model performance more systematically over selected events that caused a market reaction following important news on euro area monetary policy (such as announcements of APP or negative interest rate policy), US monetary policy (such as the LSAP announcement) or relevant euro area or US macro releases. Table 2 lists the selected events, and our prior expectation of the specific shock in our model that should dominate financial market movements on that day. Figure 4 plots the two-day reaction of euro area long-term rates for each of the selected events, together with the contributions of the underlying drivers.[24] The results for US yields, euro area stock prices and the exchange rate are reported in the Online Appendix.

[Table 2 roughly intended here.]

Two findings are worth highlighting. First, the results show that the model identification is successful at capturing the specific nature of each event. For events that are caused by an important monetary policy announcement, the model tends to identify the monetary policy shock as the dominant driver of the change in euro area long-term rates over the two-day window around the event (see left panel in Figure 4). Similar conclusions apply to spillovers around US monetary policy events; US monetary policy

[23]This is consistent with evidence of investors' fears of a euro area breakdown, as captured by rising redenomination risk (De Santis, 2019).

[24]On any given day, releases of macroeconomic data, monetary policy announcements, or any other type event can generally coincide. The daily VAR, decomposes the reduced from residuals of the system into orthogonal structural shocks, conditional on our set of identifying sign restrictions. The historical decompositions that form the basis for our event study utilize the identified VAR to express all variables and hence daily movements as a sum of current and past shocks, conditional on the dynamics of the system. This is why the contributions are generally non- zero anywhere, even though the underlying shocks are orthogonal.

shocks tend to be the dominant driver of euro area long-term rates on these days (see middle panel in Figure 4). Finally, also global risk and macro events are well-captured (see right panel). For example, the Brexit referendum is associated with a large decline in the 10-year OIS in the euro area (-20 basis points), which is equally split between two factors – global risk and euro area macro. This decomposition sheds light on the market perception of the implications of Brexit: increased risk aversion leading to investment flows into safe dollar-denominated assets, combined with a sudden negative re-appraisal of the euro area macro landscape through close trade and financial linkages with the UK.

[Figure 4 roughly intended here.]

Second, the exercise also underlines that – while one shock might dominate developments on a given day – other shocks also matter. This may reflect two elements. First, news typically encompasses diverse topics. Some of these updates are focused on monetary policy, while others revolve around macro information. For example, the ECB Governing Council meetings tend to coincide with the release of important US macro news such as the preliminary release of US non-farm payroll data. This might blur the signal associated to the specific event that one tries to isolate. Second, the announcement may give rise to a re-appraisal along dimensions that are not directly related to the original signal. For instance, euro area monetary policy events tend to be associated not only with a monetary policy shock, but also with a re-appraisal of the euro area macro factor. This result is consistent with the well-documented finding that ECB monetary policy events give rise to two types of monetary policy signals, namely a classic "Delphic" component (signal about a turn in the monetary policy stance) as well as an "Odyssean" component (signal on the central bank's assessment of the economic outlook), see also Andrade and Ferroni (2021) and Jarociński and Karadi (2020). Our approach allows us to effectively isolate the Delphic component of monetary news. At the same time, our results also suggest an important role of non-monetary news – shifts in macro and global risk – in explaining the daily reaction of asset prices around monetary policy events, which is consistent with the findings from the literature (Nakamura and Steinsson, 2018, Cieslak and Schrimpf, 2019).

3 Empirical results

3.1 What drives euro area and US financial markets?

To get a broader overview of the drivers of euro area asset prices, we present the historical decomposition of euro area long-term rates, equity prices and the euro- dollar exchange rate over three sub-periods: (i) January 2008 – December 2013, dominated by the global financial and euro area sovereign debt crises ("double-dip recession"), (ii) January 2014 – December 2019, containing the shift of the ECB's monetary policy into unconventional domain and (iii) the COVID-19 pandemic and the inflation surge of 2022.[25]

Double-dip recession. During the global financial crisis, the deterioration of the euro area domestic macro outlook explained about half of the decline in euro area risk-free rates and caused close to 20% fall in euro area equity prices compared to early 2008, see top panel in Figure 5. The ECB's monetary policy response (as captured in the euro area policy factor) lowered long-term yields, while supporting domestic equity markets. The euro fell substantially against the US dollar in the first months of the crisis, reflecting safe haven flows into dollar-denominated assets (as captured by the global risk shock). As the macroeconomic outlook deteriorated on both sides of the Atlantic, macro shocks did not steer the bilateral exchange rate in a specific direction. That changed in the years thereafter, however, when the US economy recovered from the global financial crisis while adverse macro shocks continued to weigh on financial markets in the euro area as the sovereign debt crisis intensified, lowering long-term yields and equity prices further. The euro exchange rate weakened substantially as investors questioned the robustness of the common currency (captured by a combination of euro area macro and global risk shocks). These factors more than offset upward pressures on the euro from the Fed's unconventional policy measures in 2011-2012 that depreciated the US dollar. The persistent drag of adverse macro risk shocks on the outlook for economic activity and inflation in the euro area triggered the ECB to resort to unconventional monetary policy in the months thereafter.

[Figure 5 roughly intended here.]

[25] The corresponding results for the US are shown in the Online Appendix, see Figure A.8.

Unconventional monetary policy. Over the period 2014-2019, the ECB widened its toolkit to include unconventional measures such as negative interest rates, rate forward guidance and asset purchases, with the objective to bring inflation back to target in face of persistent deflationary pressures. Model results show that these measures left a significant footprint on euro area financial markets. This is particularly visible in the contribution of the policy factor, which lowered euro area long-term yields by about 60 basis points in cumulated terms over 2014-2019. This supported domestic equity markets and significantly depreciated the euro exchange rate throughout the review period, see panel (b) in Figure 5. The deterioration in the euro area macro outlook added to the downward pressure on long-term yields and the euro exchange rate. By contrast, the improvement in the US macroeconomic outlook pushed up euro area long-term yields and stock prices, while adding downward pressures on the euro exchange rate. Although the Fed started to raise policy rates in December 2015, the US policy factor continued to exert downward pressures on US and euro area yields, indicating a persistently accommodative stance.

COVID-19 pandemic and the inflation surge. The outbreak of the COVID-19 pandemic in early 2020 affected euro area financial markets differently. The shock mainly impacted markets through inflows into safe assets, lowering euro area long-term yields further, and explaining a substantial part of the fall in equity prices in the first months of 2020. Shifts in global risk sentiment were even more impactful in the US – aligning with its recognized status as a safe haven — and accounted for a significant portion of the strengthening of the US dollar in the early part of the pandemic, see panel (c) in Figure 5. Domestic macro and monetary policy factors did not point to a clear direction initially, which might be consistent with the highly accommodative ECB monetary policy stance before the pandemic hit.[26] Central bank communication might have also played a role. Model results suggest that initial ECB communication failed to fully reassure markets, as visible in the large tightening shock at the early March press conference. This was however soon followed by a sharp reversal in the accommodative direction after the 18 March decision to launch PEPP.

[26] With policy rates in negative territory and a sizeable balance sheet, markets might have anticipated that room for monetary policy to maneuver was limited, at least regarding the ability to further lower the risk-free yield curve.

In the years thereafter, yields and equity prices increased again as the global economy recovered from the pandemic slump. Between 2021 and 2023, the model attributes a sizeable part of the recovery in yields and equity prices to improving expectations on the macro outlook on both sides of the Atlantic. As macro dynamics were stronger in the US, however, the euro depreciated against the dollar. At the same time, monetary policy started to tighten at an unprecedented pace as inflation hit record high levels due to the recovery in demand and surging energy prices after Russia invaded Ukraine.[27] The simultaneous economic rebound in both the euro area and the US, accompanied by a synchronous tightening of monetary policies, largely accounted for the sharp rise in yields in the euro area, while intensifying fluctuations in euro area equities, see panel (c) in Figure 5. By contrast, because both euro area and US factors were of similar nature but tended to offset each others in terms of their exchange rate impact, movements in the euro-US dollar were relatively more contained.

Overall, these events illustrate that financial markets in the euro area are influenced by a complex interplay of shocks that do not occur in isolation and can amplify, or suppress, financial dynamics. This is particularly the case for US spillovers to euro area markets, as illustrated next.

3.2 Cross-Atlantic financial spillovers

Financial market dynamics – particularly in the euro area – are significantly determined by cross-Atlantic spillovers. The forecast error variance decomposition indicates that US shocks are found to explain close to 40% of variability in euro area yields and equity prices over the full sample, see Figure 6. Shocks originating in the euro area, while relatively less important, still exert sizeable influence on US financial markets, and account for about 30% of the dynamics in US equity prices on average. Interestingly, our finding that spillovers might run both ways is similar to Kearns et al., 2023, who focus on monetary policy shocks and find that Fed spillovers tend to dominate ECB spillovers but that ECB

[27] This additional tightening impulse – over and above the reaction to an improving macro outlook – might in part reflect the resurgence of adverse supply factors. In theory, the impact of a supply shock on asset prices is ambiguous and depends on how markets expect the central bank to react. If the shock is perceived to be temporary, markets may expect the central bank to look through, leaving financial variables unaffected. On the other hand, the types of supply shock observed during the pandemic recovery — especially the sharp increase in energy prices — are likely to have contributed to a more forceful monetary policy response than during "normal" times, hence leading the central bank to deviate from its standard reaction function and adding upward pressures on yields as shown by the model results.

spillovers to US financial conditions remain tangible. Euro area financial markets are also affected by shifts in global risk sentiment, although these types of shocks play a larger role for US financial markets given the safe haven status of US dollar-denominated assets. Taken together, spillovers from US shocks and changes in global risk aversion can explain close to half of the average variation in selected asset prices in the euro area.

Interestingly, the extent to which foreign shocks drive euro area financial markets differs across assets. Foreign forces explain more than half of euro area equity prices over our sample, while this share is less for euro area yields, possibly reflecting the role of ECB's rate forward guidance in shielding euro area shorter-term rate expectations from foreign influence. For the euro-US dollar exchange rate, euro area-specific shocks only account for about 20% of the variability, with US shocks explaining about double that amount. Variation in global risk sentiment is however the dominant driver of the bilateral euro-US dollar pair, which is in line with the literature that underscores the importance of risk premia in driving exchange rates (Engel, 2014), as well as the safe haven role of the US dollar (Georgiadis et al., 2024).

[Figure 6 roughly intended here.]

To illustrate the importance of cross-Atlantic financial spillovers, it is useful to focus on periods that brought about major shifts in financial markets. As the extent of spillovers depends on the underlying dominant shock, we study the spillovers during (i) the US dot-com bubble (US macro shock), (ii) the euro area sovereign debt crisis (euro area macro shock), (iii) the aftermath of the first round of LSAP by the Fed (US monetary policy shock) and (iv) the period since the ECB started using unconventional monetary policy (euro area monetary policy shocks).

The US dot-com bubble period illustrates that US-driven macro shocks can significantly steer euro area financial markets. After a prolonged period of optimistic macro prospects, the burst of the dot-com bubble in early March 2000 triggered a sharp sell-off in equity markets in the US that largely transmitted to EA equity prices. Adverse US macro shocks caused EA equity prices to decline by about 20% over a period of almost two years, which is close to the magnitude of the domestic US equity price reaction. The burst of the bubble also motivated investors to shift their portfolios from equities to bonds — as captured by the global risk shock — which further weighed on euro area equity prices. The negative US shock came at a time when the ECB was tightening its policy, causing the overall decline in equity prices in the euro area to be much more pronounced than the one observed in the US over that period.

[Figure 7 roughly intended here.]

In comparison, the spillovers of euro area macro shocks to US financial markets are found to be noticeably smaller. Whereas the transmission following the US dot-com bubble across equity markets was close to full, only less than half of the drop in euro area equity prices caused by adverse macro shocks spilled over to US equity markets following the sovereign debt crisis (see panel B in Figure 7). However, as the debt crisis also triggered flows into safer assets such as bonds, particularly dollar-denominated ones, US equity prices and long-term yields were importantly affected through the global risk channel instead.

Regarding monetary policy spillovers, it is also the case that US monetary policy shocks spill over more significantly to euro area financial markets than the other way around, which is in line with the literature that underlines the dominant role of US monetary policy in steering the global financial cycle (Miranda-Agrippino and Rey, 2020; Ca'Zorzi et al., 2023). After the Fed embarked upon quantitative easing policies in late 2008, accommodative US monetary policy shocks are found to have considerably lowered euro area long-term yields, see panel C in Figure 7. Overall, as the ECB was loosening its policy stance as well over most of that period, the spillovers from the Fed supported domestic efforts to ease financial conditions. In contrast, the spillovers of the ECB's unconventional policies since mid-2013 – comprising forward guidance, negative short-term rates, and asset purchases – are hardly registered in US long-term yields, as shown in panel D. At that time, rates in the US were partly anchored by rate forward guidance, which might have been a reason why euro area-to-US spillovers were smaller than those of the Fed's policies to euro area yields before 2013 when the ECB introduced rate forward guidance as well.

In sum, these findings underscore the necessity of considering external influences when dissecting financial conditions. For the euro area, changes in US monetary policy as well as global risk perceptions play important roles, impacting yields, equity prices, and determining the strength of the euro exchange rate. For US financial markets, by contrast, euro area-specific dynamics can matter, but are typically less relevant than domestic or global risk factors. Overall, looking beyond borders appears key for a proper understanding of financial market dynamics in real time.

4 Transmission to the macroeconomy: Proxy SVAR

As a final exercise, this section analyses the response of macroeconomic variables to the shocks extracted in the previous section. In doing so, we draw on the proxy-SVAR literature (see e.g. Gertler and Karadi, 2015; Mertens and Ravn, 2013; Stock and Watson, 2012) and employ the Bayesian proxy-SVAR algorithm proposed by Caldara and Herbst (2019). The starting point is a VAR at monthly frequency that includes the financial variables contained in the daily model as well as industrial production, inflation, and the unemployment rate for both the euro area and the US. Stacking these variables in a vector denoted by Y_t, yields the structural form VAR

$$B_0 Y_t = B_+ Y_{t-1} + \varepsilon_t, \tag{4.1}$$

where B_0 and B_+ contain the structural parameters, and $\varepsilon_t \sim N(0, I)$ is the vector of structural shocks. The reduced form residuals $u_t \sim N(0, \Sigma)$ are hence given by $u_t = B_0^{-1}\varepsilon_t$, with $\Sigma = (B_0' B_0)^{-1}$ and the reduced form VAR coefficients by $\bar{B}_+ = B_0^{-1} B_+$, where without loss of generality $\bar{B}_+$ and B_+ collect constants and coefficients on lags.

As with any standard VAR, this model requires additional restrictions for identification due to the many combinations of structural parameters that yield the same reduced form parameters and hence likelihood function. We leverage this identification challenge to connect high-frequency shocks derived from our daily financial VAR to the set of monthly macroeconomic variables.

In doing so, we draw from the proxy-SVAR literature (see e.g. Gertler and Karadi, 2015; Mertens and Ravn, 2013; Stock and Watson, 2012) and identify the structural shocks in the monthly VAR one at a time using a single instrument, Z_t, for each economic shock of interest, εt^p, and its corresponding row in the inverse impact matrix, B_0^p. In our setup, the natural choice for the instruments are then the structural shocks from our daily BVAR. Formally, we follow Caldara and Herbst (2019) and establish a link between the structural shock, ε_t^p, and the instrument, Z_t, through:

$$Z_t = \beta\varepsilon_t^p + \sigma_\nu\nu_t, \qquad \text{with } \nu_t \sim N(0,1) \text{ and } \nu_t \perp \varepsilon_t. \tag{4.2}$$

Two critical assumptions in the proxy-SVAR literature are directly implied by this mapping:

$$E[Z_t\varepsilon_t^{p\prime}] = \theta \tag{4.3}$$

$$E[Z_t\varepsilon_t^{q\prime}] = 0 \tag{4.4}$$

Assumption 4.3 requires that the instrument is correlated with the policy shock of interest, ε_t^p. The relevance of the proxy is directly related to the signal-to-noise ratio β/σ_ν. The higher this ratio, the more information the proxy contains on the structural shock and the closer the time series of the structural shock to the time series of the proxy. Conversely, when $\beta/\sigma_\nu = 0$, then the proxy is driven by noise entirely and does not contain information on ε_t. Weak identification results when β/σ_ν is close to zero. Because the structural shocks extracted from the daily VAR are identified using sign restrictions that embody the economic interpretation of ε_t^p, condition 4.3 is by construction fulfilled. In addition, prior believes about the relationship between the proxy and the structural shock of interest can be directly introduced through the tightness of the prior on σ_ν (Caldara and Herbst, 2019). In this exercise, we focus on macro-level responses to our daily financial shocks. Therefore, we favor structural shocks that closely align with the proxy by adopting the high relevance prior outlined in (Caldara and Herbst, 2019). This prior suggests that only half of the variation in the proxy can be attributed to measurement error, although our empirical results remain robust even when imposing an uninformative prior.

Assumption (4.4) requires that the instrument is orthogonal to the other structural shocks, ε_t^q, in the macro VAR. To ensure that this condition continues to hold once we aggregate the daily structural shocks to monthly frequency, we control for possible correlations during the aggregation process.[28]

[28]To obtain the monthly instruments we aggregate the daily structural shock series from the BVAR model over the number of successful draws and over time, which introduces some correlation between the instruments in monthly frequency – even though shocks from each draw are uncorrelated at the daily frequency. To address this issue, we purge the instruments by sequentially regressing these on the other shock series to ensure the shock instruments are uncorrelated.

4.1 Proxy SVAR methodology and estimation

To estimate the proxy SVAR described above, we employ the algorithm in Caldara and Herbst (2019) throughout, which has key advantages over other algorithms in the literature. Taking the proxy into account, the structural VAR can be augmented such that

$$\tilde{B}_0 \tilde{Y}_t = \tilde{B}_j \tilde{Y}_{t-1} + \tilde{\varepsilon}_t, \tag{4.5}$$

where $\tilde{Y}_t = [Y_t' Z_t]'$ and $\tilde{\varepsilon}_t = [\varepsilon_t' \nu_t]'$. $\tilde{B}_0$ and $\tilde{B}_0$ contain the SVAR parameters as well as the parameters from proxy equation, 4.2 with

$$\tilde{B}_0 = \begin{bmatrix} B_0 & 0 \\ -\frac{\beta}{\sigma_\nu} B_0^p & \frac{1}{\sigma_\nu} \end{bmatrix} \text{ and } \tilde{B}_+ = \begin{bmatrix} B_+ \\ -\frac{\beta}{\sigma_\nu} B_+^p \end{bmatrix}. \tag{4.6}$$

This gives rise to the likelihood function

$$p(Y_{1:T}, Z_{1:T} | \tilde{B}_0, \tilde{B}_+) = p(Y_{1:T} | \Sigma, \bar{B}_+) p(Z_{1:T} | Y_{1:T}, B_0, B_+, \beta, \sigma_\nu), \tag{4.7}$$

which contains not only the likelihood function of the reduced form VAR but also the likelihood of the proxy given the macroeconomic data and structural parameters. This allows for efficient use of information contained in the proxy, as it is utilized during the estimation of both the structural and reduced form parameters, while also allowing for the joint modeling of all sources of uncertainty (Caldara and Herbst, 2019). In contrast, traditional proxy-SVAR approaches rely on a two-step procedure which does not leverage proxy information during the estimation of the reduced form VAR.[29]

For comprehensive explanations and detailed derivations of the algorithm, readers are directed to Caldara and Herbst (2019).

4.2 Empirical results: shock dependence matters

Figure 8 shows the estimated macroeconomic effects of an impact increase in long-term rates in the euro area by 10 basis points depending on the shock causing higher yields:

[29] The first stage regression isolates the variation of the reduced form residual, u_t^p, that can be explained by the proxy. In the second stage regression, the reduced form residuals of the other variables in the VAR are regressed on the fitted values, which then allows to compute B_0^p based on the restrictions implied by these regression estimates.

(i) a euro area monetary policy shock, (ii) a US monetary policy shock, (iii) a euro area macro shock, (iv) a US macro shock or a (v) global risk shock. Here we report results using the euro area yields to normalise the impact of the shocks, but the macro implications are the same when another endogenous variable is used to normalize, such as the exchange rate.

[Figure 8 roughly intended here.]

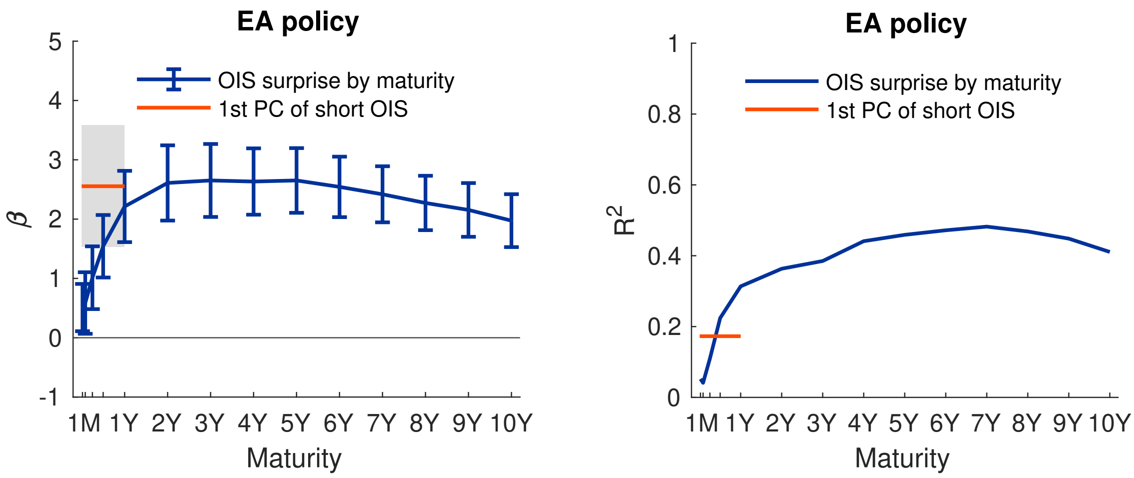
The results show that indeed, the implications of higher yields for euro area industrial production, inflation and unemployment differ depending on the underlying driver. For example, a monetary policy shock originating within the euro area leads to higher unemployment and lower output, whereas the same shock originating in the US has largely insignificant effects. Likewise, euro area inflation responds less strongly to a US monetary policy tightening, likely due to the conflicting effect of the euro depreciation. However, in both cases, the responses are generally insignificant and accompanied by wide confidence bounds. In contrast, when long-term euro area yields rise due to an improving domestic macroeconomic outlook, industrial production and inflation tend to benefit from stronger demand rather than being dampened by higher yields and an appreciating euro. Similarly, when euro area yields increase in response to positive US macroeconomic news that spills over into euro area financial markets, domestic industrial production and inflation increase. Finally, when euro area risk-free rates are higher because of improving global risk sentiment – in the recovery phase from the global financial crisis or the COVID-19 pandemic for example – higher yields will also be associated with strengthening growth and rising inflationary pressures.

These findings confirm that looking at daily financial market dynamics is useful for policy makers; their co-movements convey valuable information on how changes in financial assets will transmit to the real economy and inflation. Depending on the dominant driver, the implications can differ greatly. This underscores the need to understand the drivers of financial market dynamics in the first place.

5 Conclusions

Understanding financial market dynamics in the euro area requires looking beyond borders. In this paper, we provide a novel, parsimonious model which jointly estimates key drivers of euro area financial asset prices. The model explicitly accounts for the unique role of the US in shaping global financial market dynamics and cross-Atlantic spillovers. The results show that euro area financial markets are driven by a complex interplay of domestic and foreign shocks that can amplify, or suppress, financial dynamics at home. Spillovers from the US and changes in global risk aversion account for close to half of the average variation in selected asset prices in the euro area. This high degree of spillovers can pose challenges for monetary policy making and at times counteract domestic efforts to stabilise inflation. Moreover, depending on the driving force, the same change in financial market variables can have different implications for macroeconomic variables. Therefore, a comprehensive understanding of the underlying drivers of financial market dynamics is crucial.

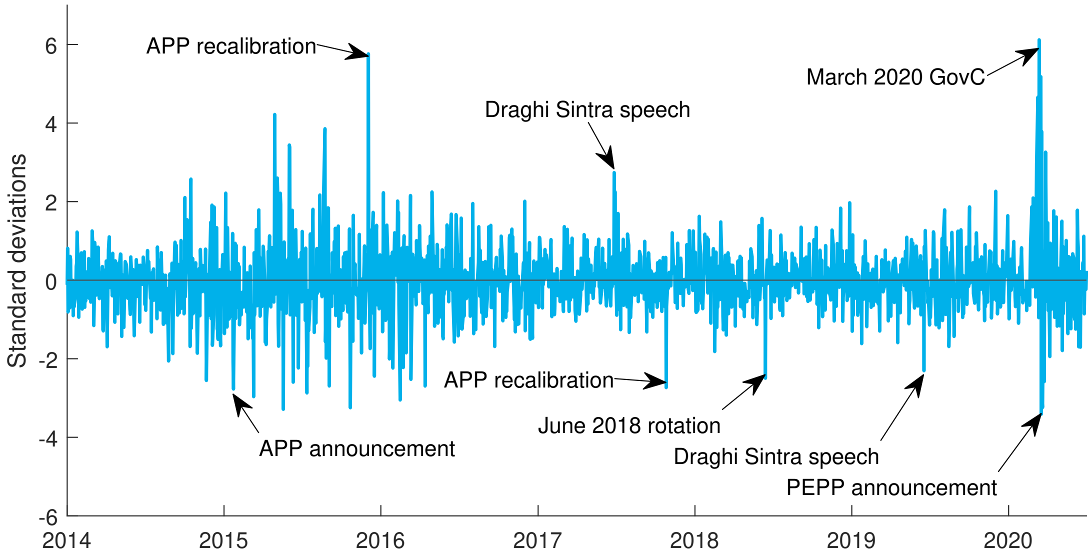
Figures and Tables



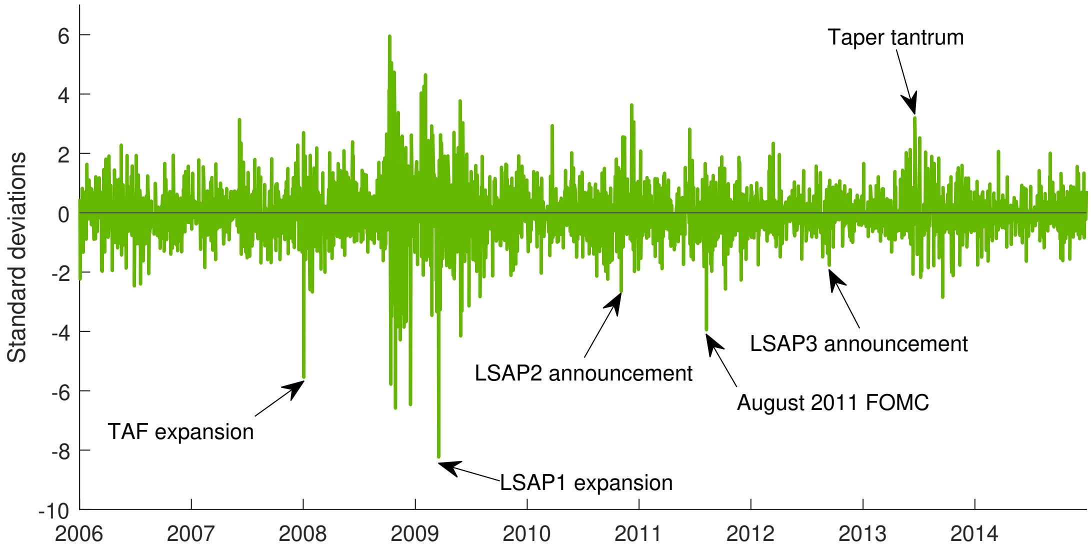
(a) **Effect of EA policy by maturity** (b) **R^2 of EA policy by maturity**

Figure 1: Explanatory power of euro area shocks for high-frequency changes in OIS rates around ECB policy announcements

Notes: Panel (a) shows the term structure of regression coefficients from equation 2.6. Error bars denote the 95% confidence interval. Panel (b) shows the associated share of variance explained. Orange lines and grey swathes additionally show the respective parameters of the regression with the first principal component of OIS with maturity up to one year on the left-hand side; as in, for example, Nakamura and Steinsson (2018) and Ca'Zorzi et al. (2023).



(a) **Euro area: 1 January 2014 - 30 June 2020**



(b) **United States: 1 January 2006 - 31 December 2014**

Figure 2: Euro area and US monetary policy shocks during periods of unconventional policy

Notes: The figures show the respective posterior mean over all accepted draws from the BVAR.

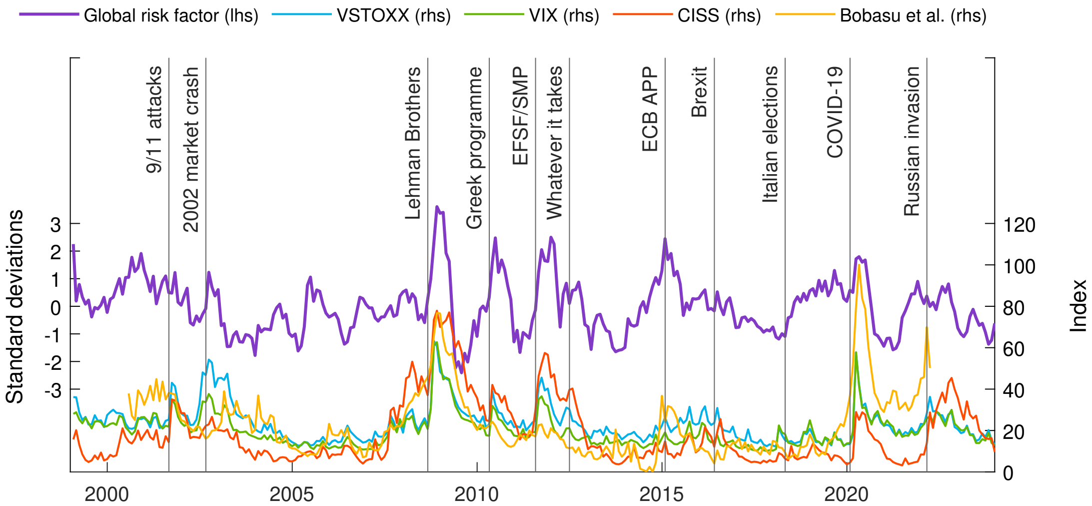


Figure 3: Comparison of the global risk factor with alternative risk indicators

Notes: To align the volatility of our global risk measure to that of other measures for easier visual comparison, the global risk factor is the six-months moving average of the standardised posterior mean global risk shock from the daily BVAR, while financial market indicators are shown as monthly averages. The yellow line shows the Global Uncertainty Measure of Bobasu et al. (2024). To note, the measures are not fully comparable, because by construction the global risk shock takes positive and negative values (capturing risk-on and risk-off episodes), while financial market indicators measure volatility and only take positive values, hence the two distinct scales.

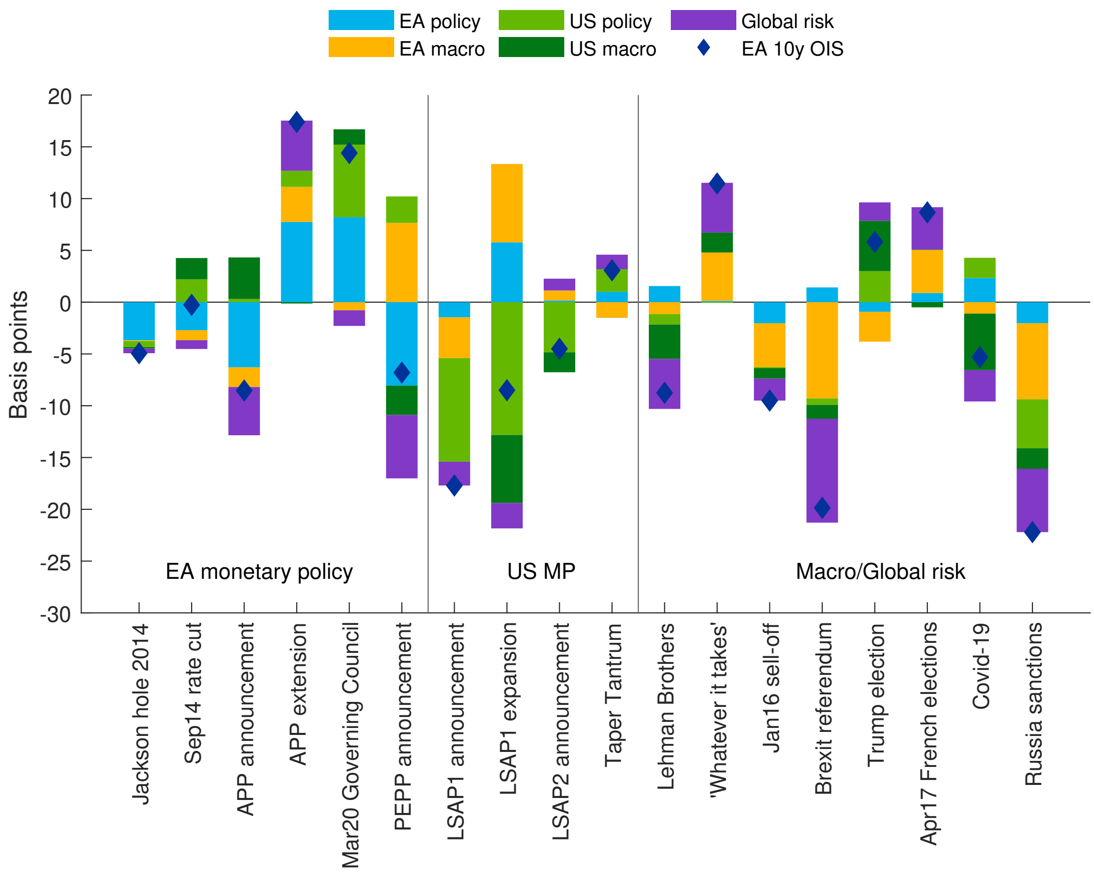
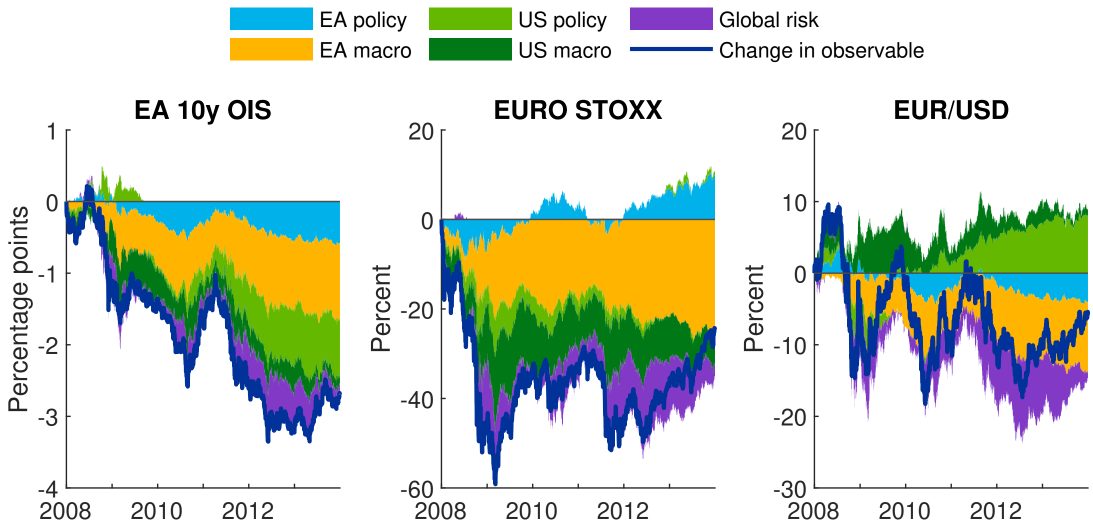
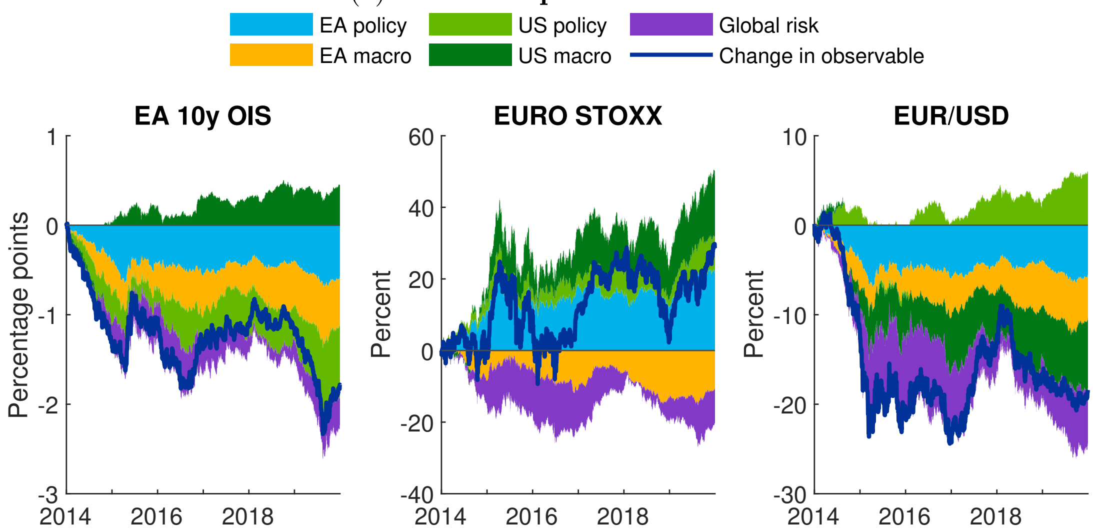


Figure 4: Drivers of the euro area 10-year OIS rate around selected events

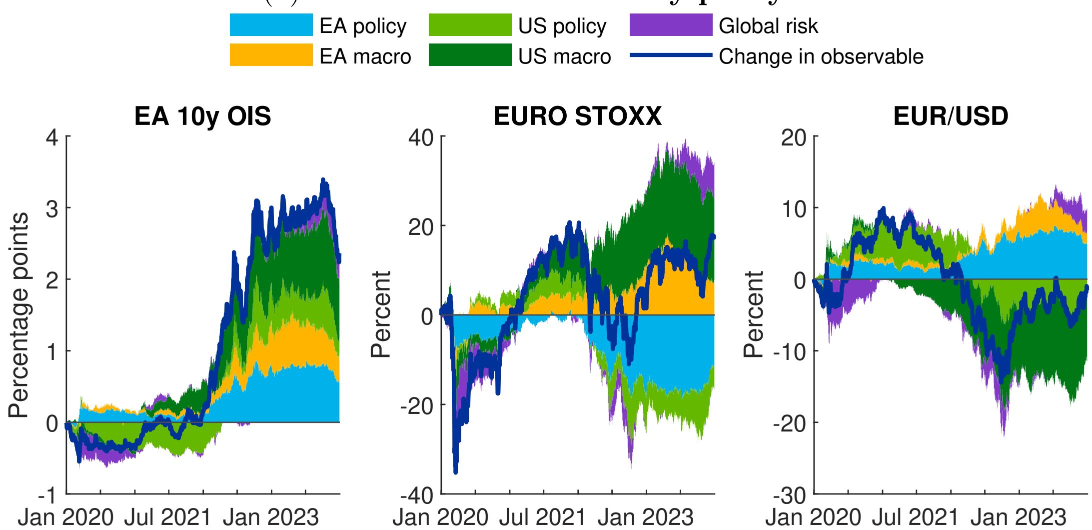
Notes: The chart shows the decomposition of the change on the day of the event and the day after. The results for the variables not shown can be found in the online appendix, see Figures A.4 to A.7



(a) **Double-dip recession: 2008-2013**



(b) **Unconventional monetary policy: 2014-2019**



(c) **Covid and inflation surge: 2020-2023**

Figure 5: Historical decomposition of euro area asset prices

Notes: Contributions are rebased to zero at the beginning of the review period. For equity prices and the exchange rate they are re-scaled to match cumulative growth in the observable variable in percent instead of log-differences. The corresponding decomposition of the US variables can be found in the online appendix, see Figure A.8.

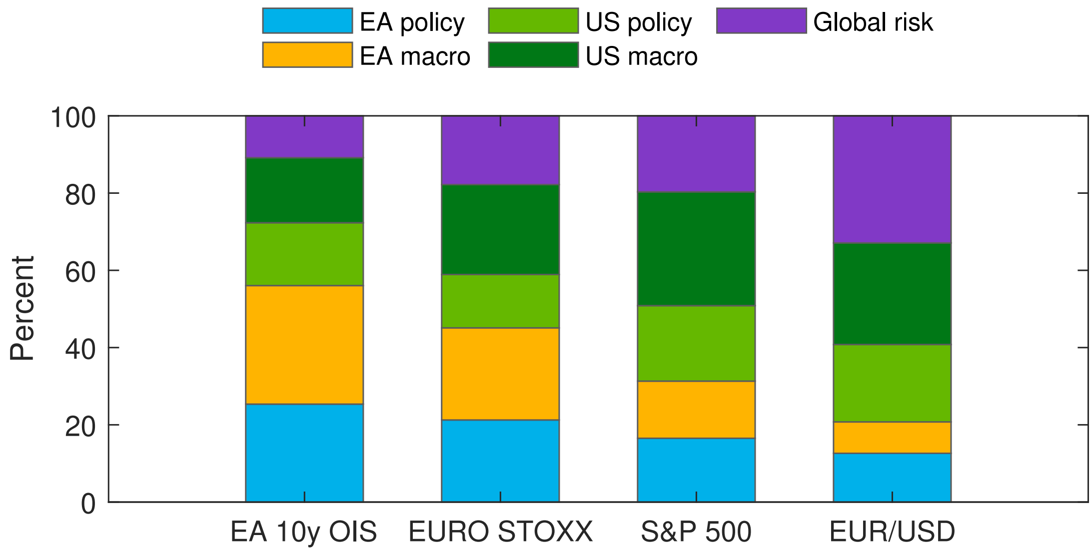
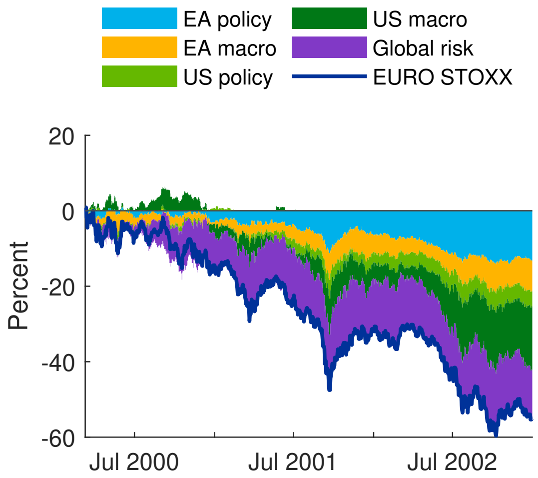
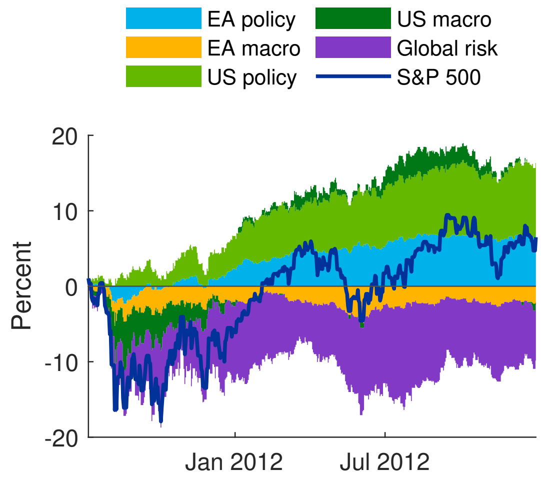


Figure 6: Forecast error variance decomposition

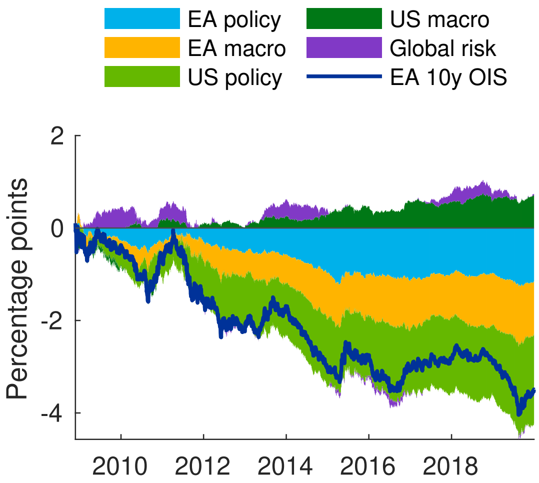
Notes: The figure shows the one-step ahead forecast error variance decomposition, averaged over all accepted draws from the daily BVAR.



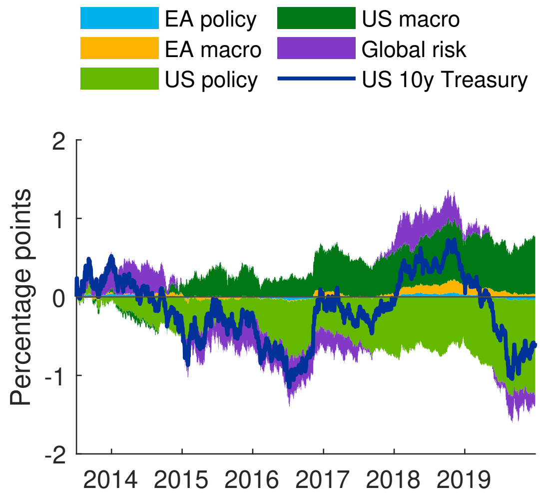
(a) **US dot-com crash: spillovers to EA equity prices**



(b) **EA sovereign debt crisis: spillovers to US equity prices**



(c) **Fed unconventional policy: spillovers to EA long-term yields**



(d) **ECB unconventional policy: spillovers to US long-term yields**

Figure 7: Cross-Atlantic spillovers in financial markets

Notes: Panel A shows cumulative changes in EA equity prices from 10 March 2000 to 31 December 2002 and panel B shows cumulative changes in US equity prices from 07 July 2011 to 31 December 2012. Panel C shows cumulative changes in EA 10y OIS from 24 November 2008 to 31 December 2019, and panel D cumulative changes in 10y US Treasury yields from 04 July 2013 to 31 December 2019. All shock contributions are normalised to zero at the beginning of the review period. The corresponding decomposition of variables not shown here can be found in the online appendix, see Figures A.9 to A.12.

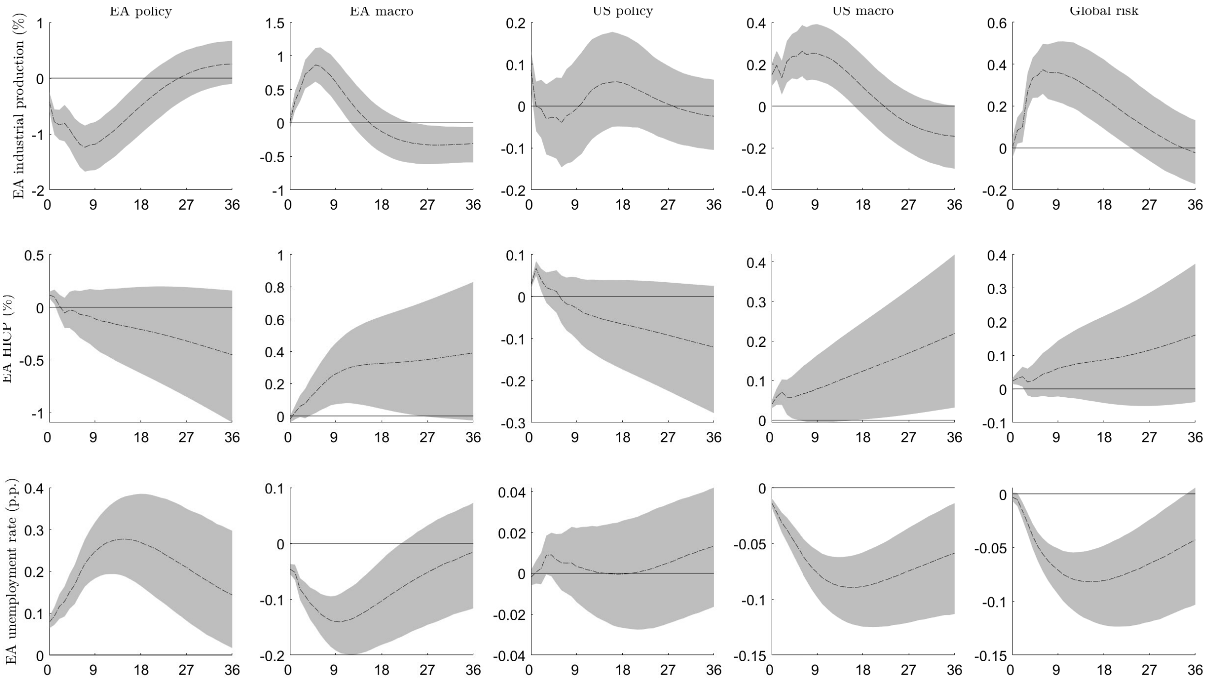


Figure 8: PSVAR impulse response functions for euro area macro variables

Notes: Responses to the policy and macro shocks are normalised to a shock which increases the respective long-term interest rate by 10 basis points on impact. Responses to the global risk shock are normalised to a shock which causes an appreciation of the bilateral euro-Dollar exchange rate by 1 percent on impact. The responses in the US and the financial block are shown in Online Appendix Figures A.13 and A.14 respectively.

Table 1: Sign restriction table

	EA monetary policy	EA macro news	US monetary policy	US macro news	global risk
EA LT yields	+	+	+	+	−
EA equity	−	+			−
US equity			−	+	−
USD/EUR	+	+	−	−	−
EA-US yield spread	+	+	−	−	+

Notes: Empty fields leave that parameter unrestricted, "+" and "–" denote an increase or a decrease in the respective variable on impact. A "+" ("–") for the USD/EUR denotes an appreciation (a depreciation) of the euro vis-à-vis the US dollar. The global risk shock displays a worsening of global risk sentiment.

Table 2: List of selected events

Date	Announcement	Type of shock
15 Sep 2008	Lehman Brothers collapse	Global risk/macro
25 Nov 2008	LSAP1 ann.	US monetary policy
18 Mar 2009	LSAP1 expansion	US monetary policy
10 May 2010	Greek programme + EFSF + SMP ann.	EA monetary policy/macro
3 Nov 2010	LSAP2 ann.	US monetary policy
26 Jul 2012	Draghi London speech: “Whatever it takes”	EA monetary policy/risk
19 Jun 2013	FOMC meeting; Fed taper tantrum	US monetary policy
22 Aug 2014	Draghi Jackson Hole speech	EA monetary policy
4 Sep 2014	10bps DFR cut and ABSPP/CBPP ann.	EA monetary policy
22 Jan 2015	APP ann.	EA monetary policy
3 Dec 2015	10bps DFR cut and APP extension	EA monetary policy
4 Jan 2016	Stock market sell-off	EA macro/global risk
23 Jun 2016	Brexit referendum	EA macro/global risk
8 Nov 2016	US presidential elections	US macro/global risk
23 Apr 2017	First round French presidential elections	EA macro/global risk
25 Feb 2020	Intensification COVID-19 crisis	Global risk/macro
12 Mar 2020	March 2020 Governing Council	EA monetary policy
18 Mar 2020	PEPP ann.	EA monetary policy

Notes: “ann.” stands for announcement, “DFR” for deposit facility rate.

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Online Appendix

A Additional figures

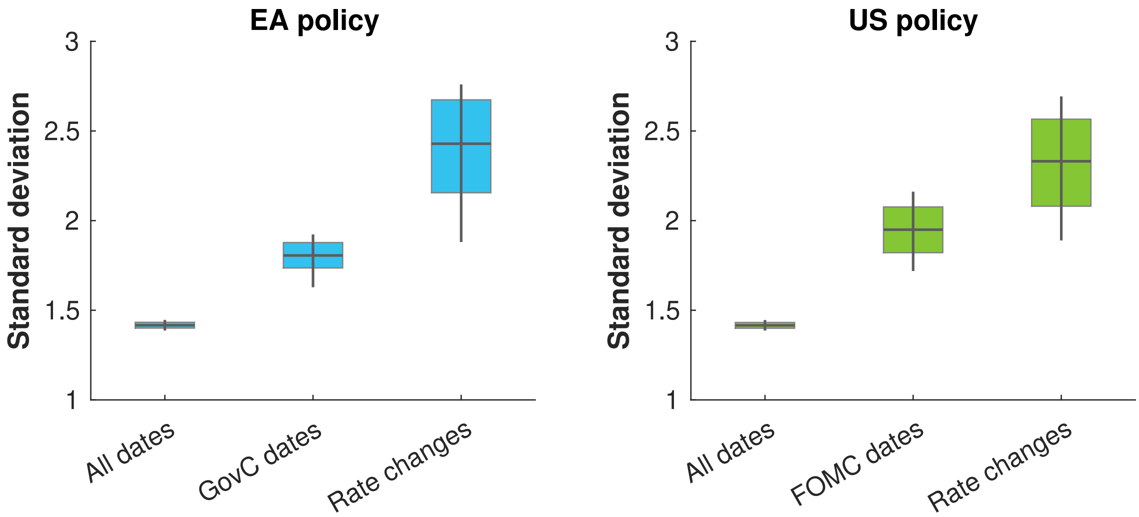
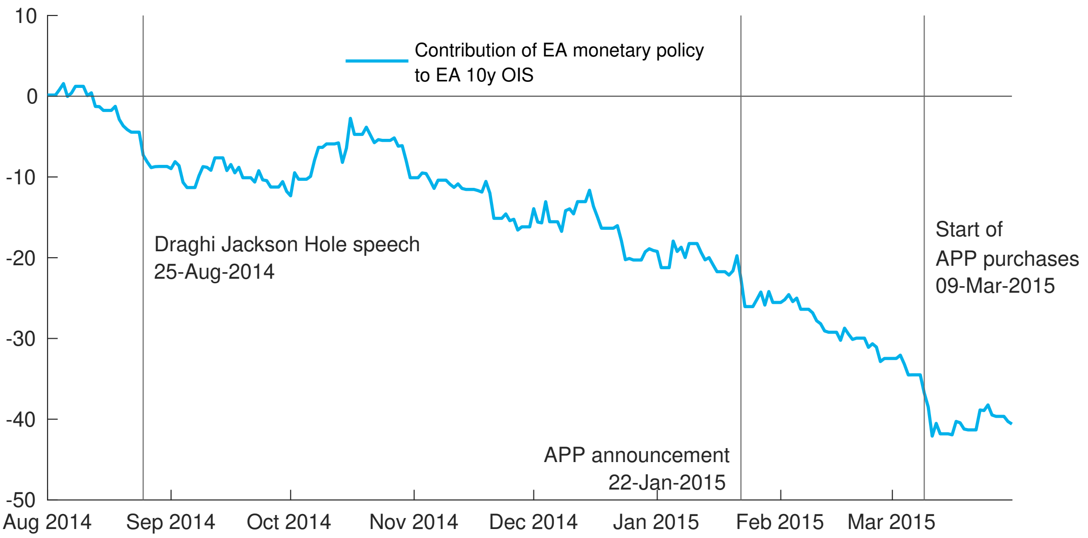
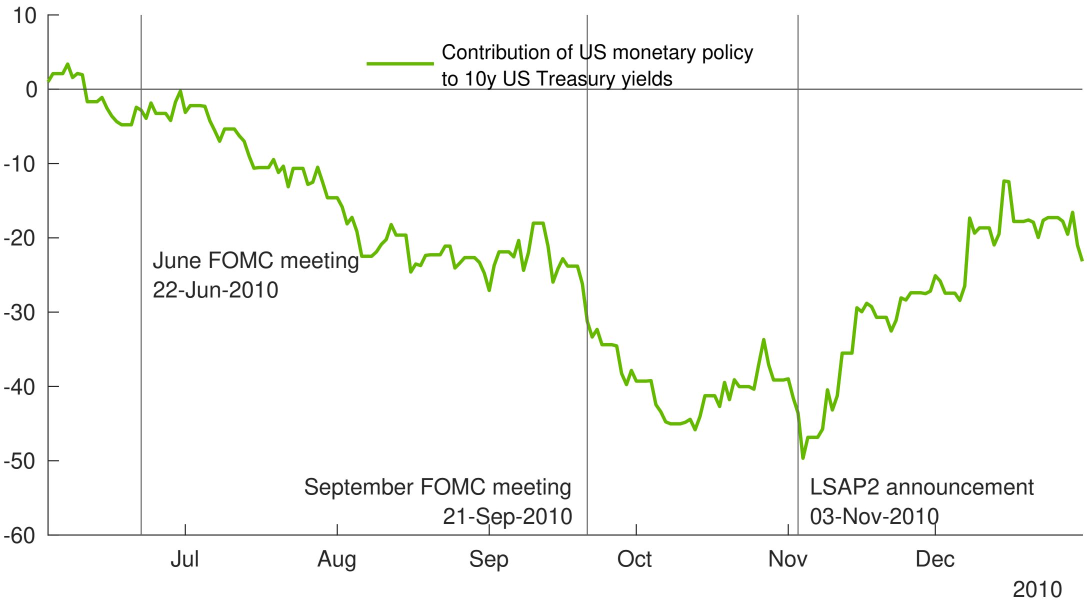


Figure A.1: Posterior distribution of policy shock volatilities

Notes: The two panels show the posterior distribution of standard deviations of the two policy shocks summed over (i) all overlapping 2-day windows, (ii) days of policy meetings and the day after, and (iii) those policy meetings at which rates were changed. The one-day standard deviation of the shocks in the model is standardised to unity. Therefore, the expected standard deviation of two-day sums is roughly $\sqrt{2} = 1.41$.



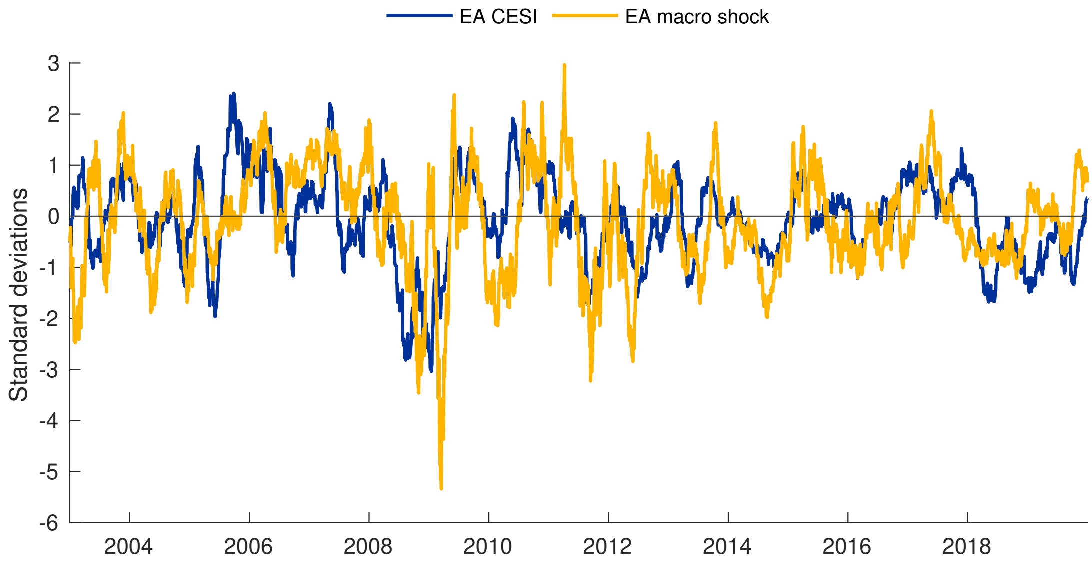
(a) **Euro area: 1 August 2014 - 31 March 2015**



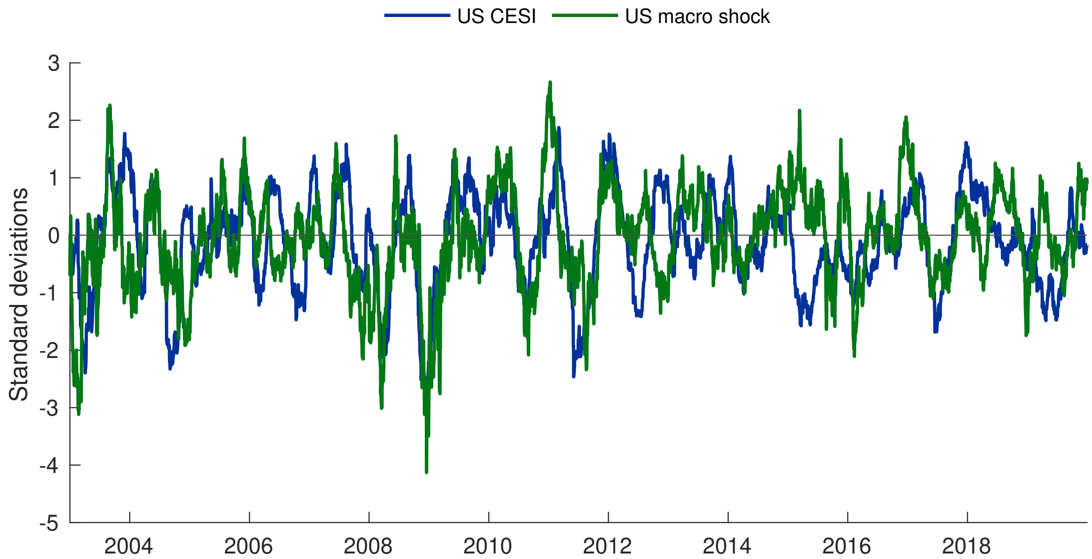
(b) **United States: 3 June 2010 - 31 December 2010**

Figure A.2: Anticipation of ECB and Fed asset purchases

Notes: Panel (a) shows the cumulative contribution of the euro area monetary policy shock to changes in the euro area 10y OIS rate from 1 August 2014 to 31 March 2015. Panel (b) that of the US monetary policy shock to the US 10y Treasury yield from 3 June 2010 to 31 December 2010.



(a) **Euro area**



(b) **United States**

Figure A.3: Comparison of estimated macro shocks with the Citigroup Economic Surprise Index

Notes: The figures show the standardised rolling three-month sum of the respective posterior mean over all accepted draws from the daily BVAR.

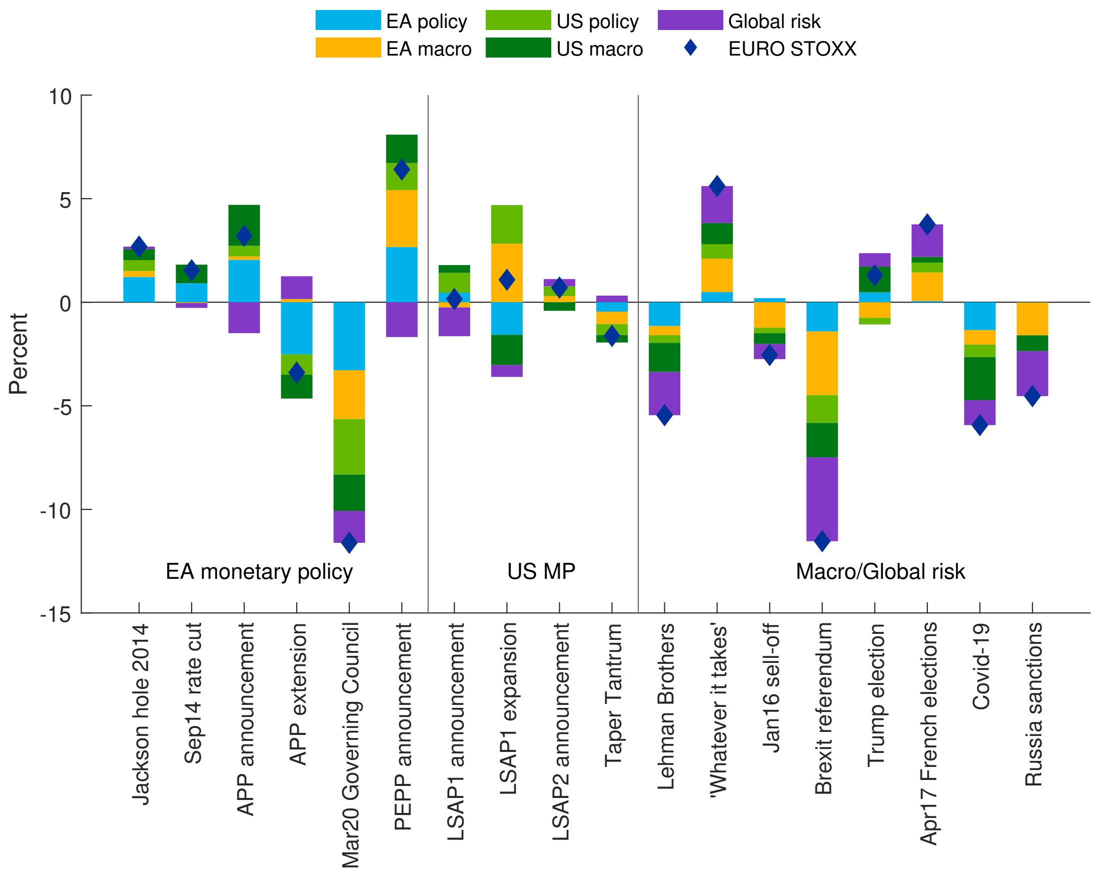


Figure A.4: Drivers of the euro area equity prices around selected events

Notes: The chart shows the decomposition of the change on the day of the event and the day after.

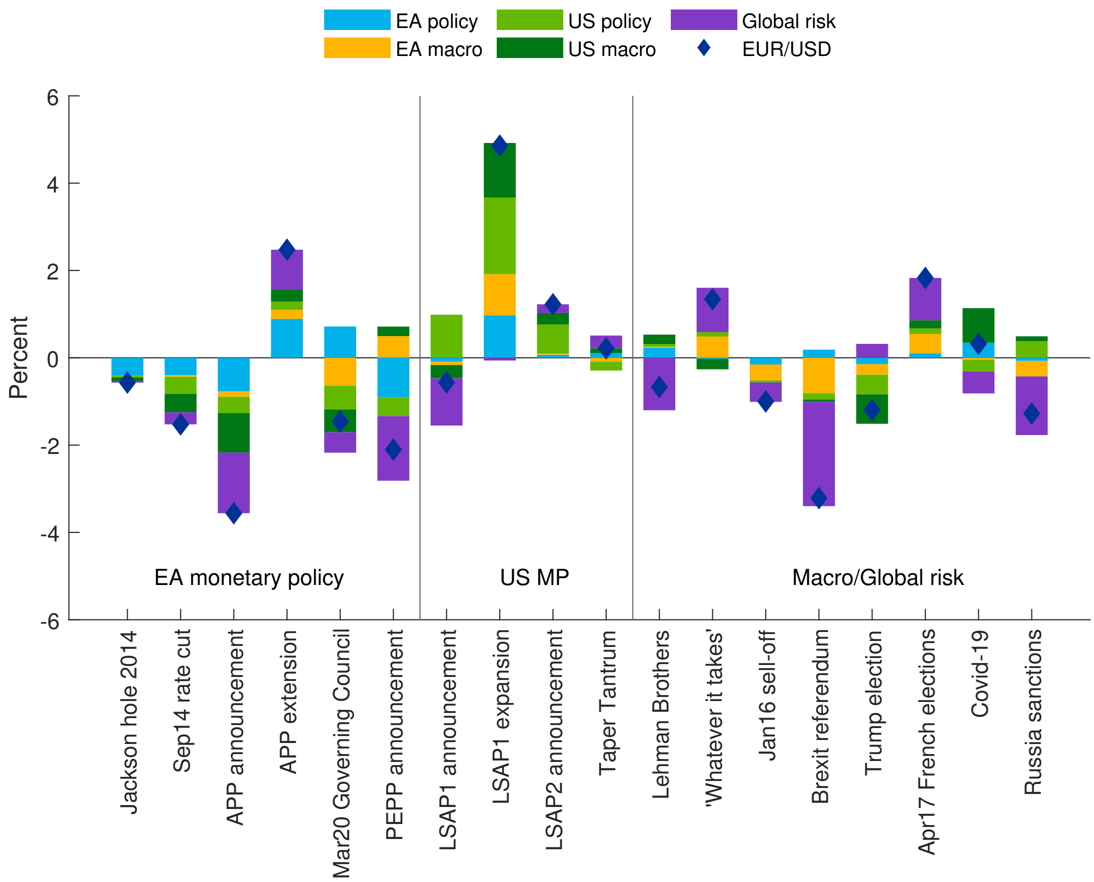


Figure A.5: Drivers of the Euro-Dollar exchange rate around selected events

Notes: The chart shows the decomposition of the change on the day of the event and the day after.

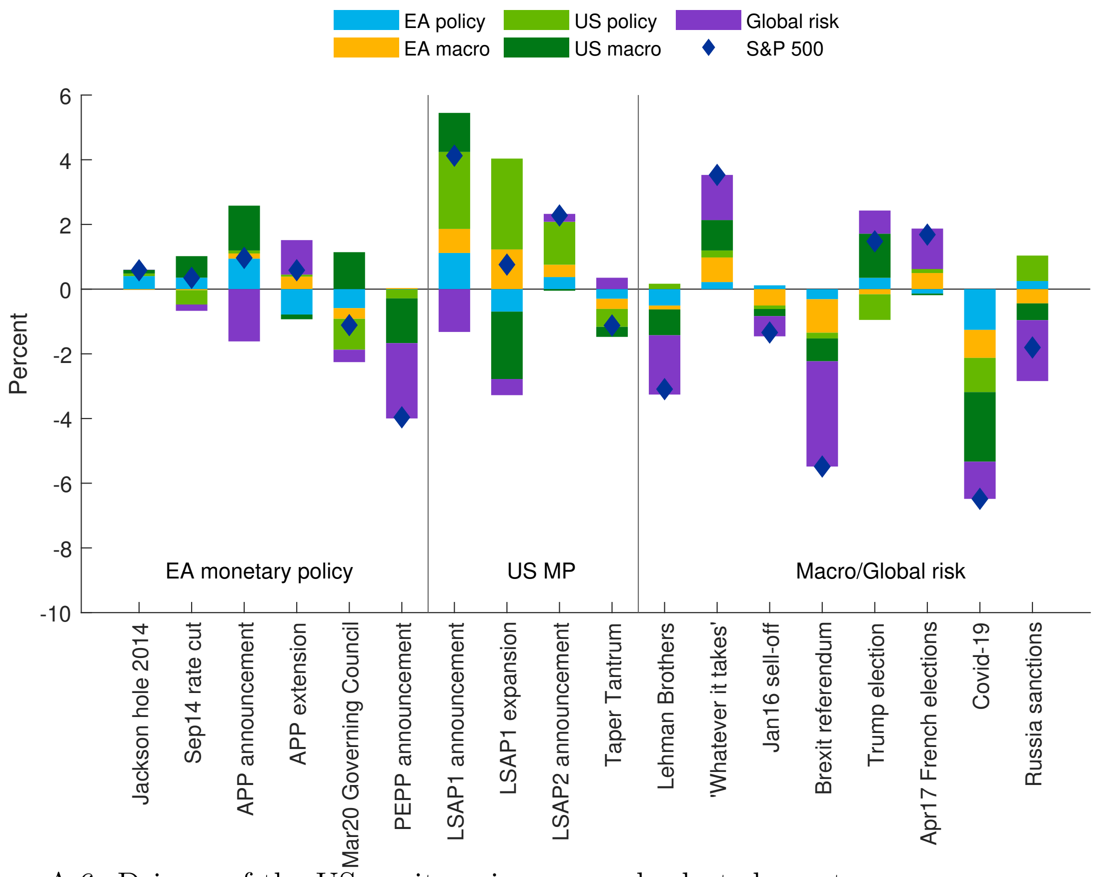


Figure A.6: Drivers of the US equity prices around selected events

Notes: The chart shows the decomposition of the change on the day of the event and the day after.

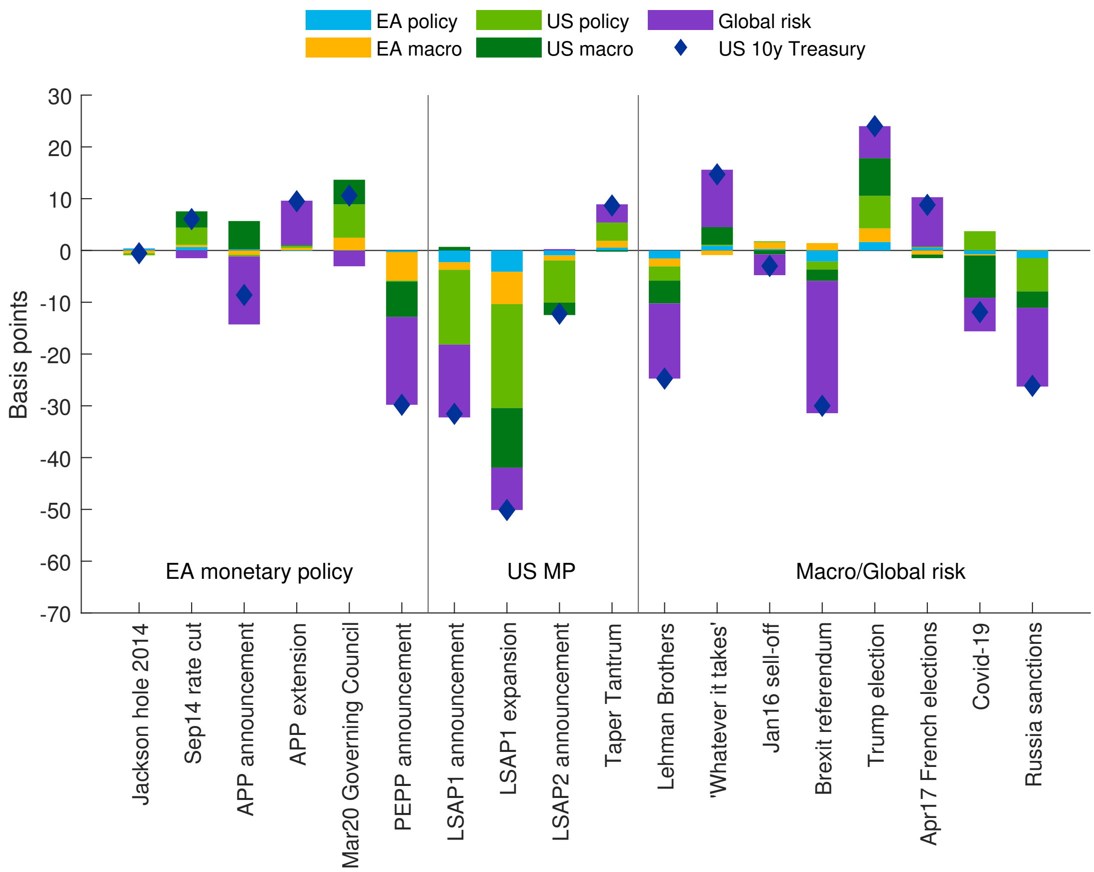
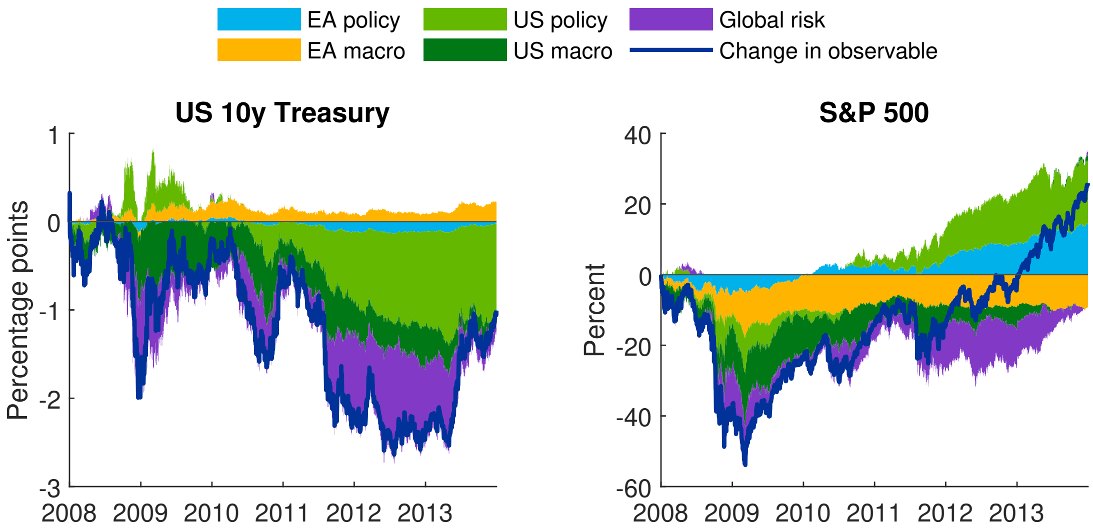
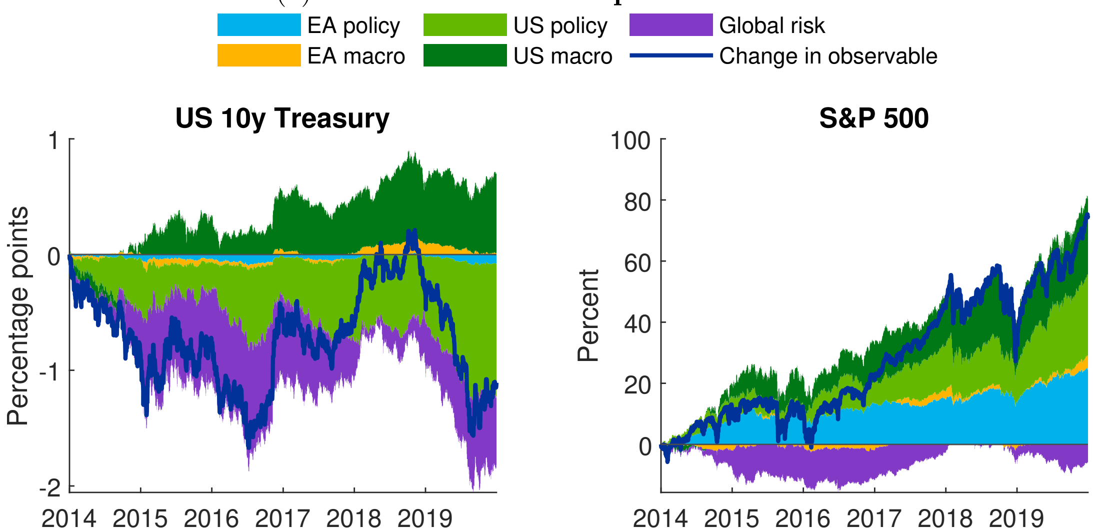


Figure A.7: Drivers of the US Treasury yields around selected events

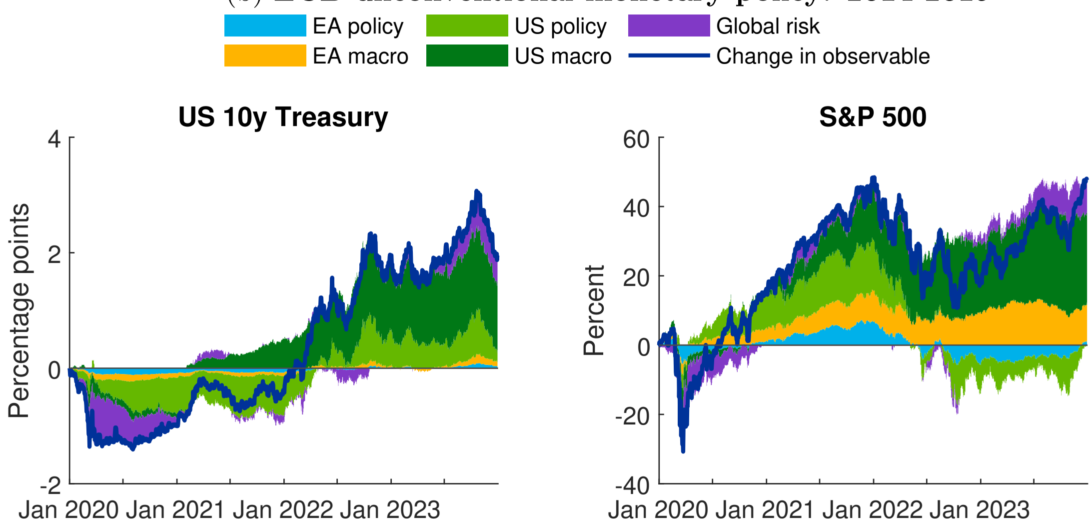
Notes: The chart shows the decomposition of the change on the day of the event and the day after.



(a) **Euro area double-dip recession: 2008-2013**



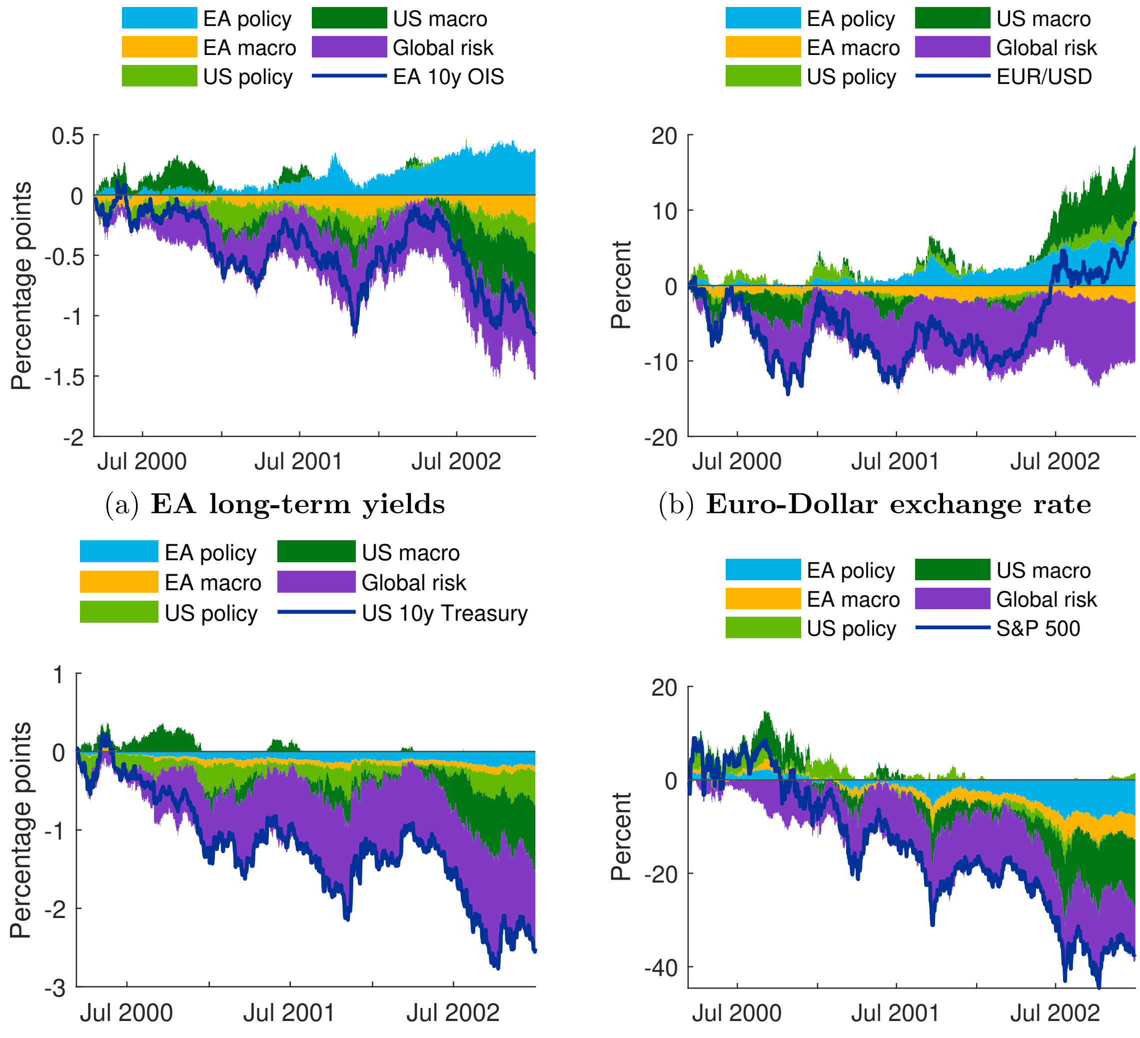
(b) **ECB unconventional monetary policy: 2014-2019**



(c) **Covid and inflation surge: 2020-2023**

Figure A.8: Historical decomposition of US asset prices

Notes: Contributions are rebased to zero at the beginning of the review period. For equity prices and the exchange rate they are re-scaled to match cumulative growth in the observable variable in percent instead of log-differences.



(a) **EA long-term yields**

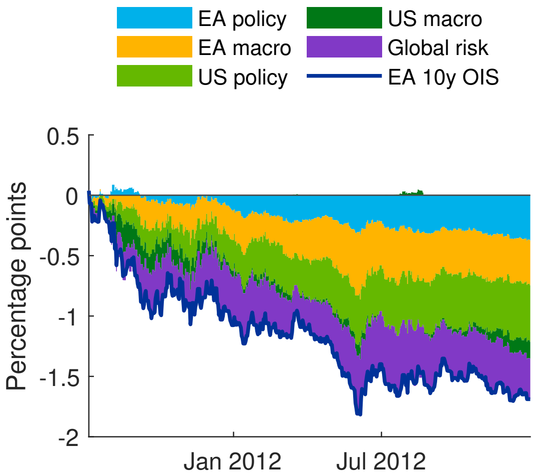
(b) **Euro-Dollar exchange rate**

(c) **US long-term yields**

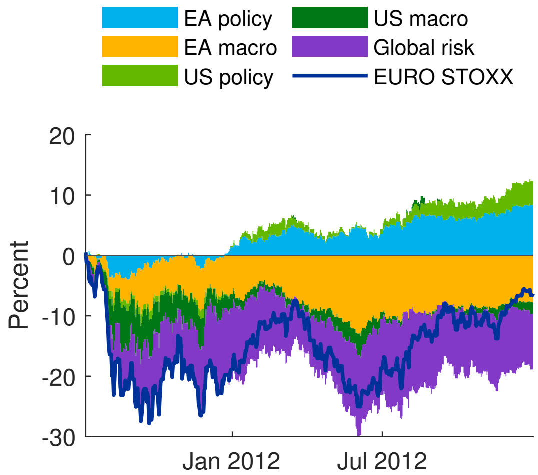
(d) **US equity prices**

Figure A.9: Cross-Atlantic spillovers in financial markets: US dot-com crash 2000-2002

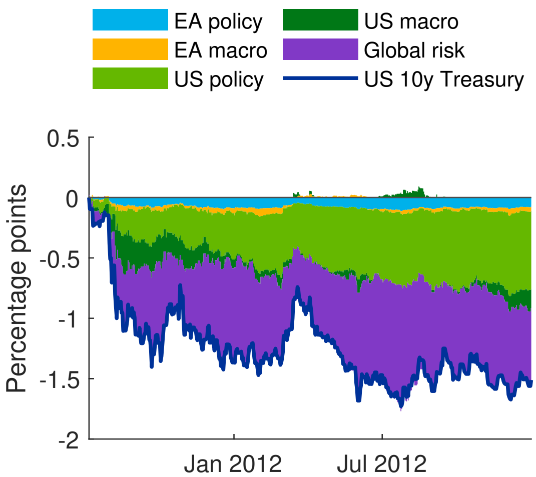
Notes: The charts show the average historical decomposition of changes from 10 March 2000 to 31 December 2002 in asset prices not displayed in Figure 7. All shock contributions are normalised to zero at the beginning of the review period.



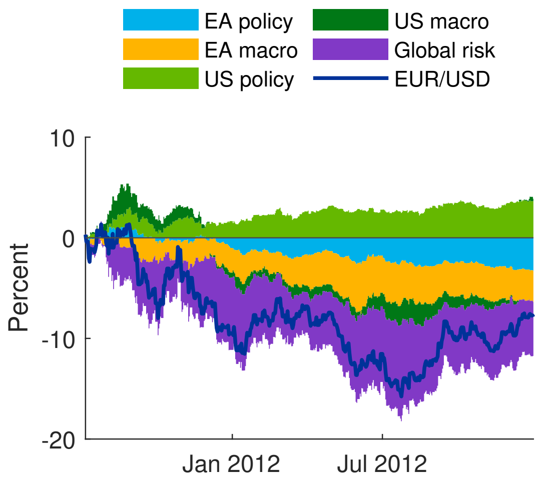
(a) **EA long-term yields**



(b) **EA equity prices**



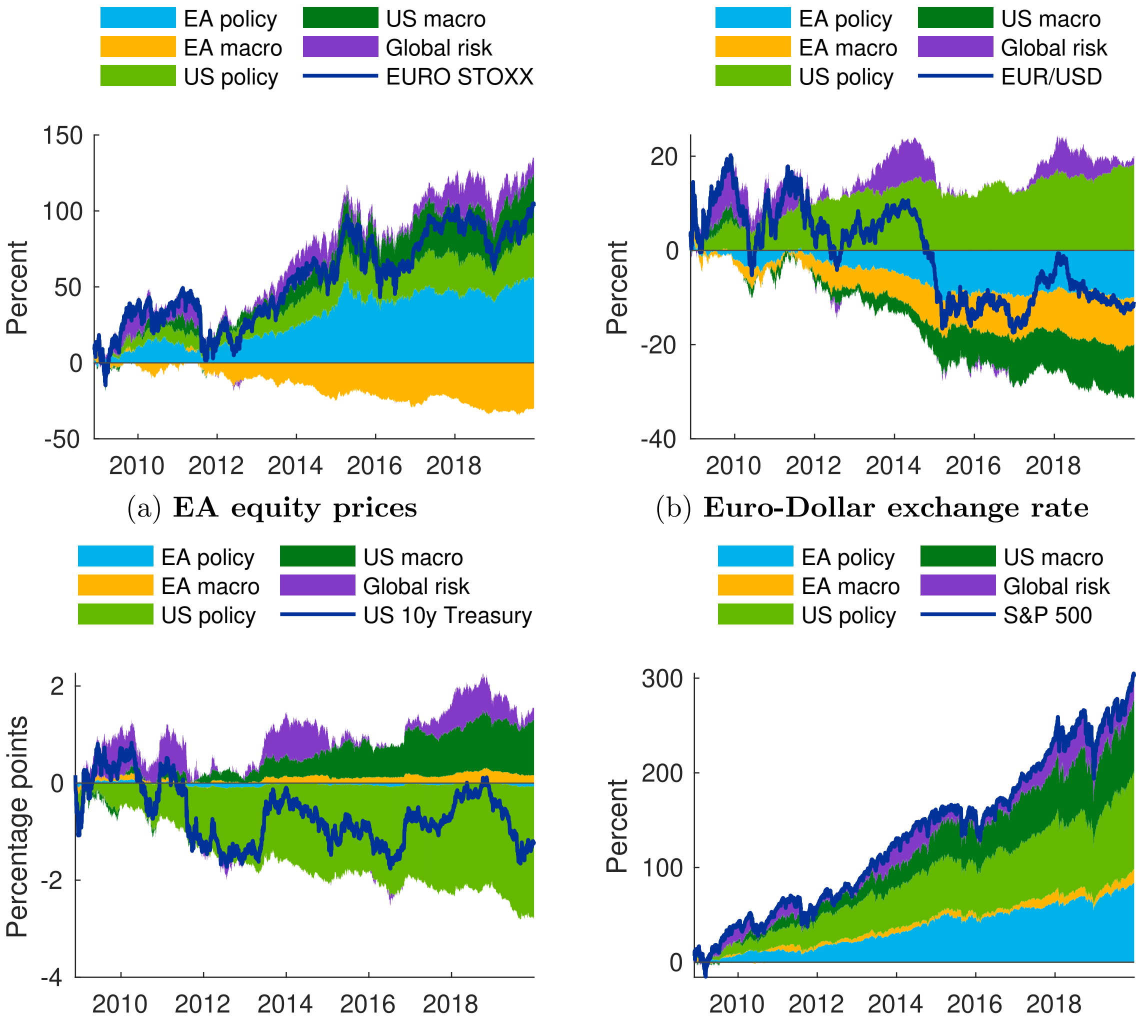
(c) **US long-term yields**



(d) **Euro-Dollar exchange rate**

Figure A.10: Cross-Atlantic spillovers in financial markets: EA sovereign debt crisis 2011-2012

Notes: The charts show the average historical decomposition of changes from 7 July 2011 to 31 December 2012 in asset prices not displayed in Figure 7. All shock contributions are normalised to zero at the beginning of the review period.

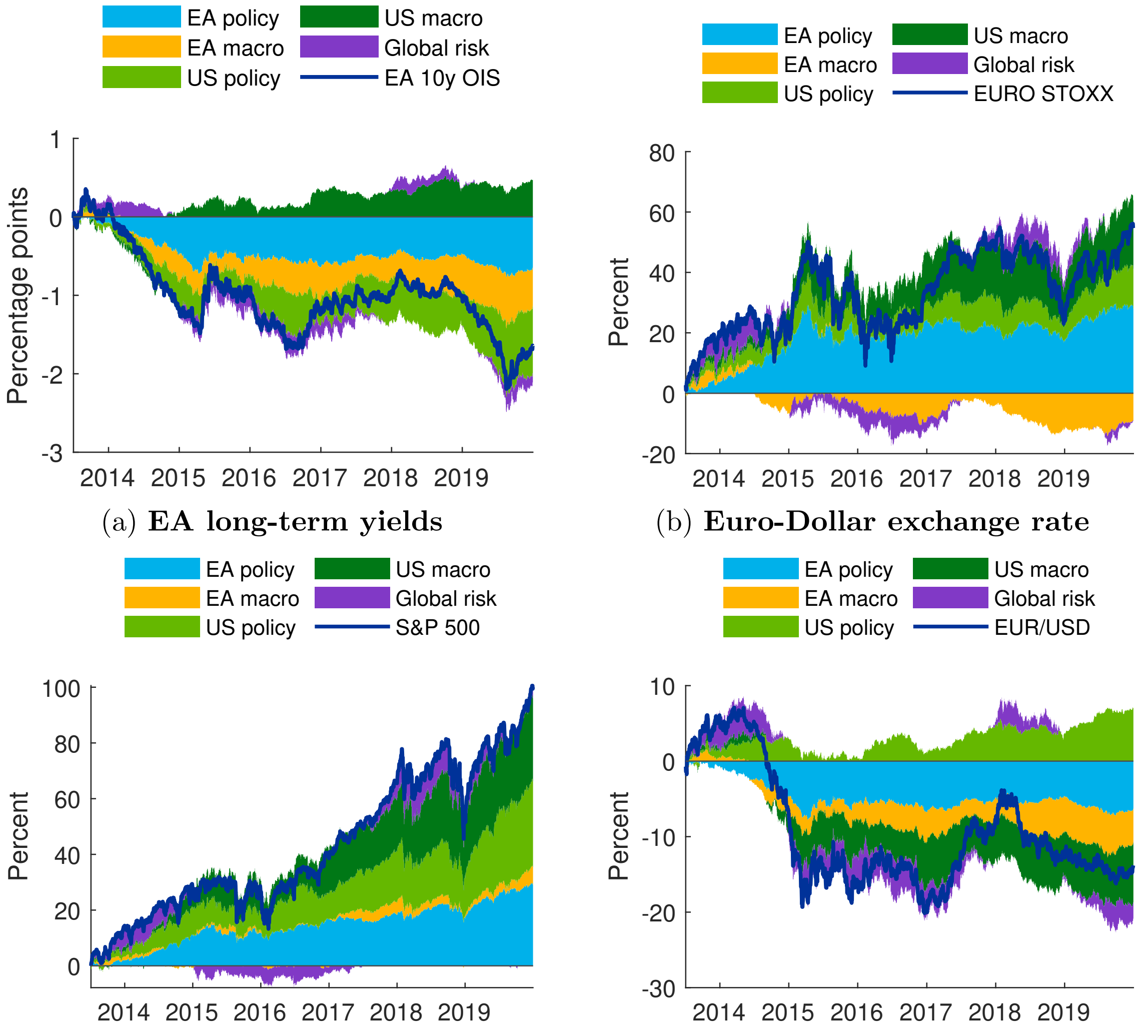


(a) **EA equity prices** (b) **Euro-Dollar exchange rate**

(c) **US long-term yields** (d) **US equity prices**

Figure A.11: Cross-Atlantic spillovers in financial markets: Fed unconventional policy 2008-2019

Notes: The charts show the average historical decomposition of changes from 24 November 2008 to 31 December 2019 in asset prices not displayed in Figure 7. All shock contributions are normalised to zero at the beginning of the review period.



(a) **EA long-term yields**

(b) **Euro-Dollar exchange rate**

(c) **US long-term yields**

(d) **US equity prices**

Figure A.12: Cross-Atlantic spillovers in financial markets: ECB unconventional policy 2013-2019

Notes: The charts show the average historical decomposition of changes from 4 July 2013 to 31 December 2019 in asset prices not displayed in Figure 7. All shock contributions are normalised to zero at the beginning of the review period.

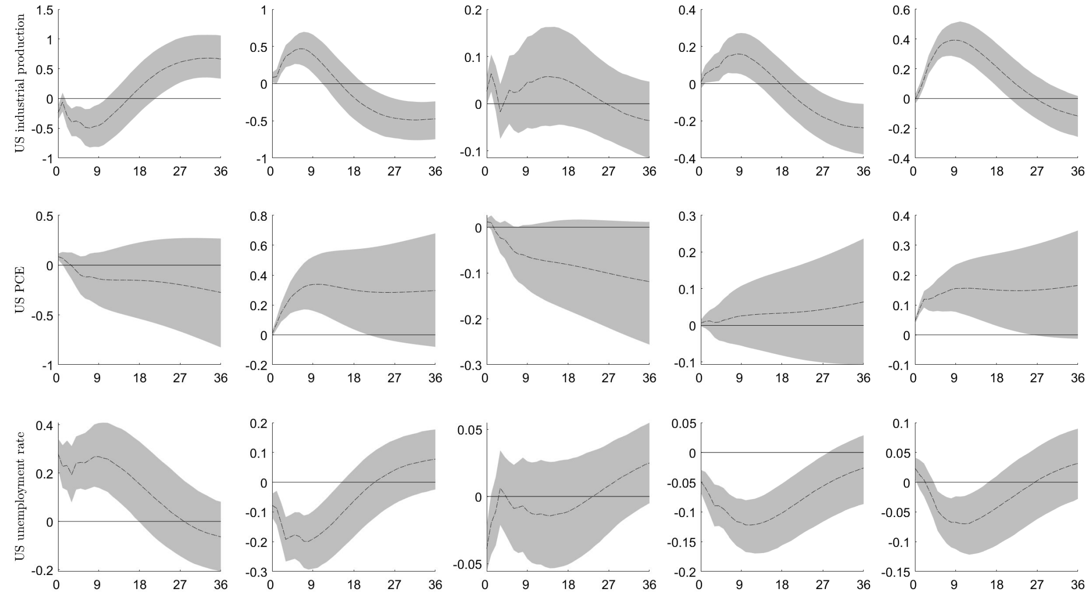


Figure A.13: PSVAR impulse response functions for US macro variables

Notes: Responses to the policy and macro shocks are normalised to a shock which increases the respective long-term interest rate by 10 basis points on impact. Responses to the global risk shock are normalised to a shock which causes an appreciation of the bilateral euro-Dollar exchange rate by 1 percent on impact.

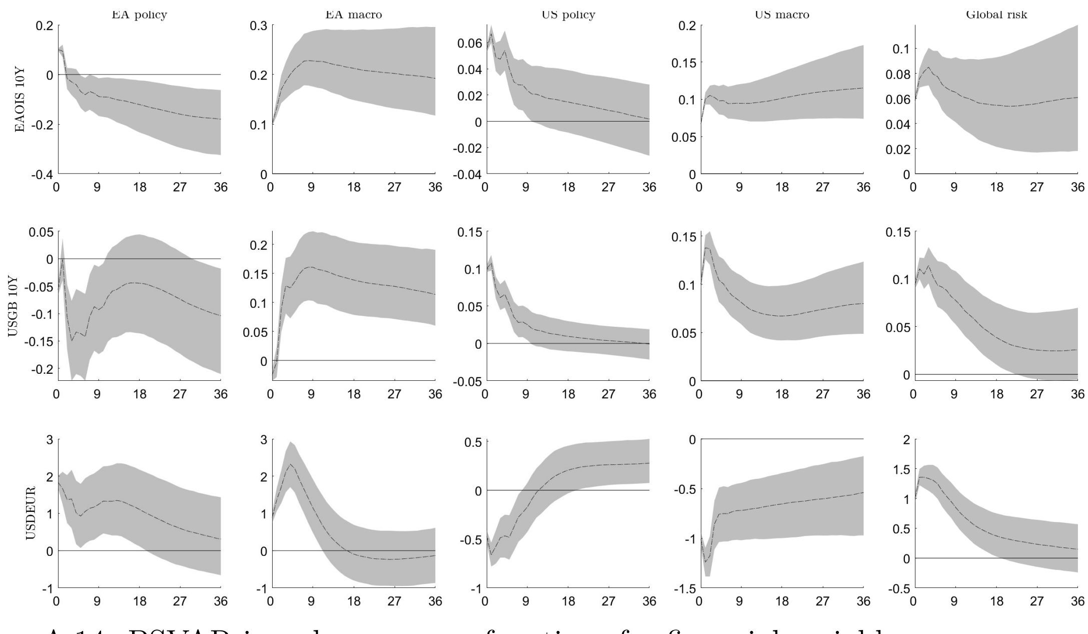


Figure A.14: PSVAR impulse response functions for financial variables

Notes: Responses to the policy and macro shocks are normalised to a shock which increases the respective long-term interest rate by 10 basis points on impact. Responses to the global risk shock are normalised to a shock which causes an appreciation of the bilateral euro-Dollar exchange rate by 1 percent on impact.

B Additional robustness exercises

B.1 Choice of maturity

The table below presents the results of an alternative estimation of the model using the 2-year rate instead of the 10-year rate. The maturity affects the identification of the various shocks, but overall the results remain close with a highly positive correlation across the shocks from the two specifications.

	EA policy	EA macro	US policy	US macro	Global risk
2-year	0.79	0.74	0.85	0.95	0.86

Table B.1: Correlation of shocks relative to benchmark specification

B.2 Alternative risk indicators

In the below, we test the robustness of the model by (i) replacing the bilateral euro-US dollar exchange rate with the broad US dollar exchange rate and (ii) replacing the euro area 10-year OIS rate with the euro area GDP-weighed sovereign yield (also in the interest rate spread). It appears that the estimated global risk shock in both cases is highly correlated with the global risk shock of our benchmark model when making these changes (correlation of 0.7 and 0.99, respectively), which indicates that the results are robust to these alternative risk indicators.

	EA policy	EA macro	US policy	US macro	Global risk
EA Sov.	0.75	0.74	0.98	0.96	0.99
US NEER	0.92	0.99	0.91	0.74	0.70

Table B.2: Correlation of shocks relative to benchmark specification

However, it is important to note that using euro area sovereign yields to identify shocks might inadvertently incorporate euro area-specific risk factors into broader shock definitions, such as the global risk shock and the euro area monetary policy shock. The correlation of shocks shown in the table above suggests, for example, that the identified euro area monetary policy shocks differ when using sovereign yields. This discrepancy may arise because sovereign yields could misinterpret shifts in euro area sovereign spreads – such as those observed during the euro area sovereign debt crisis – as monetary policy shocks, which might be problematic.

B.3 Composition of the monetary policy shocks

In this section, we present a robustness exercise where we regress the three monetary policy factors from Miranda-Agrippino and Nenova (target, path, QE) onto our own monetary policy factor. Several results are worth highlighting. First, all three monetary policy factors load positively on our monetary policy factor with a reasonable fit (see Figure B.15 below). Second, as expected, our monetary policy shock loads more positively on the path and QE dimensions than on the target dimension. And when using the 2-year rate instead, the loading on the target factor increases significantly (Figure B.16). Last, using the target, path and QE shocks purged from the information effects, as has become usual practice in the literature, tends to improve the fit of the regression (see light blue bars compared to dark blue bars). This is reassuring because our identification scheme to separate monetary policy and macro shocks based on the co-movement of yields and stock prices bears similarity with the "poor man's restriction" of Jarocinski and Karadi, which is precisely intended to extract monetary policy shocks distinct from information effects.

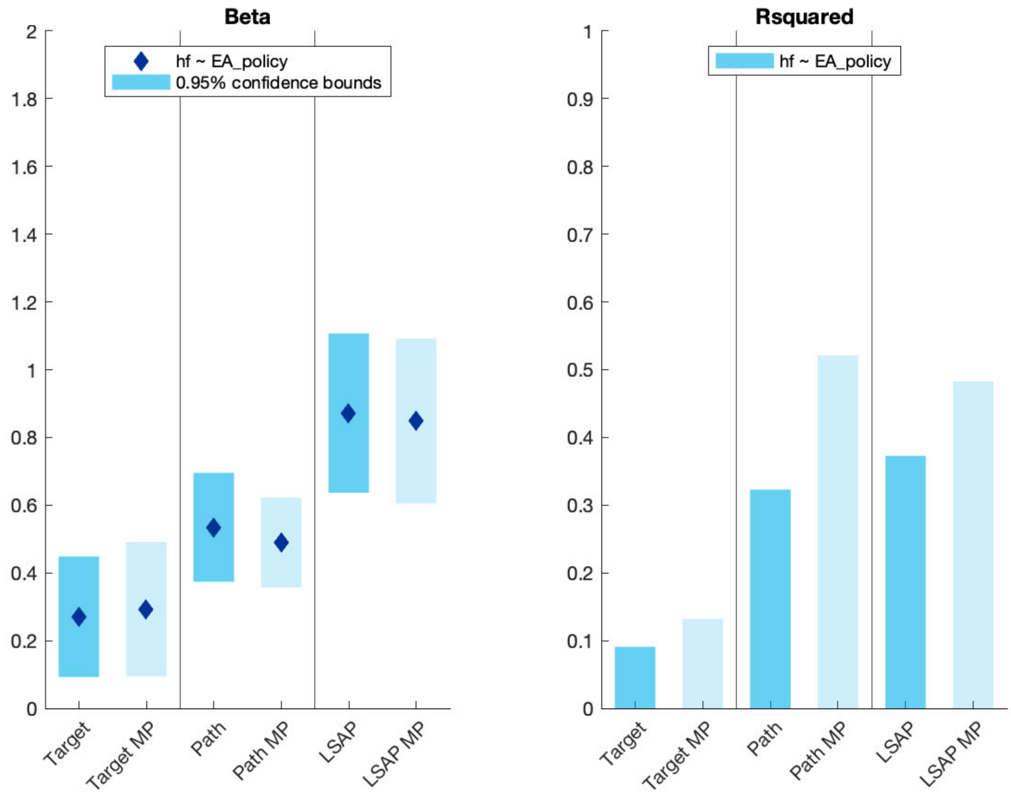


Figure B.15: Euro area: benchmark specification
Notes: This figure shows coefficients and goodness-of-fit statistics from a regression of the EA monetary policy factors of Miranda-Agrippino and Nenova (2022) onto the mean EA policy shock from the benchmark specification of the daily VAR.

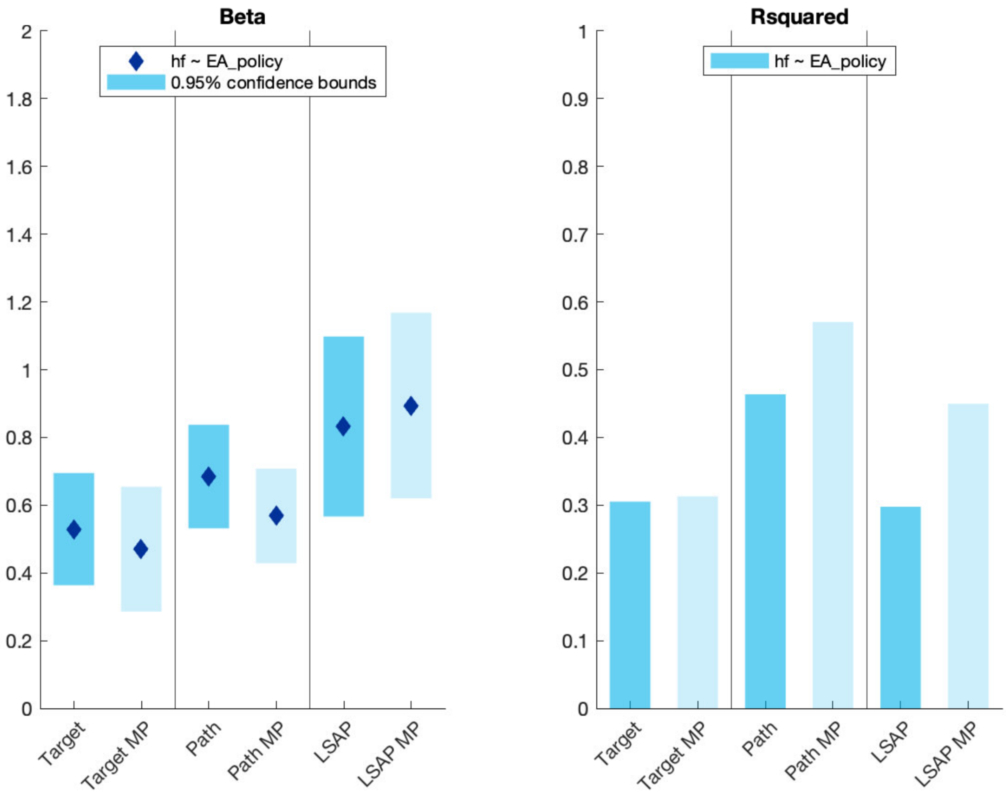


Figure B.16: Euro area: alternative specification

Notes: This figure shows coefficients and goodness-of-fit statistics from a regression of the EA monetary policy factors of Miranda-Agrippino and Nenova (2022) onto the mean EA policy shock from an alternative specification using 2y yields in the daily VAR.

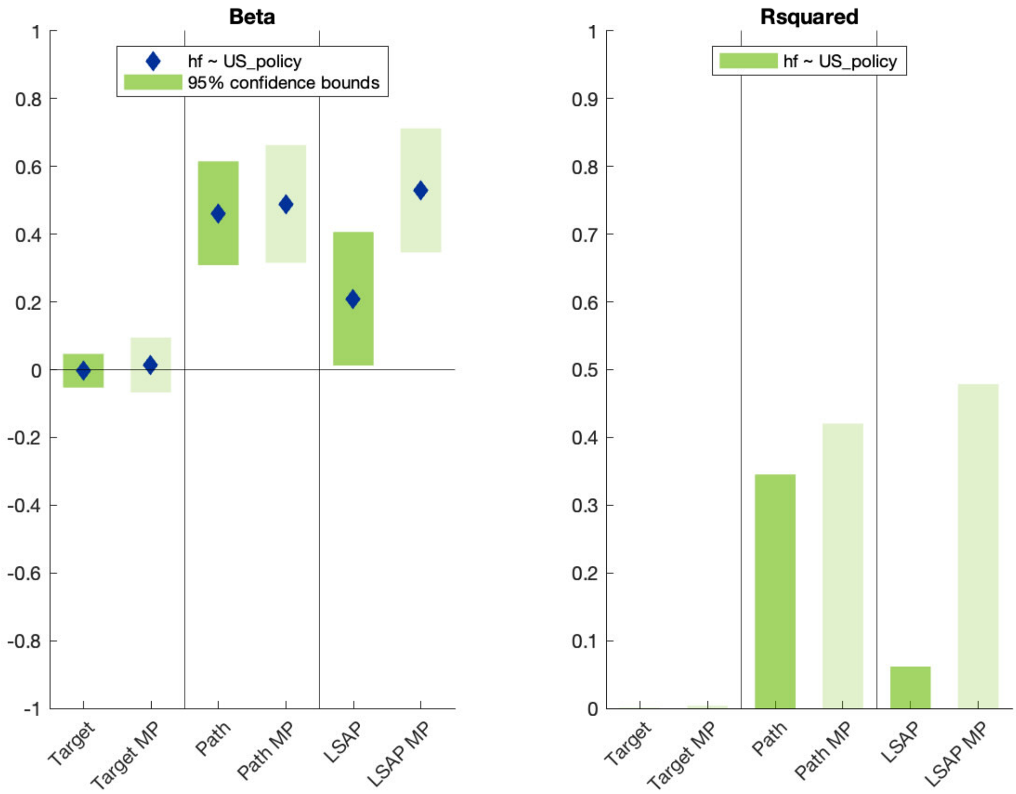


Figure B.17: US: benchmark specification

Notes: This figure shows coefficients and goodness-of-fit statistics from a regression of the US monetary policy factors of Miranda-Agrippino and Nenova (2022) onto the mean US policy shock from the benchmark specification of the daily VAR.

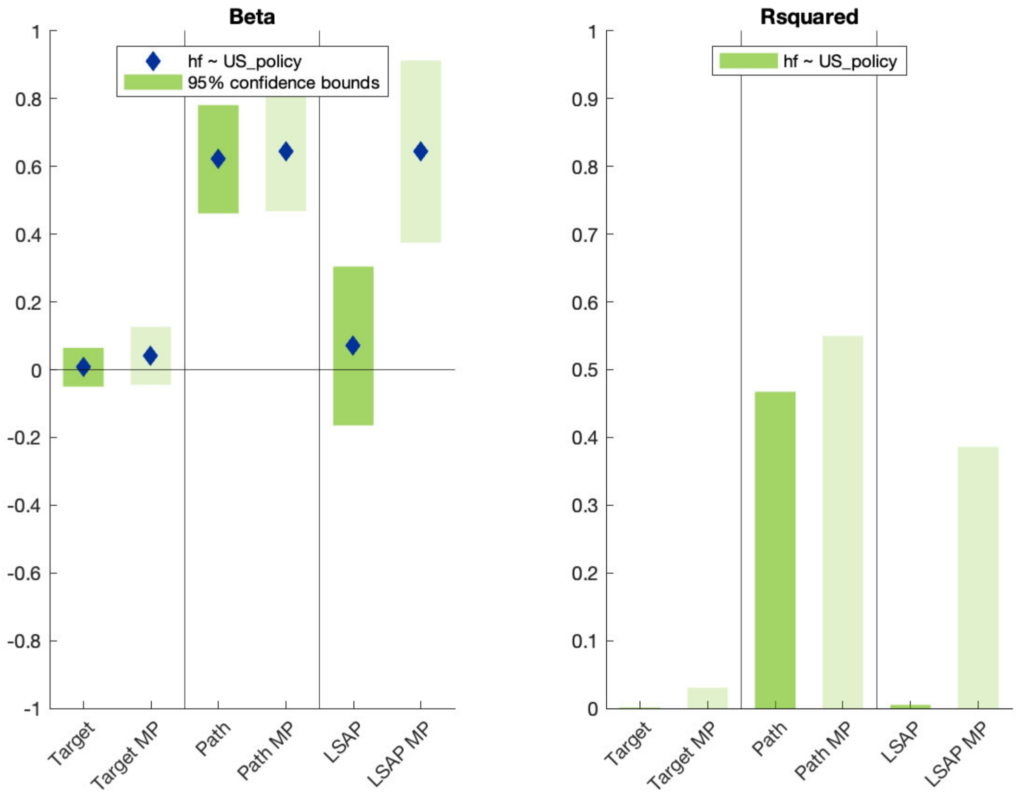


Figure B.18: US: alternative specification

Notes: This figure shows coefficients and goodness-of-fit statistics from a regression of the US monetary policy factors of Miranda-Agrippino and Nenova (2022) onto the mean US policy shock from an alternative specification using 2y yields in the daily VAR.