Global spillovers from multi-dimensional US monetary policy*

Georgios Georgiadis† — *European Central Bank*

Marek Jarociński‡ — *European Central Bank*

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Abstract

We estimate international spillovers from both conventional and unconventional US monetary policy. We use novel measures of exogenous variation in conventional policy, forward guidance and large-scale asset purchases (LSAPs), based on high-frequency asset price surprises around a broad set of Federal Reserve communications. The identification relies on relatively weak assumptions and accounts for potential endogenous policy components—including central bank information effects—in these asset price surprises. We find that: (i) conventional policy, forward guidance and LSAPs all generate large and comparable spillovers; (ii) these spillovers transmit through trade and financial channels to a similar extent; (iii) LSAPs trigger immediate international portfolio rebalancing between US and foreign bonds that are relatively close substitutes, but they produce only limited spillovers in term premia; (iv) all Fed policy measures create trade-offs for emerging market monetary policy between stabilizing output and prices vs. ensuring financial stability, particularly with regard to capital inflows.

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†E-mail address: georgios.georgiadis@ecb.europa.eu.

‡E-mail address: marek.jarocinski@ecb.europa.eu.

1 Introduction

The dominant role of the dollar in global trade and finance has sparked a rich literature on the spillovers from Federal Reserve (Fed) monetary policy (e.g. Miranda-Agrippino and Rey, 2020b). However, despite the large amount of work, important gaps in our understanding remain. In particular, after the Global Financial Crisis (GFC) examining the effects of Fed policy has become more complex due to the use of unconventional policies, such as forward guidance about the future course of policy rates and large-scale asset purchases (LSAPs).

A case in point is the Fed's policy tightening in 2022, which involved interest-rate hikes that were telegraphed in advance by means of forward guidance and accompanied by the unwinding of the stock of previously purchased assets. Disentangling the implications of policy normalization across conventional and unconventional measures is critical as the Fed may resort to all of them more frequently in the future (Reis et al., 2016), and as optimal policy responses in the rest of the world may differ depending on the nature of the associated spillovers (IMF, 2020).

While research on spillovers from Fed forward guidance and LSAPs exists, it has drawn on limited variation in the data as these measures have become central only more recently. Moreover, most of the existing work has focused on individual unconventional measures rather than comparing their transmission to that of conventional or among different unconventional measures.

Against this background, in this paper we study global Fed policy spillovers for conventional and different unconventional measures. We make use of the conventional policy, forward guidance and LSAP shocks identified in Jarociński and Karadi (2025a), who extend the work of Jarociński (2024). The identification is based on heteroskedasticity of high-frequency asset-price surprises around diverse types of Fed monetary policy communications and improves in important dimensions relative to existing literature on spillovers.

In particular, the identification exploits substantially more information and thereby provides stronger instruments for the estimation of spillovers from all measures in the Fed's toolkit. First, the identification allows us to expand the time period studied and thereby exploit more variation in Fed policies by adding the easing cycle in response to the COVID pandemic and the tightening cycle in response to the post-pandemic inflation surge. Second, following Swanson and Jayawickrema (2023) and Swanson (forthcoming), the identification considers surprises not only around Federal Open Market Committee (FOMC) meetings but also around other communications, such as Fed Chair speeches, testimonies and press conferences as well as minutes releases. In addition, it accounts for confounding residual endogenous components in high-frequency monetary policy surprises, such as central bank information (CBI) effects (Romer and Romer, 2000; Nakamura and Steinsson, 2018).

We estimate the effects of the different Fed policy measures on rest-of-the-world (RoW) real activity, trade, exchange rates, asset prices and capital flows, explore whether they transmit more through trade or financial channels, and whether they induce trade-offs for central banks in emerging market economies (EMEs). Motivated by the analysis in Li et al. (2024), we use Bayesian vector-autoregressive (BVAR) models to estimate impulse responses but document robustness systematically to using local projections instead.

Our findings corroborate existing evidence but also produce important novel insights. Specifically, we confirm previous literature finding that Fed policy spillovers are large. Our contribution is to provide evidence with greater resolution across and thereby a comparison of the size of the effects of different Fed policy measures, to document that they all transmit about as much through trade and financial channels, and that they all entail trade-offs for EME monetary policy between stabilizing output and prices on the one hand and ensuring financial stability in terms of capital inflow volatility on the other hand.

In more detail our findings are as follows. We first document that spillovers are of about the same size across the different Fed policy measures. In general, it is not straightforward to compare the size of the effects across measures as there is no unique normalization that makes the size of shocks that target different segments of the yield curve perfectly comparable. We therefore compare the effects of conventional policy and forward guidance by scaling the shocks so that they entail the same effect on Treasury yields for a particular maturity. For example, when we compare conventional policy and forward guidance based on a given effect on the 1-year Treasury yield, their effects on US and RoW output are about the same. Alternatively, when we compare them based on a given effect on the 2-year Treasury yield, conventional policy impacts output about twice as strongly as forward guidance. Swanson (forthcoming) finds that the domestic effects of Fed conventional policy are larger than those of forward guidance. We extend this insight and show that this ranking also applies to Fed policy spillovers.

Second, we provide new evidence on the key role of global investors' risk aversion in the international transmission of Fed conventional policy, forward guidance and LSAPs. Consistently with a risk-off effect, we find that a Fed conventional policy and forward guidance tightening cause a decline in global equity prices and an increase in investor risk aversion as well corporate bond spreads. Our findings thus provide empirical support for the transmission mechanisms centering on risk that underpin large Fed policy spillovers in structural models (e.g. Georgiadis et al., 2023; Jiang et al., 2023; Akinci and Queralto, 2024; Akinci et al., 2024).

Third, zooming in on capital flows we document a distinct portfolio rebalancing in response to Fed LSAPs compared to conventional policy and forward guidance. In particular, while US investors gradually reduce their foreign debt and equity holdings in response to conventional policy and forward guidance tightening, contractionary LSAPs induce an immediate shedding of foreign portfolio debt but not equity. Moreover, we find that while the effects on foreign term premia are generally small, they are sizable for countries whose bonds are relatively closer substitutes to US Treasury securities, such as the UK and Germany.

These patterns are consistent with structural models featuring preferred-habitat investors in segmented markets linked by arbitrageurs (Gourinchas et al., 2022; Greenwood et al., 2023). Our finding that term-premia spillovers are overall small suggests that this specific portfolio re-balancing is not a key transmission channel for LSAP spillovers relative to financial channels centering on global investors' risk aversion.

Our findings for LSAP spillovers inform the design of structural models. For example, Alpanda and Kabaca (2020) and Kolasa and Wesołowski (2020) embed segmented markets for long and short-term bonds in two-country New Keynesian models. While in the model of Alpanda and Kabaca contractionary Fed LSAPs trigger a slowdown in RoW real activity because the contractionary effects of term premia spillovers dominate the expansionary effects of exchange rate depreciation and expenditure switching, in the model of Kolasa and Wesołowski the opposite is the case. As we find that the effect on foreign term premia is generally small, our result that contractionary LSAPs are nonetheless also contractionary for RoW real activity in the data suggests these spillovers must be transmitting through other financial channels than the narrow portfolio re-balancing considered in Alpanda and Kabaca. Shedding light on the empirical relevance of these transmission channels is an important contribution as the literature has not yet reached a consensus on how to integrate LSAPs in New Keynesian open-economy models (Krishnamurthy, 2022).

Fourth, we exploit cross-country variation in exposure to trade and financial channels to shed light on their relative importance for the transmission of output spillovers. To construct exposure indices at the country level we use information on export invoicing-currency patterns and value-added exports, as well as on *de facto* financial integration in terms of foreign portfolio debt and other investment liabilities and *de jure* financial openness in terms of capital control policies. We find that for the average economy a one-standard-deviation larger exposure to trade channels increases output spillovers about as much as a one-standard-deviation larger exposure to financial channels. We interpret this finding as indicating that trade and financial channels are equally important in the transmission of Fed policy spillovers.

Finally, we present evidence showing that Fed conventional policy, forward guidance and LSAPs all imply trade-offs between macroeconomic and financial stability for EME monetary policy. In particular, a Fed tightening of either of these policies dampens EME real activity, reduces consumer prices, and contracts capital inflows. Consequently, while EME monetary policy can in principle stabilize output and prices by loosening, this might jeopardize financial stability as it would further discourage capital inflows.

Related literature. The literature on Fed policy spillovers is large. A first wave of work neither distinguishes between the different Fed measures nor accounts for residual endogenous monetary policy surprise components (Georgiadis, 2016; Dedola et al., 2017; Iacoviello and Navarro, 2019; Kalemli-Özcan, 2019; Miranda-Agrippino and Rey, 2020b; Miranda-Agrippino et al., 2020; Dees and Galesi, 2021; Cristi et al., 2024). Subsequent work distinguishes between different Fed measures, but does not account for residual endogenous monetary policy surprise components (Tillmann, 2016; Rogers et al., 2018; Miranda-Agrippino and Rey, 2020a; Bhattarai et al., 2021). Other work does account for such residual components, but does not distinguish between different Fed measures (Bräuning and Sheremirov, 2019; Degasperi et al., 2020; Cesa-Bianchi and Sokol, 2022; Gai and Tong, 2022; Jarociński, 2022; Arteta et al., 2022; Kalemli-Özcan and Unsal, 2023; Pinchetti and Szczepaniak, 2024; Camara, forthcoming).

To our knowledge only Miranda-Agrippino and Nenova (2022) distinguish between different Fed measures and at the same time account for residual endogenous monetary policy surprise components in estimating Fed policy spillovers. The identification of Jarociński and Karadi (2025a) we use improves on that of Miranda-Agrippino and Nenova in four directions: (i) it accounts for potentially confounding interactions between shocks to the different Fed measures; (ii) it is more parsimonious as it postulates fewer primitive exogenous innovations; (iii) it shifts the end of the sample period from 2019 to 2024, adding five years of particular importance due to the COVID pandemic in 2020 and the unwinding of the Fed's balance sheet from mid-2022 together with the announced interest-rate hikes; (iv) following Swanson and Jayawickrema (2023) it does not only use FOMC meetings to construct high-frequency surprises, but also Fed Chair speeches, testimonies and press conferences as well as minutes releases. More generally, as our focus is on the Fed rather than on comparing spillovers across major central banks we can study in more detail differences in the transmission across conventional policy, forward guidance and LSAPs, across AEs and EMEs, the relative importance of trade and financial channels, and EME policy trade-offs. And while Miranda-Agrippino and Nenova focus on unconventional policy measures, we compare the effects of conventional to those of unconventional policy measures.

Our paper also connects to the literature that evaluates the relative importance of trade and financial channels in Fed policy spillovers. Kearns et al. (2023) find that financial channels are more important for interest rate spillovers than trade channels. On the other hand, Böck and Mori (forthcoming) find that trade channels are as important—and over time even more important than—financial channels for macro-financial Fed policy spillovers.

Finally, our findings for LSAPs expand existing work based on identification approaches based on sign and zero restrictions in VAR models (Baumeister and Benati, 2013; Gambacorta et al., 2014; Weale and Wieladek, 2016; Bhattarai et al., 2021).

The paper is organised as follows. Section 2 discusses the identification of Fed policy shocks we use in our empirical analysis. Section 3 presents our results on Fed policy spillovers and Section 4 for EME monetary policy trade-offs. Section 5 concludes.

2 Identification of US monetary policy shocks

This section explains the construction of the Fed policy shocks we use in the rest of the paper. The identification builds on recent developments in the literature. We use a large up-to-date dataset of high-frequency surprises around Fed events constructed in Jarociński and Karadi

(2025a). Following Swanson and Jayawickrema (2023), in addition to FOMC meetings the dataset includes also high-frequency surprises around Fed Chair speeches, testimonies and press conferences as well as minutes releases. Building on Jarociński (2024) we apply statistical identification to the high-frequency surprises to distinguish between conventional policy, forward guidance, and LSAPs while accounting for a residual endogenous component of monetary policy. In parallel work, Jarociński and Karadi (2025b) use the same identification to study domestic effects of Fed unconventional policies. In this paper, we study the international effects of conventional and unconventional Fed policy measures. To keep our paper self-contained, we explain the identification in detail.

The identification uses high-frequency surprises in four variables: the first eurodollar future (market expectation of interbank interest rates by the end of the current quarter), the 2-year Treasury yield, the 10-year Treasury yield, and the S&P500 stock index. We assume these surprises are driven by four structural (orthogonal) shocks that have different impacts on the yield curve and the stock price index. If the average mix of structural shocks is different for different Fed event types (e.g. FOMC announcements vs Fed Chair speeches), the covariances of the observed asset-price surprises differ as well. The insight of Rigobon (2003) is that such heteroskedasticity can statistically identify the structural shocks. It turns out that in our application the shocks can be sharply identified and naturally labeled *ex-post* as conventional monetary policy (CMP), forward guidance (FG), large-scale asset purchases (LSAP) and central bank information (CBI).

More specifically, the shocks are obtained by estimating the model

$$\boldsymbol{y}_t = \boldsymbol{C}'\boldsymbol{u}_t, \qquad u_{nt} \sim \mathcal{N}(0, \sigma^2_{ns}) \tag{1}$$

where t indexes the count of individual Fed events and s the event type $s \in$ {FOMC, Speech, Testimony, Press Conference, Minute}. The vector $\boldsymbol{y}_t$ contains high-frequency surprises (measured over a 30-minutes window) in the four variables listed above, namely the first eurodollar future, the 2-year Treasury yield, the 10-year Treasury yield, and the S&P500 stock index. The vector $\boldsymbol{u}_t =$ (CMP, FG, LSAP, CBI) contains structural shocks occurring at event t, and $\boldsymbol{C}$ collects the effects of the shocks $\boldsymbol{u}_t$ on the observed variables $\boldsymbol{y}_t$. The key feature of the model is that shock n ($n \in$ {CMP, FG, LSAP, CBI}) may have a different variance across different types of Fed events s ($s \in$ {FOMC, Speech, Testimony, Press Conference, Minute}). We estimate the model (1) with Bayesian methods (for details see Jarociński and Karadi, 2025a). The estimation is based on 582 Fed events between January 1991 (when the 2-year Treasury yield surprises first become available) and September 2024.[1,2]

[1]The results are based on 2,000 draws of the shocks from the posterior distribution, which are obtained by simulating 100,000 draws from the Gibbs sampler defined in Jarociński and Karadi (2025a) and storing every 50^{th} draw.

[2]The estimated shocks are similar to the analogous four shocks estimated in Jarociński (2024), who uses a related statistical identification based on fat-tailed distributions and who shows that the results for the first four shocks hardly change when the observed surprises in $\boldsymbol{y}_t$ are assumed to be driven by more shocks.

The structural shocks $\boldsymbol{u}_t$ are identified based on statistical rather than economic assumptions. Therefore, we label them only *ex post* based on the patterns in their estimated effects on financial market variables. Figure 1 presents the estimated end-of-day effects of the four (one-standard-deviation) shocks on Treasury yields with different maturities (blue), the corresponding expectations components (green) and term premia (black), as well as equity prices (cyan)[3,4] A filled bar indicates that the corresponding estimate is statistically significantly different from zero at the 10% significance level.[5]

Figure 1 shows that the first two shocks lift the Treasury yield curve through its expectations component and contract equity prices. The first shock raises the expected future path of the Fed funds rate mostly over the short term, while the second shock raises it over the medium term. Given these patterns, we label the first shock as conventional policy shock and the second as (Odyssean) forward guidance shock.

The third shock contracts equity prices and lifts only the longer end of the Treasury yield curve, and does so mostly through term premia, and so we label it as LSAP shock. The largest observation of this shock is the well-known important "QE1" announcement on March 18 2008. The financial market effects in Figure 1 are consistent with the effects of LSAPs in models featuring segmented markets and limits to arbitrage as well as empirical evidence from event studies (see the surveys of Bhattarai and Neely, 2022, and Krishnamurthy, 2022). Moreover, Figure 1 features also some evidence consistent with a signalling channel of QE in terms of a statistically significant albeit small upward effect on the expectations component.

Finally, the financial-market effects of the fourth shock are consistent with it capturing a residual endogenous monetary policy surprise component, e.g. due to a CBI effect/Delphic forward guidance (Nakamura and Steinsson, 2018; Campbell et al., 2012): it induces a positive co-movement between interest rates along the yield curve and equity prices. The rationale is

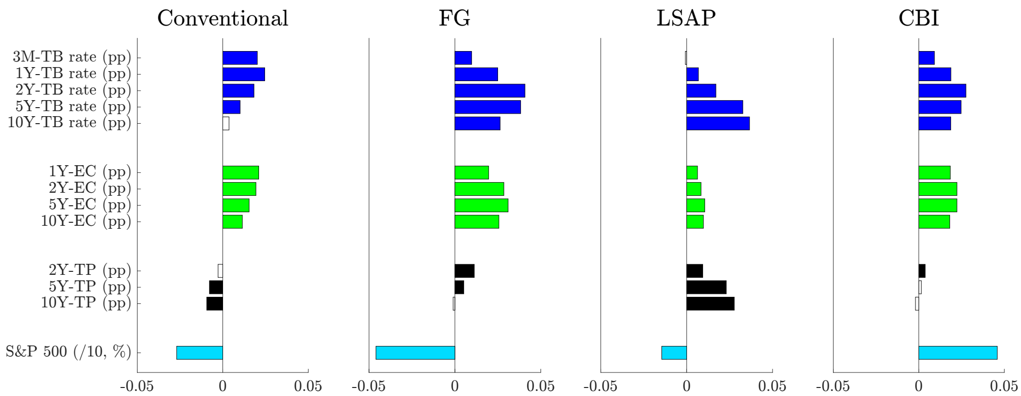
The main differences between the identifications of Jarociński (2024) and Jarociński and Karadi (2025a) are the following. First, in Jarociński and Karadi (2025a) the short end of the yield curve is represented by on average longer term interest rate expectations: six weeks ahead, rather than three weeks ahead (because of using the first eurodollar/SOFR future, rather than near-term fed funds futures). As a result, the conventional policy shock captures also some very-near term forward guidance, which renders it a stronger instrument for conventional policy. Second, in Jarociński and Karadi (2025a) the end of the sample is extended from June 2019 to September 2024, thereby including additional informative easing and tightening cycles related to the (post-)COVID inflation. Third, the set of events considered by Jarociński and Karadi (2025a) is extended to Fed communications other than FOMC announcements. This results in shocks that are much stronger instruments for Fed policy.

[3]Expectations and term-premium components are obtained as decompositions of the Treasury yield curve based on model estimates (Adrian et al., 2013). The associated estimation uncertainty afflicts the dependent variables in the regressions underlying Figure 1 and magnifies the standard errors of the estimates, but it does not compromise consistency as in a setup with classical measurement error in explanatory variables.

[4]When estimating the regressions reported in Figure 1 we account for the additional uncertainty due to the fact that the shocks are generated regressors, see the notes under the figure.

[5]Results for an alternative specification in which LSAP shocks are assumed to be zero until December 2007 are similar (see Figures B.1 and B.2). Because using these alternative LSAP shocks produces very similar estimates for macro-financial effects at business-cycle frequencies (see Figure B.3), we stick to the baseline LSAP shocks. One might also object that forward guidance was not an explicit Fed measure before the GFC. However, signals about the future path of policy rates have in fact been part of Fed announcements from as early as 2003 (Lunsford, 2020) and have been documented to be statistically and economically important in the data (Gürkaynak et al., 2005).

Figure 1: Impact-day US financial market effects of one-standard-deviation Fed policy shocks



Note: Each bar depicts the daily impact response of a Fed policy shock estimated from local projections. We include one lag and no controls, but results hardly change for less parsimonious specifications, for example when we control for Bloomberg macro surprises/news. As in Curcuru et al. (2023) the expectation components and term premia are taken from Adrian et al. (2013). The sample period spans July 1991 to June 2024. Filled bars indicate estimates that are statistically significant at the 90% confidence level. To account for the uncertainty in the construction of the shocks we estimate the local-projection coefficient and its Eicker-Huber-White variance for 2,000 draws from the posterior distribution of the shock estimates. We compute the total variance from the law of total variance. We report the mean of the coefficient estimates across the 2,000 draws and assess the 90% significance based on the total variance. Data descriptions are provided in Table A.1.

that financial markets interpret the surprise interest-rate increase as indicating that the Fed is holding a more bullish view about the economy. They upgrade their earnings expectations and they become more risk tolerant, so that equity prices rise. One of the largest (negative) observations of this shock during FOMC announcements is the one from August 9, 2011, which stated that the "economic conditions (...) are likely to warrant exceptionally low levels for the federal funds rate at least through mid-2013", and which is commonly interpreted as an example of Delphic forward guidance/CBI. We show below that the estimated effects of the fourth shock are consistent with a CBI effect also at business-cycle horizons.[6]

3 Global spillovers

We first present results for daily effects in global financial markets and then for macro-financial spillovers at business-cycle horizons.

3.1 Daily effects on global financial markets

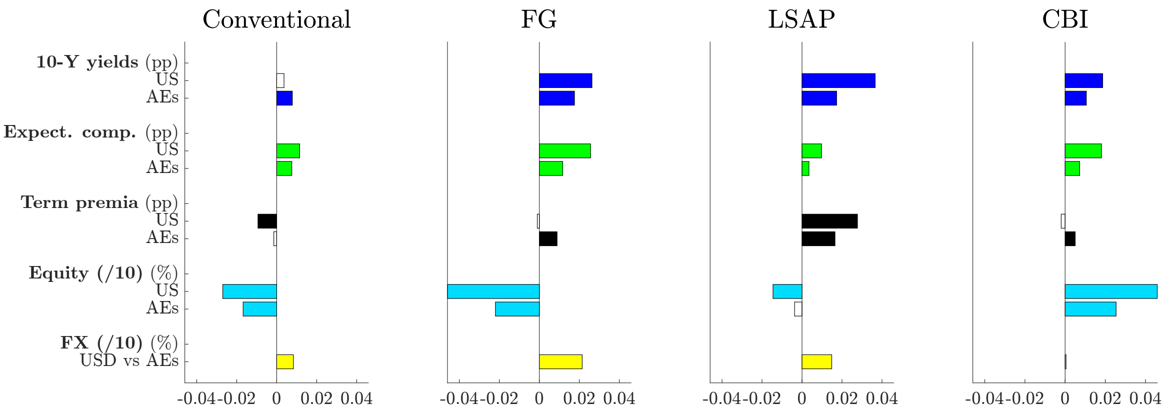
Figure 2 presents end-of-impact-day/next-day effects on non-US 10-year sovereign-bond yields, the associated expectations components and term premia, equity prices and nominal bilateral dollar exchange rates estimated from panel local-projection (LP) regressions and data for six

[6]This shock might reflect a change in the expectations of economic fundamentals, risk attitudes (Kroencke et al., 2021) and Neo-Fisherian effects (Uribe, 2022).

AEs (Australia, Canada, Germany/euro area, Japan, Sweden, UK).[7] The estimates point to large financial market spillovers from all Fed measures. This is consistent with anecdotal observations by policymakers in the RoW and their concerns about monetary autonomy, even in case of large economies (see for example Panetta, 2021).

In particular, in response to conventional policy tightenings AE long-term rate expectations components rise almost as much as their US analogue. In case of contractionary forward guidance and LSAPs, AE expectations components also rise, but only by about half as much as in the US. LSAPs lift AE term premia along with those in the US, although again only by about half as much. AE equity prices mostly move together with those in the US in response to tightenings in all Fed policy measures, again falling by about half as much. The dollar exchange rate appreciates in response to tightenings in all Fed policy measures. After a tightening due to a CBI effect AE interest rates and equity prices both rise along with those in the US, while the effective dollar exchange rate against AE currencies does not move.

Figure 2: Impact-day effects of US monetary policy shocks on global interest rates, equity prices and exchange rates



Note: The expectation components and term premia are taken from a dynamic Nelson-Siegel model. See also the notes from Figure 1.

Our findings for impact-day spillovers from LSAPs to foreign term premia and the exchange rate in Figure 2 are consistent with the empirical evidence based on event studies surveyed in Bhattarai and Neely (2022). They also align with theoretical predictions for the international transmission of LSAPs. In particular, in the models of Greenwood et al. (2023) and Gourinchas et al. (2022) arbitrageurs transmit the change in term premia required by domestic preferred-habitat investors in segmented markets in response to LSAPs across

[7] Due to time differences in market closing hours relative to the US, for countries other than Canada we follow Curcuru et al. (2023) and adjust the timing of the variables so that x_t is the first local market close price after and x_{t-1} the last local market close price before the Fed event. For the dollar exchange rate we do this also for Canada, given that the data are taken from the BIS and feature the same fixing time for all countries.

borders, causing an internationally synchronized increase in term premia of long-maturity sovereign bonds and an appreciation of the dollar. That the effect on US Treasury term premia is larger than on foreign analogues is consistent with the observation of Krishnamurthy (2022) that markets in which the announced LSAPs are carried out are typically found to be affected most strongly. The results are very similar when we set to zero the LSAP shocks before 2008 (see Figure B.2).

Our finding of large impact-day effects on AE interest rates is consistent with Curcuru et al. (2018), who estimate spillovers from surprises in long-term US Treasury yields to German bond markets around a set of notable FOMC announcements using intra-daily data. In turn, our finding that LSAPs have larger spillovers on foreign term premia than on expectations components while conventional policy and forward guidance have larger effects on foreign expectations components than on term premia is consistent with the analysis based on daily data in Curcuru et al. (2023).

3.2 Output spillovers

We follow Li et al. (2024) for the choice of impulse response estimator at the business-cycle frequency and use BVAR models as the baseline. In particular, Li et al. (2024) conduct a simulation study of LP and VAR estimators of structural impulse responses across thousands of data-generating processes designed to mimic the properties of the universe of US macroeconomic data. They show that across identification schemes and several variants of LP and VAR estimators, a bias–variance trade-off emerges: LP estimators have lower bias than VAR estimators, but they also have substantially higher variance at intermediate and long horizons. For researchers placing more weight on precision, Bayesian (OLS) VAR methods are generally most appealing at short (medium) horizons (see Figure 6 in Li et al., 2024). Against this background, as baseline estimator we use a BVAR model (with standard Minnesota prior). However, we also report results for OLS VAR models and—also for continuity with Georgiadis and Jarociński (2023)—for the smooth LPs (SLPs) developed by Barnichon and Brownlees (2019).

More specifically, we estimate the VAR model

$$\widetilde{\boldsymbol{x}}_t = \boldsymbol{c} + \sum_{j=1}^{p} \boldsymbol{A}_j \widetilde{\boldsymbol{x}}_{t-j} + \boldsymbol{e}_t, \tag{2}$$

where $\boldsymbol{c}$ is a vector of intercepts, $\widetilde{\boldsymbol{x}}_t \equiv (u_{nt}, \boldsymbol{x}_t')'$ stacks one shock of interest u_{nt}, $n \in \{\text{CMP, FG, LSAP, CBI}\}$, and a set of macro-financial variables in $\boldsymbol{x}_t$, and $\boldsymbol{e}_t$ is a vector of reduced-form disturbances. We include $p = 12$ lags, and $\boldsymbol{x}_t$ includes the 1-year Treasury yield, the excess bond premium (EBP) of Gilchrist and Zakrajsek (2012), and the logarithms of the S&P 500 stock market index, monthly US real GDP and the monthly US GDP deflator. We discuss the sensitivity of our BVAR results to alternative specification choices below.

In order to estimate structural impulse responses, we adopt the internal instrumental-variable approach (see e.g. Plagborg-Møller and Wolf, 2021). In particular, we order the shock of interest first in the VAR model and carry out a Choleski decomposition of the covariance matrix after estimation to obtain the contemporaneous effects. We estimate the effects of the four different shocks u_{nt}, $n \in \{\text{CMP, FG, LSAP, CBI}\}$ in separate VAR models. In order to estimate the impulse responses of variables beyond those in $\boldsymbol{x}_t$, we augment the VAR model by one variable at a time. Also, we estimate separate BVAR models for each of the four shocks. The sample period is again July 1991 to June 2024.

Figure 3 presents results for Fed policy spillovers to RoW real activity at the monthly frequency. The first row presents results for RoW output measured by real GDP (interpolated from quarterly data), and the second row by industrial production.[8] The black solid lines depict the effects of Jarociński and Karadi's (one-standard-deviation) Fed policy shocks estimated with BVAR models. The red circled lines report estimates from OLS VAR models and the blue squared lines from SLPs.[9,10] The bottom panel compares the RoW responses to the US responses. Five observations on the output effects of Fed policy tightenings stand out in Figure 3.

First, spillovers from Fed policy are qualitatively similar whether output is measured by real GDP or industrial production; for the sake of brevity, we focus on industrial production in the following.

Second, the results indicate that spillovers are rather similar qualitatively for one-standard-deviation Fed policy shocks of different types, at least according to the VAR-based estimates. However—as in any application with multiple types of monetary policy shocks—it is not straightforward to compare policies that have a different impact on the shape of the yield curve: There is no unique way to make two different changes in the shape of the yield curve equivalent. Therefore, when comparing the effects between shocks, it is useful to refer to Figure 1 for the meaning of one-standard-deviation shocks. For example, notice first that a one-standard-deviation forward guidance shock increases the 2-year Treasury yield by about 4 basis points while a one-standard-deviation conventional policy shock increases it by about 2 basis points. To compare the effects of the conventional policy and the forward guidance shocks for the same impact on the 2-year Treasury yield, one would have to scale the impulse response to the conventional policy shock in Figure 3 up by about two. For this normalization, our estimates imply that Fed conventional policy entails much larger output spillovers than forward guidance (which would be consistent with the findings for the domestic effects in the US of e.g. Swanson, forthcoming). Alternatively, as impact-day effects of one-standard-deviation conventional policy and forward guidance shocks are very similar, if one were to

[8] The data are purchasing-power-parity-weighted averages of 39 country-specific indices (see Table 4 in Grossman et al., 2013, as well as Table A.2 for more information on the data we use).

[9] To obtain the latter two estimates, we use the replication package for Li et al. (2024) and their model specification settings.

[10] Results are similar when we set LSAP shocks to zero before 2008 (see Figure B.3).

assume that two shocks are most comparable if they have the same impact-day effect on the 1-year instead of the 2-year Treasury yield, then the two impulse responses in Figure 3 can be compared without rescaling. Hence, for this normalization our estimates imply that output spillovers from Fed conventional policy and forward guidance are about as strong.

Third, results in the last two rows indicate that contractionary Fed policy measures induce a contraction in RoW real activity (black solid lines) that is about as large as the domestic effects in the US (green squared lines).

Fourth, in response to the fourth shock of Jarociński and Karadi (2025a) RoW and US real activity accelerate, again consistent with a CBI effect.

Finally, we note for future reference that while the estimates obtained from VAR models and SLPs generally agree, for conventional policy SLPs estimate a very muted effect on RoW output. We discount this finding, as the VAR estimators show a stronger effect and Li et al. (2024) advocate for these for most researcher's loss functions.[11]

Figure 4 presents results for the output spillovers estimated separately for AEs and EMEs. The estimates suggest that spillovers are quite similar across AEs and EMEs. Spillovers to EMEs are estimated to be slightly more persistent, but the difference is small.

We next discuss how Fed policy measures transmit to RoW trade and financial variables. We investigate the relative role of trade and financial channels farther below in Section 3.7.

3.3 Effects on non-US RoW financial variables

Figure 5 presents the effects of Fed policy tightenings on global financial variables. The first three columns show that tightenings in all Fed policy measures trigger an immediate increase in the global investor risk aversion index constructed by Bekaert et al. (2021) and the ICE BofA option-adjusted euro and EME high-yield corporate-bond spreads, as well as a drop in RoW equity prices. The last column in Figure 5 shows that a Fed tightening due to a CBI effect eases financial conditions in terms of global investor risk aversion, bond spreads, and equity prices, consistent with a risk-on effect.[12]

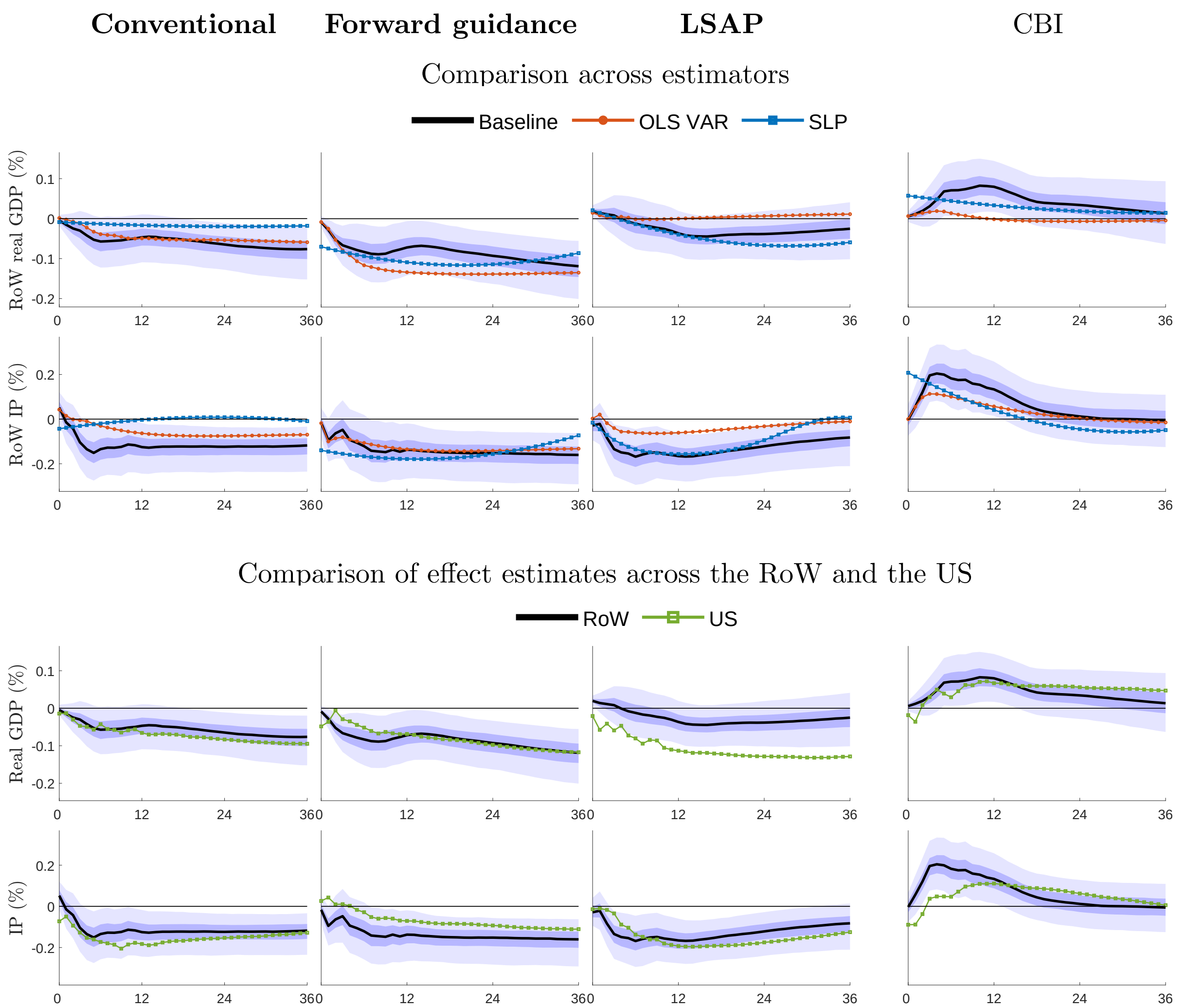
The panels in the last two rows in Figure 5 again compare the spillovers to financial markets in the RoW (black solid lines) to the domestic effects in the US (green squared lines). We estimate spillovers to be of remarkably similar magnitude as the domestic effects. Domestic effects in the US are more persistent for equity prices.

Our findings inform the theoretical literature on the international transmission of LSAPs at the macroeconomic level. In particular, the two-country New Keynesian models of Alpanda and Kabaca (2020) and Kolasa and Wesołowski (2020) highlight the role of term

[11] Figure B.4 shows that the results for output spillovers shown in Figure 3 and further outcome variables are very similar with alternative BVAR model specifications, namely with shorter lags $p = 3$, a linear time trend, and additional endogenous variables (the price of oil, the US dollar nominal effective exchange rate, and the risk aversion index of Bekaert et al., 2021).

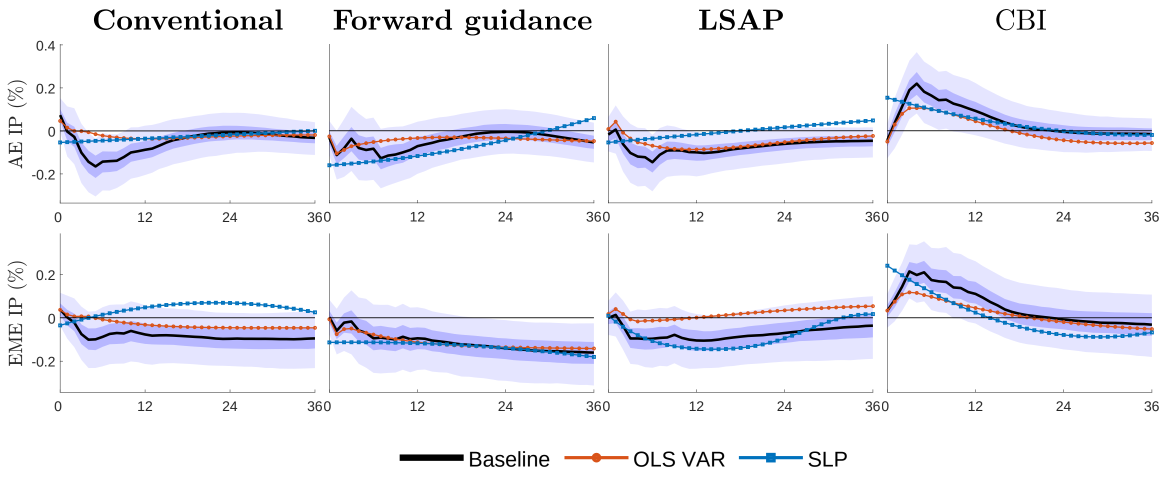
[12] Figure B.5 shows that the global factor in risky asset prices originally introduced by Miranda-Agrippino and Rey (2020b) and extended in Miranda-Agrippino et al. (2020) falls in response to Fed tightenings for all measures, but rises in response to CBI effects.

Figure 3: Effects of US monetary policy shocks on non-US RoW real activity



Note: The black solid lines depict spillovers to the RoW estimated using BVAR models. We estimate separate BVAR models for each shock. We order the shock first in the vector of endogenous variables and then perform a Choleski decomposition for the contemporaneous effects (Plagborg-Møller and Wolf, 2021). The posterior simulation accounts also for the uncertainty in the construction of the shocks, by first drawing the shocks and then the BVAR model coefficients conditional on the drawn shocks. The black solid lines depict the posterior median and the shaded areas the 68% and 90% centered posterior probability mass.

Figure 4: Effects of US monetary policy shocks on non-US AE and EME real activity



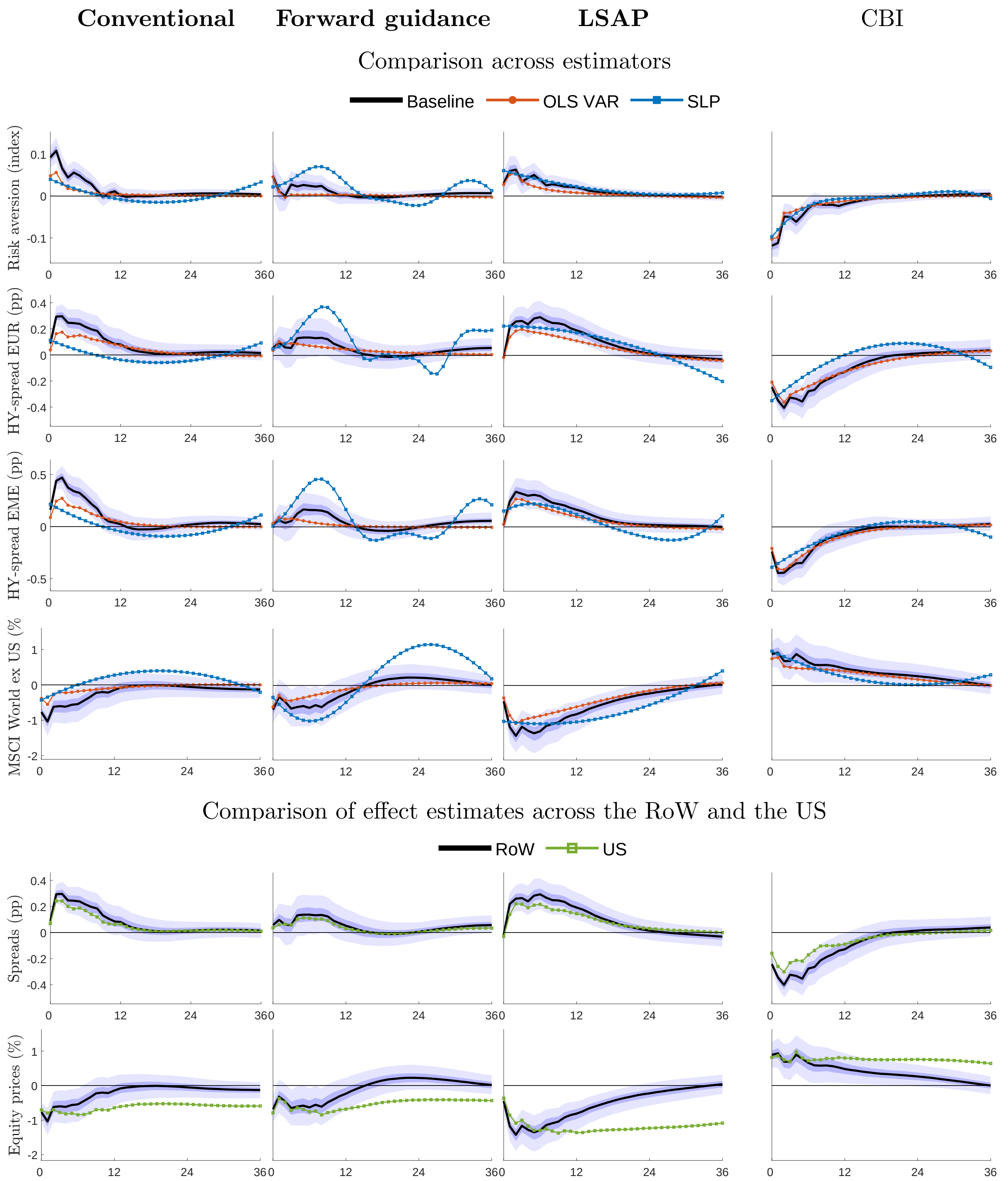
Note: Impulse responses depict deviations from baseline in percent. The black solid lines depict spillovers to the RoW, and red crossed lines the domestic effects in the US. See also the notes to Figure 3.

premia spillovers resulting from international portfolio re-balancing of sovereign-bond holdings. Figure 6 reports the impulse responses of AE sovereign bond term premia (data for EME are not readily available). Unlike the perfectly observed financial asset prices shown in the previous figure, term premia are constructed, model-based objects and consequently these results need to be taken with more caution. With this caveat in mind, Figure 6 shows that contractionary LSAPs raise AE term premia (left-hand side panel). However, spillovers are muted compared to the domestic effects in US (right-hand side panel). That said, notice that term premia spillovers are large in specific cases, especially for the UK and Germany (see Figure B.6).[13] These results suggest term-premia spillovers due to international portfolio re-balancing of US sovereign-bond holdings and foreign close substitutes are unlikely to be the key transmission channel for the effects of LSAPs on the RoW in general and may be important only for specific economies. Instead, the findings in Figure 6 suggest that also for LSAPs changes in investors' appetite for risky assets play a key role in transmitting spillovers to the RoW. Of course, these effects through variation in risk appetite may themselves manifest in part in cross-country co-movements in term premia. As data on term premia for EME sovereign bonds are not readily available, we confine this analysis to AEs.

We next provide further evidence based on capital flows and the dollar exchange rate to corroborate the key role of global investors' risk aversion for the international transmission of Fed policy within financial channels.

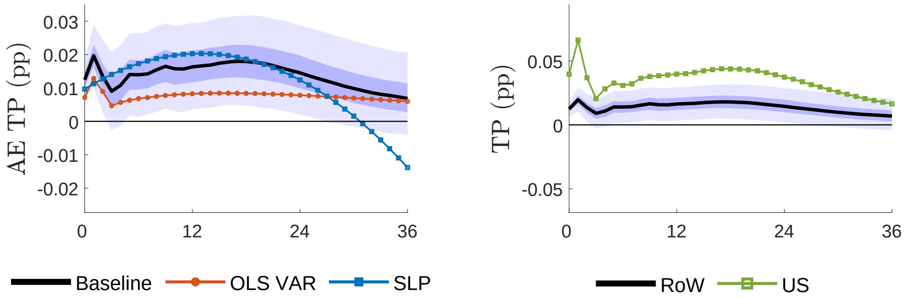
[13]Overall, UK term premia react the most, Japanese the least. This ranking is consistent with the analysis in Greenwood et al. (2023), who point out that the strength of term-premia spillovers should be positively related to the correlation of short rates.

Figure 5: Effects of US monetary policy shocks non-US RoW financial variables



Note: See the note to Figure 3.

Figure 6: Effects of LSAP shocks on AE sovereign-bond term premia



Note: The term premia refer to 10-year sovereign bonds and are taken from the estimation of the models of D'Amico et al. (2018) and Diebold et al. (2006). The AE term premium is calculated as a GDP-weighted average across Japan, Germany, Switzerland, the UK, Australia, Sweden, Canada and New Zealand. See also the note to Figure 3.

3.4 Capital flows

We use two data sets to explore the effects of the different Fed policy measures on global portfolio investment flows. First, we study US investors' foreign portfolio equity and debt holdings from Treasury International Capital (TIC) with state-of-the-art adjustments for valuation effects (see e.g. Bertaut and Judson, 2022). Second, we study portfolio flows of non-US AE and EME investors from the IMF Balance of Payments Statistics.

We find that contractionary conventional policy, forward guidance and LSAPs induce US investors to reduce holdings of AE/EME equity and debt. The effects of conventional policy and forward guidance on capital flows display hump-shaped patterns. In contrast, LSAPs have an immediate impact on holdings of especially AE debt, consistently with international portfolio re-balancing between US and AE bonds, which are viewed as close substitutes and also as implied by state-of-the-art theory (Gourinchas et al., 2022; Greenwood et al., 2023). The patterns in the responses of non-US AE investors holdings of foreign equity and debt are overall similar to those for US investors.

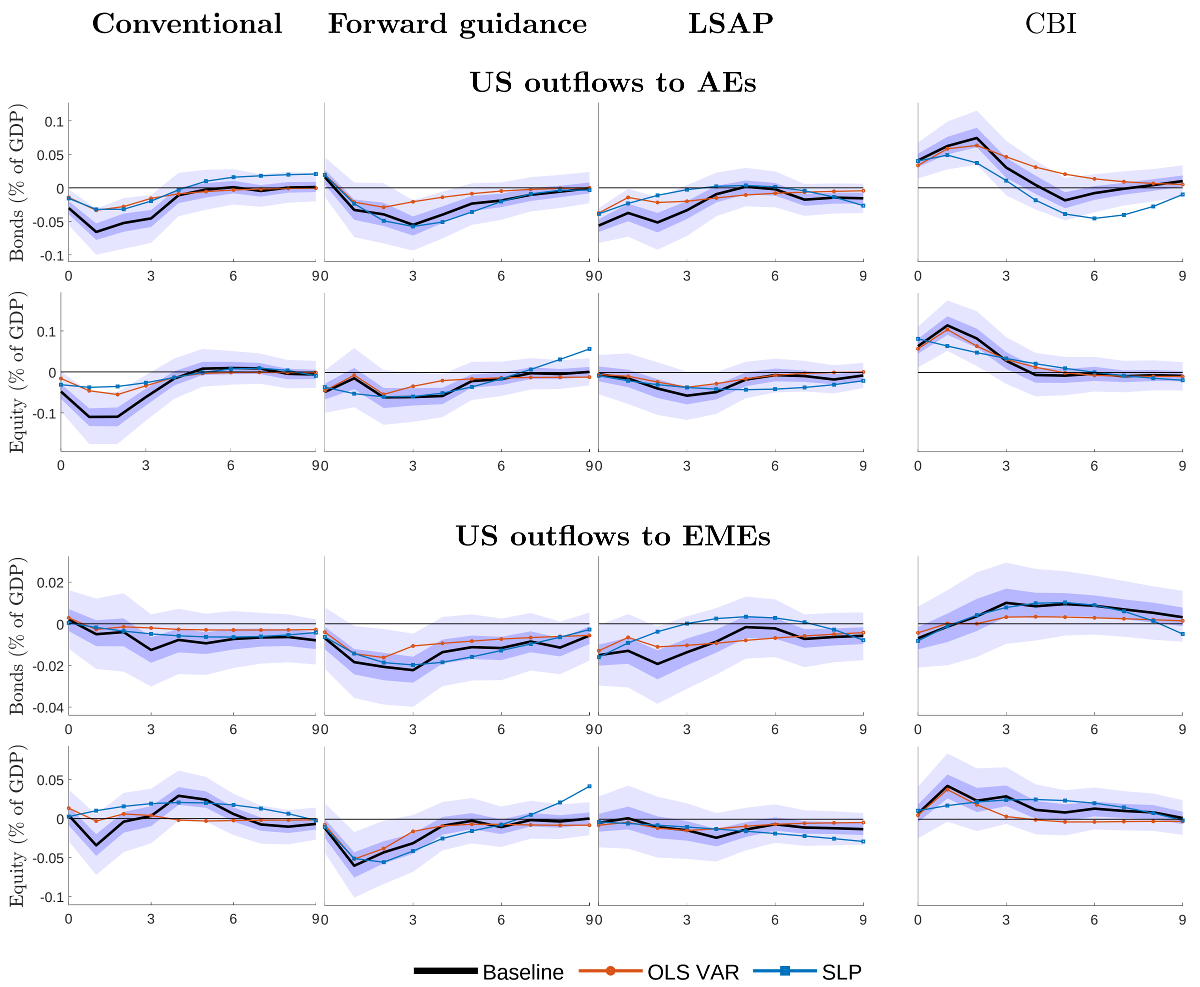
We first consider US capital flows given that the corresponding data are of relatively high quality and detail in terms of instruments/counterpart-country and available at the monthly frequency. In particular, we consider US outflows defined as net purchases of foreign assets by US residents. We focus on portfolio equity and debt. The data are from TIC and adjusted for valuation effects by Bertaut and Tryon (2007) and Bertaut and Judson (2014, 2022).[14]

[14]The TIC system collects cross-border securities positions and transactions data based on surveys and is the primary source of information on foreign official and private demand for US Treasuries and other US securities (inflows) as well as for US investment in foreign securities (outflows). As advocated by Tabova and Warnock (2021) and Bertaut and Judson (2022), we use the 'BTBJ' data of Bertaut and Tryon (2007) and Bertaut and Judson (2014). Bertaut and Judson (2014) estimate flows as changes in positions adjusted by estimates of valuation effects based on the monthly TIC-SLT and annual TIC-SHL/SHC positions data for December 2011 to December 2019. Bertaut and Tryon (2007) estimate flows adjusting the monthly TIC-S flows data by financial center transactions bias based on the annual TIC-SHL/SHC positions data for December 1994 to December 2010.

Because capital flows at the country level and the monthly frequency are quite volatile, we consider effects only up to a horizon of nine months and use three-month moving averages. We scale US outflows by lagged US GDP.

The first two columns in Figure 7 show that changes in conventional policy and forward guidance trigger a hump-shaped drop in US outflows to AE/EME equity and debt. The effects are estimated more precisely for holdings of AE assets, which account for a much larger share of US foreign portfolio investment holdings than EME assets (see Figure B.7). The effects are also somewhat more precisely estimated for EME equity holdings, which account for a much larger share of US portfolio investment holdings of EME assets than bonds (see Figure B.7). These results are consistent with a risk-off effect of Fed conventional policy and forward guidance tightenings.

Figure 7: Effects of US monetary policy shocks on US portfolio outflows by destination and instrument, scaled by lagged US GDP



Note: See also the note to Figure 3.

The third column of Figure 7 shows that after contractionary LSAPs US holdings of AE and EME bonds fall immediately, while US holdings of AE and EME equity fall with a delay. Moreover, holdings of AE bonds fall more strongly than holdings of EME bonds, As AE debt is arguably a closer substitute for the assets purchased by the Fed under the different QE programs, these patterns are consistent with LSAPs triggering international portfolio rebalancing in the very short term between Treasury securities and foreign sovereign bonds by US arbitrageurs across segmented markets populated by preferred-habitat investors as in the models of Gourinchas et al. (2022) and Greenwood et al. (2023): As the Fed is anticipated to shed Treasury securities after contractionary LSAP announcements, investors prepare to absorb these by shedding their holdings of foreign—especially closer AE—substitutes. Unfortunately, we cannot split US portfolio debt *outflows* across public and private bonds due to data availability in the TIC surveys. Over the medium term when US investors shed foreign holdings of both equity and bonds, the results are consistent with a risk-off effect of Fed LSAP tightenings.[15]

Finally, the last column in Figure 7 shows that US outflows rise in response to a Fed tightening due to a CBI effect, again consistent with a risk-on effect.

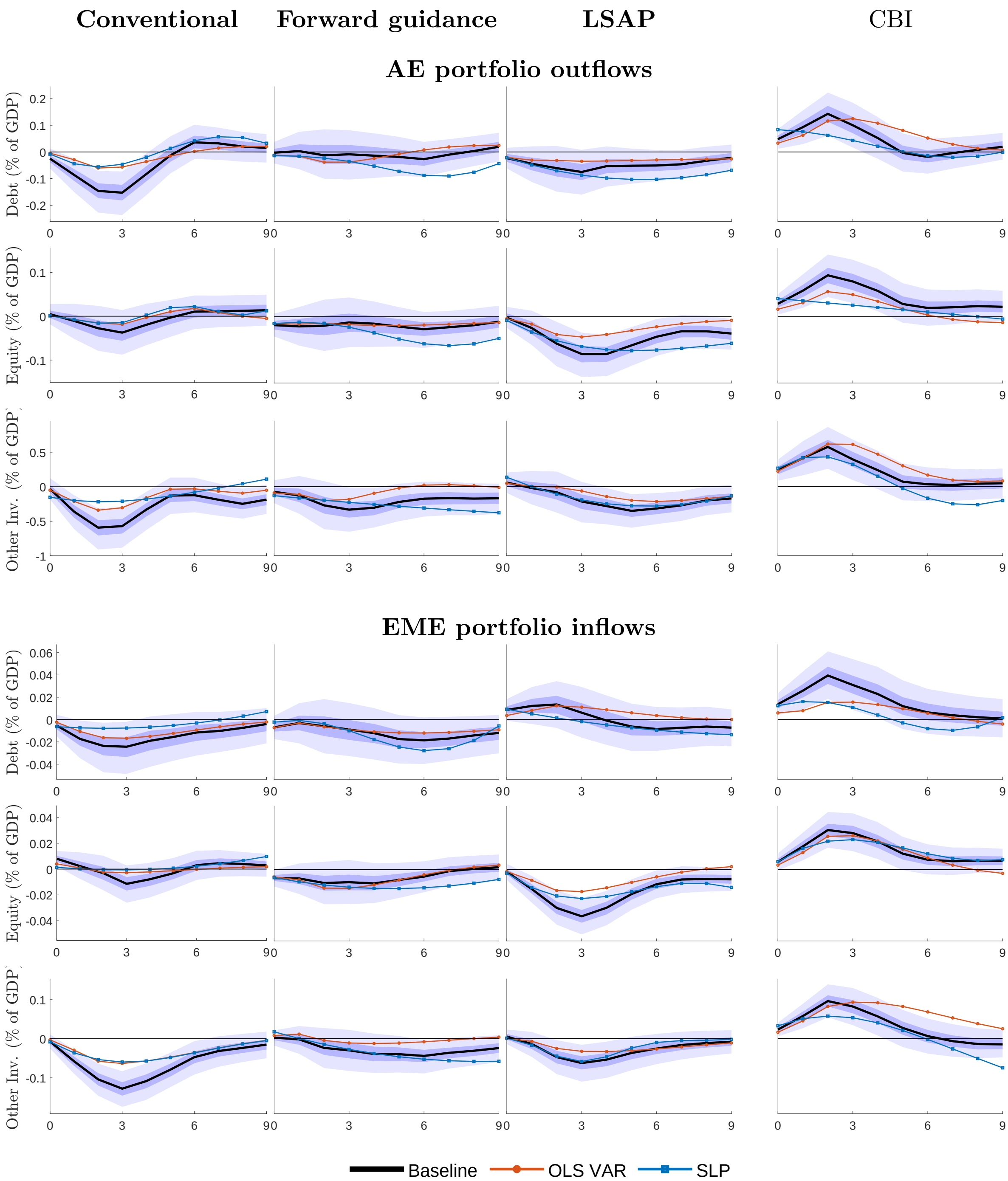
While Figure 7 considers US investors' outflows, we next turn to non-US, AE and EME investors' capital flows based on quarterly IMF Balance of Payments Statistics data, studied e.g. in Miranda-Agrippino et al. (2020) and Degasperi et al. (2020). We consider the broad sample of 81 countries of Miranda-Agrippino et al. (2020) and also linearly interpolate from quarterly to monthly frequency. Note that in this data we cannot distinguish whether outflows (inflows) are destined to (originate from) the US, other AEs or other EMEs, and we can also not distinguish between public and private bonds.

For AEs we again present results for outflows. For EMEs, we present results for inflows—defined as net purchases of domestic assets by foreigners—since they are more sensitive to variation in the supply of foreign capital than AEs due to their shallower and less developed domestic financial markets and since they are only relatively small international investors in general. We estimate impulse responses using data on cross-country averages of economies' ratio of capital flows to GDP.

The results in Figure 8 are overall consistent with those for US outflows discussed above but provide additional insights. First, the first two columns show that consistently with a risk-off effect AEs (EMEs) exhibit a drop in equity and debt outflows (inflows) in response to Fed conventional policy and forward guidance tightenings. Moreover, Figure 8 shows that Fed conventional policy and forward guidance tightenings trigger the largest effects in other investment flows (which includes bank loans) and is the single largest share of AE total foreign assets and accounts for most of EME total foreign liabilities (see Figure B.9). These findings for AE and EME capital flows in Figure 8 point to a pervasive reach of risk-off effects of Fed conventional policy and forward guidance tightenings across *global*—and thus beyond

[15] Figure B.8 documents that our results for the effects of US holdings of foreign assets and global investor risk aversion hardly change when we omit LSAP from the taper tantrum in May 2013.

Figure 8: Effects of US monetary policy shocks on non-US AE portfolio outflows and EME portfolio inflows, scaled by lagged GDP



Note: The first (second) [third] row present results for AE portfolio equity (portfolio debt) [other investment] outflows, and the fourth (fifth) [sixth] row present results for EME portfolio equity (portfolio debt) [other investment] inflows. The data are taken from the IMF Balance of Payments Statistic, are interpolated from quarterly to monthly frequency, and span 1996 to 2023. We use the cross-country mean of economies' ratio of capital flows to GDP. See also the note to Figure 3.

US—cross-border investment.

For LSAPs the results in the third column in Figure 8 are consistent with a gradually emerging broad portfolio re-balancing driven by variation in investor risk aversion. There is no evidence for a large, immediate drop in AE portfolio debt outflows. This may be because Figure 8 shows responses of AE holdings of portfolio debt assets in *all* other AEs rather than only the US.

Finally, the last column in Figure 8 shows that Fed tightenings due to CBI effects induce an increase in AE and EME portfolio and other investment flows, again consistent with a global risk-on effect.

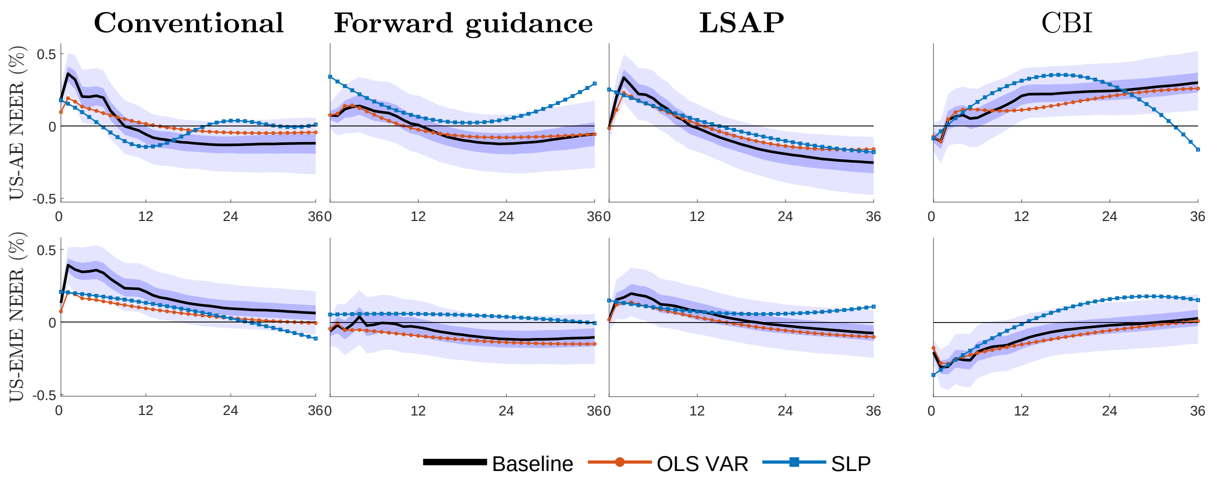
Our results for global capital flows improve existing evidence in terms of resolution regarding instruments, countries, policy measures, and identification: we distinguish between the US, non-US AEs and EMEs, and we compare effects of conventional policy, forward guidance and LSAPs while accounting for residual endogenous components in monetary policy surprises in the identification. Miranda-Agrippino et al. (2020) consider IMF Balance of Payments data, do not account for endogenous surprise components, and do not distinguish between debt and equity flows and between conventional and unconventional measures. Dahlhaus and Vasishtha (2020) focus on the effects of forward guidance on bond and equity fund flows in Emerging Portfolio Funds Research (EPFR) data, but do not account for endogenous surprise components. Ciminelli et al. (2022) also consider EPFR data and do account for endogenous surprise components, but do not distinguish between conventional and unconventional measures. Chari et al. (2021) focus on the effects of LSAPs on US debt and equity flows in TIC data, but do not account for endogenous surprise components. Degasperi et al. (2020) and Pinchetti and Szczepaniak (2024) study IMF Balance of Payments and International Institute of Finance data and account for endogenous surprise components, but do not distinguish between conventional and unconventional measures and between debt and equity flows.

3.5 The dollar exchange rate

Figure 9 presents the effects of Fed policy shocks on the dollar exchange rate separately for AEs and EMEs. While contractionary Fed conventional policy and LSAPs appreciate the broad dollar NEER similarly against both AE and EME currencies, in case of forward guidance the dollar appreciates more clearly against AE than EME currencies. Interestingly, we estimate Fed tightenings due to CBI effects have opposite effects across AEs and EMEs currencies. In particular, the dollar initially depreciates in response to a CBI effect against both AE and EME currencies, but soon appreciates against AE currencies while it remains persistently depreciated against EME currencies.

These patterns in AE and EME exchange rate responses are consistent with existing evidence on the relationship between the dollar exchange rate and risk. First, consistent with uncovered interest rate parity (UIP), increases in interest-rate differentials vis-à-vis the

Figure 9: Effects of US monetary policy shocks on the dollar NEER



Note: An increase in the dollar NEER indicates an appreciation. See also the note to Figure 3.

US following Fed tightenings appreciate the dollar. At the same time, it is well known that standard UIP does not hold and that risk premia for holding non-US dollar currencies are important determinants of exchange rates especially for EMEs (Kalemli-Özcan, 2019). This means that in case of a risk-on shock—such as a Fed tightening due to a CBI effect—risk premia for holding EME dollar currencies fall, reducing or even overturning the effect of an increase in US relative to EME interest rates as implied by UIP. In contrast, in case of a risk-off shock—such as contractionary Fed policy shocks—risk premia for holding EME currencies rise and amplify the dollar's appreciation due to an increase in US relative to RoW interest rates.[16]

Interestingly, recent literature highlights the dollar's role as a 'barometer of risk appetite', especially vis-à-vis EMEs (Avdjiev et al., 2019a; Hofmann et al., 2020; Hofmann and Park, 2024). This is consistent with the divergence in the dollar NEER across AE and EME currencies in response to CBI effects in Figure 9.

3.6 Effects on trade

The first row in Figure 10 reports that the US dollar real effective exchange rate (REER) appreciates in response to tightenings in all Fed policy measures. The responses are consistent with that of the AE and EME NEERs in Figure 9. The appreciation of the REER is somewhat muted in case of Fed forward guidance. In case of CBI effects the REER depreciates persistently after a delay, consistently with the response of the NEER against AEs in Figure

[16]For EMEs Kalemli-Özcan (2019) documents that short-term interest rates increase by more than in the US following a Fed tightening, implying a drop in the interest-rate differential vis-à-vis the US. At the same time, Kalemli-Özcan documents that risk premia increase by so much that they overcompensate the drop in the interest-rate differential vis-à-vis the US and cause EME currency depreciation. De Leo et al. (2022) provide similar evidence.

9.

The second and third row in Figure 10 show that real US exports and imports (deflated by US CPI) fall in tandem in response to changes in all Fed policy measures. The effect of forward guidance is somewhat muted, consistent with weaker expenditure switching effects given the limited appreciation of the REER in the first row.

The fourth row shows that RoW trade—including trade between non-US economies—also persistently drops following tightenings in all Fed policy measures. This last result is consistent with the pervasive use of the dollar as an invoicing currency in trade between non-US economies, as discussed in more detail in Section 3.7. In particular, as a result of the dollar's dominant role in trade invoicing, dollar appreciation reduces *global* imports, that is not only imports from the US (Gopinath et al., 2020). In contrast, when the dollar depreciates in response to Fed tightening due to a CBI effect global trade picks up, as shown in the last column.

Finally, the last row in Figure 10 shows that commodity prices as measured by the Commodity Research Bureau (CRB) index fall in response to Fed tightenings for all measures but rise following a CBI effect. Degasperi et al. (2020) provide a detailed analysis of the role of commodity prices for the transmission of Fed policy to the rest of the world.

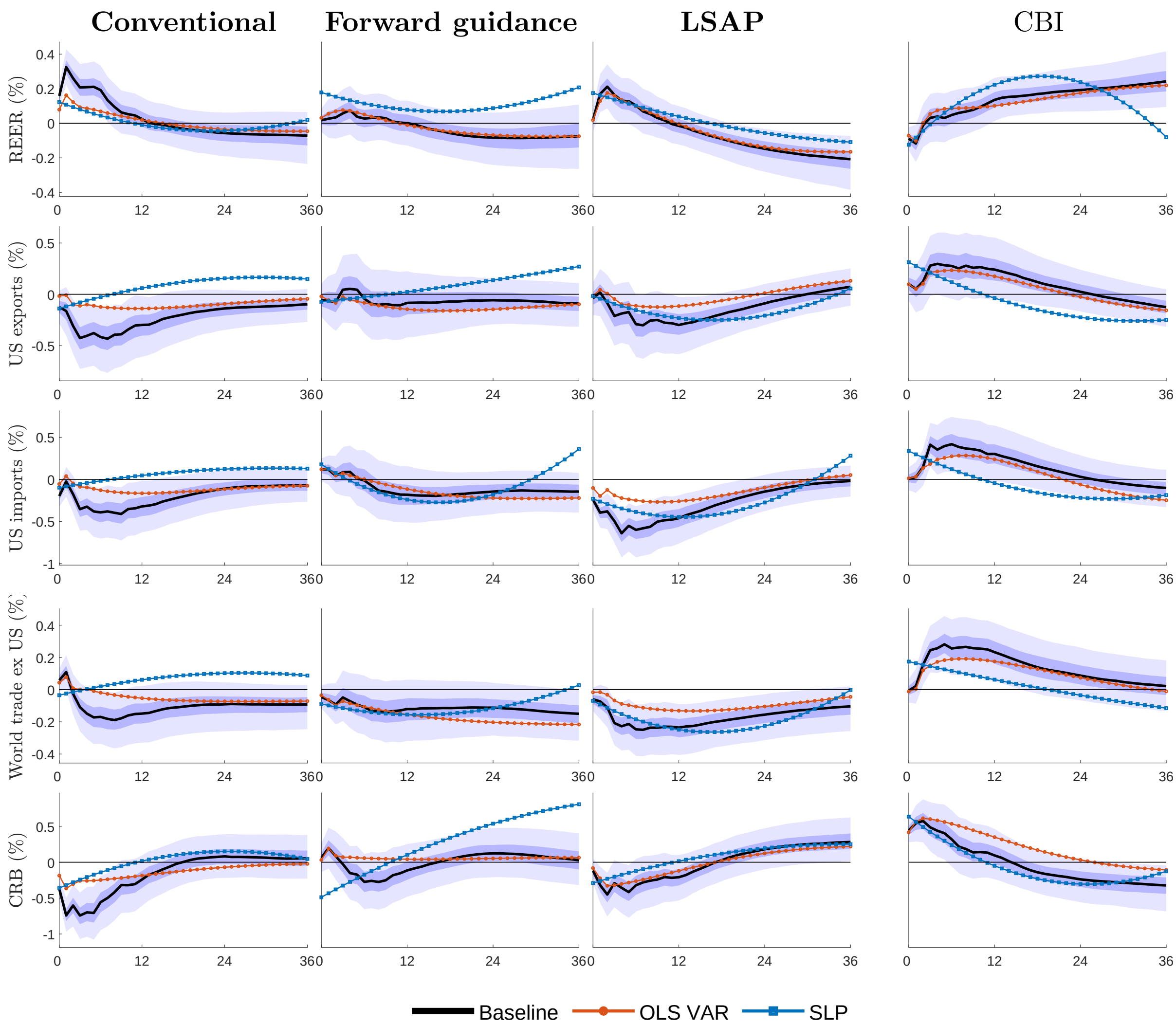
Our results so far are equally consistent with the notions that (i) a Fed tightening dampens investor risk appetite, which tightens financial conditions, which depresses real activity, and as a consequence causes a slowdown in trade, as well as (ii) a Fed tightening appreciates the dollar, contracts global trade, which depresses real activity, and as a consequence financial conditions tighten; of course intermediate combinations are also consistent with our findings, namely that spillovers occur both through trade and financial channels. We next evaluate the relative importance of trade and financial channels for output spillovers from Fed policy tightenings.

3.7 Trade or financial channels?

We first review conceptually how Fed policy may transmit to the RoW through trade and financial channels and then present our evidence for their relative role in the data. Then we present our result that trade and financial channels are about as important for the transmission of output spillovers for all Fed measures.

In theory, Fed policy affects RoW real activity through trade. First, dollar appreciation following a Fed tightening induces expenditure switching away from imports from the US to domestically produced goods in the RoW. All else equal, this bolsters RoW aggregate demand. Theory thus predicts that the effect of a Fed tightening on the RoW through expenditure switching in bilateral US-RoW trade is expansionary. Second, US-RoW trade is affected by a demand effect following a Fed tightening. For example, if the US and RoW economies slow down in response to a Fed tightening through other channels, demand for RoW exports falls, which is contractionary. Taken together, theory predicts that the effect

Figure 10: Effects of US monetary policy shocks on the dollar real effective exchange rate and US real exports and imports



Note: An increase in the dollar REER indicates an appreciation. See also the note to Figure 3.

of a Fed tightening through US trade could be either expansionary or contractionary for the RoW. Third, Fed policy may also transmit through non-US trade. In particular, as a large share of non-US trade is invoiced in US dollar (Boz et al., 2022), dollar appreciation raises prices even for imports from countries other than the US. This slows down global exports and hence real activity (Gopinath et al., 2020; Georgiadis and Schumann, 2021).[17]

In theory, US monetary policy affects RoW real activity also through financial channels (e.g. Avdjiev et al., 2019b; Jiang et al., 2023; Akinci and Queralto, 2024). First, as the US is the key supplier of global safe assets its monetary policy can have a direct effect on aggregate demand abroad: a Fed policy tightening increases global demand for US assets and thus directly reduces global aggregate demand. Second, exchange-rate valuation effects in cross-border assets and liabilities change the value of foreign-currency denominated collateral, and thereby borrowing and leverage. For example, when a firm borrows in foreign currency, currency depreciation tightens its borrowing constraint and reduces its borrowing capacity. Third, a Fed policy tightening depresses the value of domestic assets via a higher discount factor and lower expected cash flows. Some holders of these assets are leveraged investors, including financial intermediaries. The decline in asset values tightens their balance-sheet constraints and raises their borrowing costs. This domestic balance-sheet channel propagates across borders via asset-price equalization and the synchronization of credit spreads and borrowing costs of leveraged cross-border investors.

In order to shed light on the relative importance of trade and financial channels for the transmission of Fed policy to the RoW, we consider state-dependent panel LPs. This empirical framework allows us to explore to what extent Fed policy spillovers vary with economies' trade and financial exposure, respectively.

In order to benchmark the panel LP spillover estimates to those obtained from the baseline BVAR model and the SLPs estimated on aggregate RoW data in Section 3.2, in a first step we omit state-dependence and consider

$$y_{i,t+h} - y_{i,t-1} = \theta_i^{(n,h)} + \gamma^{(n,h)} u_{nt} + \sum_{\ell=1}^{p_y} \alpha_j^{(n,h)} y_{i,t-j} + \sum_{\ell=1}^{p_w} \boldsymbol{\beta}_j^{(n,h)\prime} \boldsymbol{w}_{t-j} + \epsilon_{it}^{(n,h)}, \tag{3}$$

where y_{it} is the logarithm of country i industrial production, $\boldsymbol{w}_t$ are controls, u_{nt} is either the conventional policy, forward guidance, or LSAP shock or CBI effect we also used in the BVAR model estimations in Equation (2), and h is the impulse-response horizon. We set $p_y = p_w = 1$ and include as controls the 1-year Treasury yield, the logarithms of US and RoW industrial production, and the US EBP of Gilchrist and Zakrajsek (2012). We consider data for 46 individual economies.[18] Depending on data availability at the country level, the

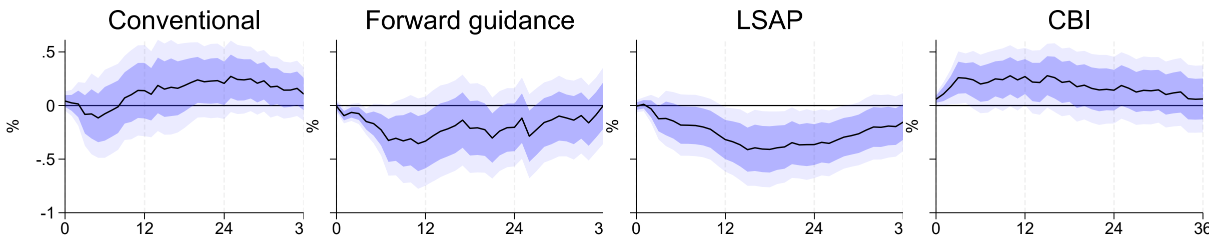
[17] Fed policy spillovers may furthermore materialize through amplification in intra-RoW global value chains. This amplification may be further exacerbated due to a rise in borrowing costs for dollar-denominated working capital and intermediate inputs as the dollar appreciates (Bruno and Shin, 2023; Akinci et al., 2024).

[18] These are: Argentina, Australia, Austria, Belgium, Bosnia & Herzegovina, Belarus, Brazil, Canada, Chile, Colombia, Czech Republic, Germany, Denmark, Egypt, Spain, Estonia, Finland, France, Greece, Croatia, Hun-

sample period is again July 1991 to June 2024.

Figure 11 presents the results for the panel LP estimation of Equation (3). The results are consistent with the results from the estimation of the BVARs model and SLPs on aggregate RoW data shown in Figure 3. In particular, real activity in non-US economies slows down in response to Fed forward guidance and LSAP tightenings, and it accelerates in response to Fed tightenings due to CBI effects. The effects are estimated to be of similar magnitude in absolute terms across forward guidance, LSAPs and CBI effects. For conventional policy tightenings we estimate a limited slowdown in real activity when using panel LPs, which, however, aligns with the counterintuitive SLP estimates based on aggregate RoW data in Figure 3 (blue squared line). Recall that the SLPs in Figure 3 are not our preferred estimator, but it is not straightforward to explore state-dependent impulse responses in BVAR models, while panel LPs are a natural framework for this purpose.

Figure 11: Effects of US monetary policy shocks on RoW industrial production from panel local projections



Note: We obtain the impulse responses from panel LP estimations. We estimate separate panel LPs for each shock. For inference we use Driscoll-Kraay standard errors robust to cross-section dependence and serial correlation.

Next we extend Equation (3) and introduce state-dependent panel LPs

$$\begin{aligned} y_{i,t+h} - y_{i,t-1} \quad = \quad & \left(\gamma^{(k,h)} + \phi^{(k,h)}_{finance} exposure^{finance}_{it} + \phi^{(k,h)}_{trade} exposure^{trade}_{it}\right) u_{kt} \\ & + \theta^{(k,h)}_i + \sum_{\ell=1}^{p} \alpha^{(k,h)}_j y_{i,t-j} + \sum_{\ell=1}^{p} \boldsymbol{\beta}^{(k,h)\prime}_j \boldsymbol{w}_{t-j} + \epsilon^{(k,h)}_{it}, \end{aligned} \tag{4}$$

where $exposure^{finance}_{it}$ and $exposure^{trade}_{it}$ denote indices that reflect an economy's financial and trade exposure, respectively, discussed below. The coefficients of interest are $\phi^{(k,h)}_{finance}$ and $\phi^{(k,h)}_{trade}$, as they indicate the effect of an economy's financial and trade exposure on the output spillovers from Fed policy.

To construct $exposure^{finance}_{it}$ we combine data on economies' stock of dollar-denominated portfolio equity, debt and other investment liabilities scaled by GDP, their net dollar exposure (defined as the difference between dollar denominated liabilities and assets scaled by the

gary, Indonesia, India, Israel, Italy, Jordan, Japan, Kazakhstan, South Korea, Lithuania, Latvia, Malaysia, Norway, Pakistan, Philippines, Poland, Portugal, Romania, Russia, Slovak Republic, Slovenia, Sweden, Thailand, Turkey, Ukraine, South Africa. The data are from national sources retrieved through Haver.

gross foreign asset and liability position), as well as the *de jure* capital account openness. For measurement we use data from Benetrix et al. (2015) and Chinn and Ito (2006). To aggregate these variables into the financial exposure index, we first standardize them, then take the unweighted average, linearly interpolate from annual to monthly frequency, and then smooth the resulting index using a Hodrick-Prescott filter. The last step reduces the risk that the Fed policy shocks affect the index and thereby jeopardize consistency of estimation of the state-dependent panel LPs (Goncalves et al., 2024).[19]

To construct $exposure_{it}^{trade}$ we combine data on economies' value-added exports taken from the United Nations EORA database described in Casella et al. (2019) scaled by nominal GDP taken from the World Bank World Development Indicators and the share of exports invoiced in US dollar taken from Boz et al. (2022). Using value-added exports instead of gross exports accounts for the important role of global value chains. In particular, a large part of economies' exports just represents re-exports of previously imported value added in terms of intermediate inputs produced elsewhere used in domestic production. Not accounting for such double-counting overstates the actual exposure of domestic production to Fed policy spillovers through trade channels. To aggregate these variables into a trade exposure index, we again first standardize them, take the unweighted average, linearly interpolate from annual to monthly frequency, and then smooth using a Hodrick-Prescott filter.[20]

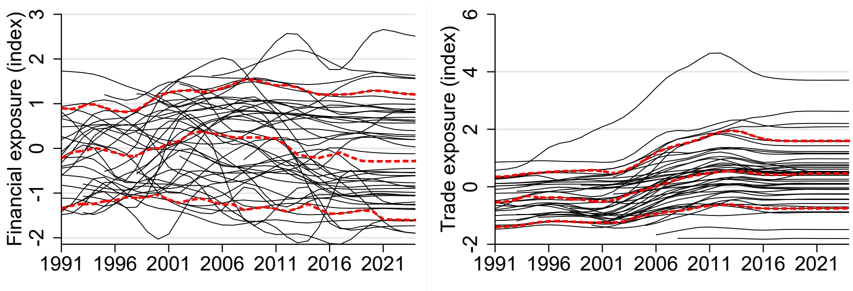
The black solid lines in the left-hand side panel in Figure 12 present the evolution of financial exposures at the country level over time; the red dashed lines indicate the evolution of the median as well as 10% and 90% percentiles of the cross-country distribution at a given point in time. Financial exposures as measured by $exposure_{it}^{finance}$ have overall not changed much over time. If anything, more recently they have somewhat declined, which is consistent with the notion that currency mismatches have been reduced especially in EMEs. Over the full sample period, the evidence on the evolution of financial exposures is in line with existing evidence on related vulnerabilities (Chitu and Quint, 2018; Kalemli-Özcan and Unsal, 2023).

The black solid lines in the right-hand side panel in Figure 12 present the evolution of trade exposures at the country level over time, and the red dashed lines again indicate the corresponding cross-country distribution. Trade exposures as measured by $exposure_{it}^{trade}$ rose systematically across countries until the GFC and have plateaued since then. This is consistent with the deepening in trade integration after China's accession to the World Trade Organization in the early 2000s and the rise of global value chains, as well as their stalling after the GFC. Overall, the evidence on the evolution of trade exposures is again in line with existing evidence (IMF, 2016).

[19] The data on dollar exposures are available until 2012; to the extent possible we update these using the data from Benetrix et al. (2020). The Chinn-Ito index is available until 2021. In order to estimate Equation (4) over July 1991 to June 2024, we assume the values of these variables do not change at the country level after the last year they are available.

[20] The data on value-added exports are available until 2018 and for export invoicing currency shares until 2019. In order to estimate Equation (4) over July 1991 to June 2024, we assume the values of these variables do not change at the country level after the last year they are available.

Figure 12: Evolution of the cross-country distribution of financial and trade exposure



Note: The panels display the evolution of the financial (left) and trade (right) indices at the country level. The red dashed lines indicate the cross-country median and 10/90% percentiles of the cross-country distribution in a given period.

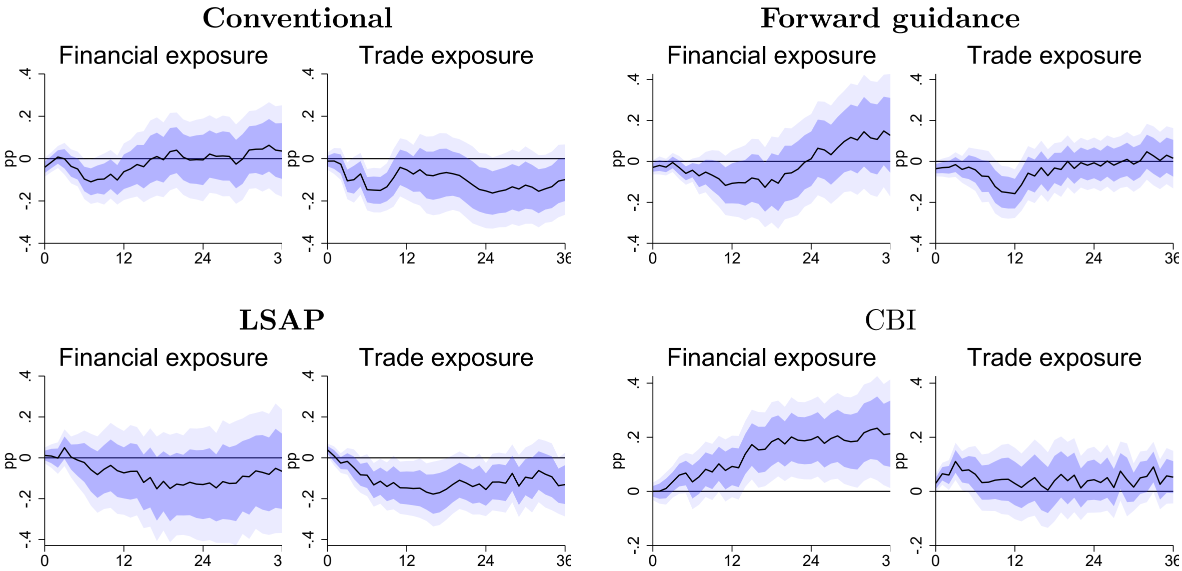
Figure 13 presents the results from the estimation of Equation (4). In each subplot, the left-hand side panel presents the coefficient estimates for $\phi^{(k,h)}_{finance}$, that is the additional output spillover from Fed policy measures for a country that exhibits a greater financial exposure according to $exposure^{finance}_{it}$ at response horizon h. As the indices are standardized, the coefficient estimates represent the percentage-point change in the output spillovers for a country with a one-standard-deviation larger exposure. The right-hand side panel in each subplot presents analogous results for trade exposure.

The results in the first three sub-panels of Figure 13 suggest that output spillovers from Fed policy tightenings are more contractionary the more economies are exposed to trade and financial channels as measured by $exposure^{trade}_{it}$ and $exposure^{finance}_{it}$. Quantitatively, the change in the output spillovers is rather similar across trade and financial exposure, in the sense that a one-standard-deviation stronger trade exposure increases the spillovers about as much as a one-standard-deviation stronger financial exposure. We interpret this results as indicating that trade and financial channels are approximately equally important for the transmission of Fed policy to real activity in the RoW.

In contrast, the results in the last sub-panel suggest that spillovers from Fed tightenings due to CBI effects vary much more with economies' financial than with their trade exposure. This is consistent with the notion that Fed tightenings due to CBI effects are primarily risk-on shocks discussed in Sections 3.3 and 3.4.

Figure 14 provides results for estimations in which the financial and trade exposure indices are constructed differently. In particular, we consider six variations of the financial exposure index: We (i) do not extrapolate the component variable values so as to span until 2024; (ii) do not use the net dollar exposure as component variable; (iii) use only one *de facto* measure of financial integration (gross foreign asset and liability position scaled by GDP) and one *de jure* measure of financial openness (Chinn-Ito index); (iv) add the share of portfolio debt on total foreign liabilities as component variable; (v) use the capital controls index of Fernández et al. (2016) instead of the Chinn-Ito index; (vi) add domestic credit to GDP as component

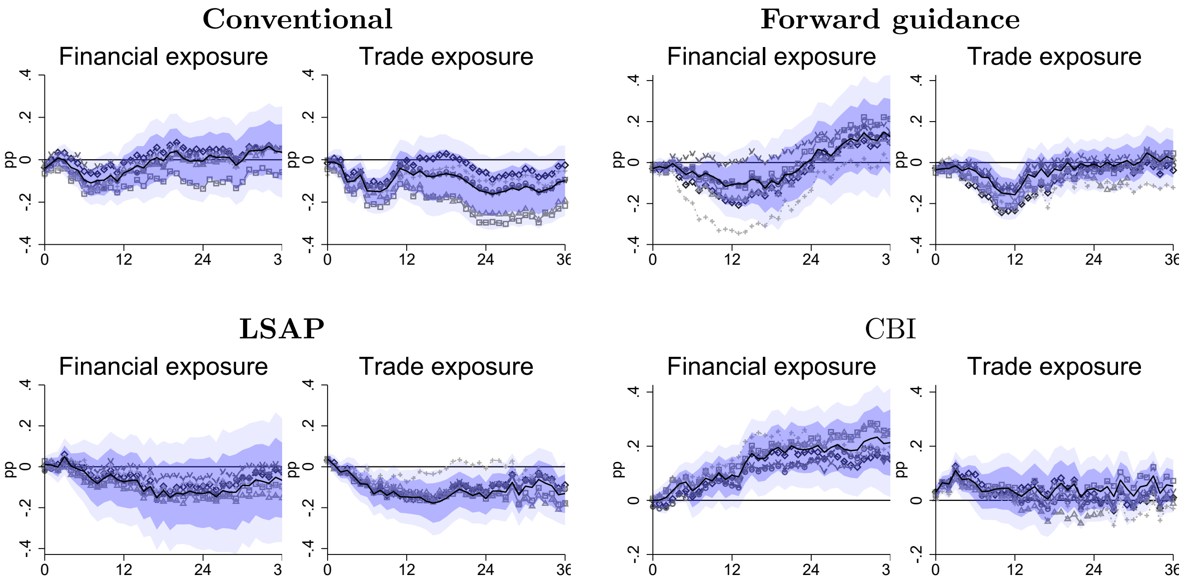
Figure 13: The role of financial and trade exposure for effects of US monetary policy shocks on RoW industrial production



Note: In each subplot, the left-hand side panel presents the coefficient estimates for $\phi^{(k,h)}_{finance}$, that is the additional output spillover from Fed policy measures for a country that exhibits a greater financial exposure according to $exposure^{finance}_{it}$ at response horizon h. As the indices are standardized, the coefficient estimates represent the percentage-point change in the output spillovers for a country with a one-standard-deviation higher than average exposure. The right-hand side panel in each subplot presents analogous results for trade exposure. See also the note to Figure 11.

variable. Analogously, we consider one variation of the trade exposure index: We do not extrapolate the component variable values so as to span until 2024. In sum, we estimate Equation (4) for seven alternative specifications of the exposure indices. Overall, the results regarding the relative role of trade and financial exposure for Fed policy spillovers to real activity in the RoW are similar to the baseline.

Figure 14: Robustness checks for the role of financial and trade exposure for effects of US monetary policy shocks on RoW industrial production



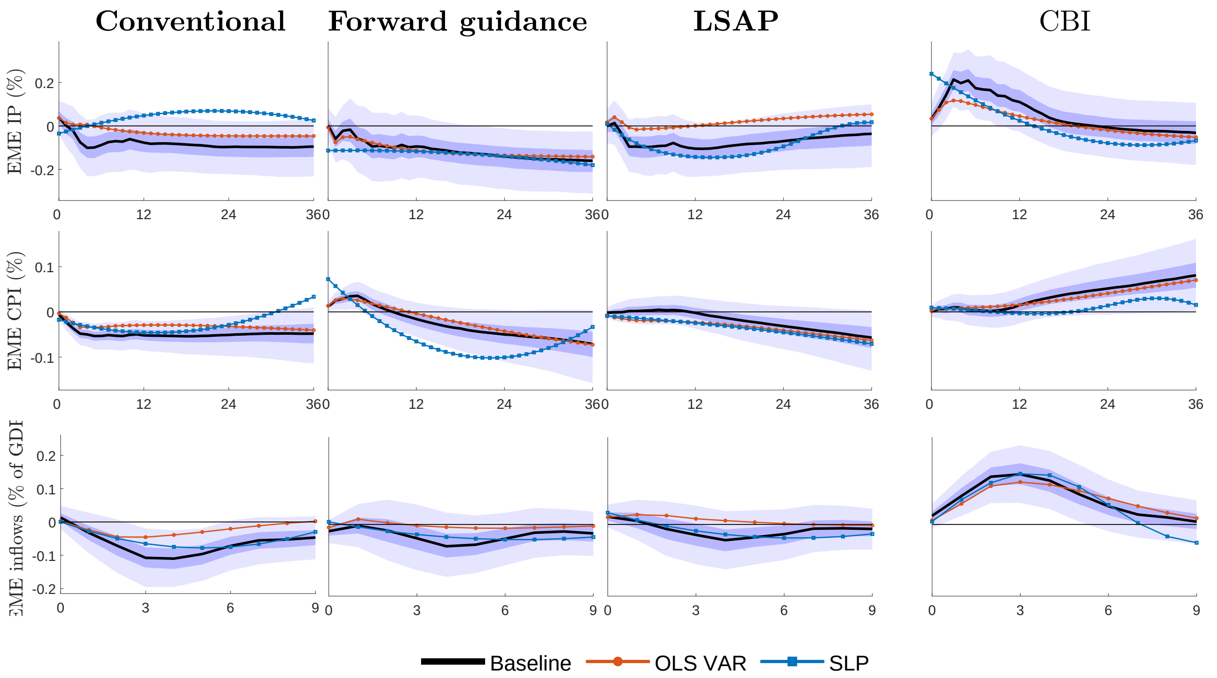
Note: In each subplot, the left-hand side panel presents the coefficient estimates for the percentage-point change in the output spillover from Fed policy measures for a country that exhibits a greater financial exposure at response horizon h. The black solid depicts results for the baseline, and the remaining lines for alternative specifications of the trade and financial exposure indices (diamond: no extrapolation for exposure$_{it}^{finance}$; crossed: no net dollar exposure; circle: single de facto and de jure measure; V: share of portfolio debt added; square: capital controls index; triangle: domestic credit/GDP added; +: no extrapolation for exposure$_{it}^{trade}$). See also the note to Figure 13.

4 Monetary policy trade-offs in EMEs

EME policymakers have repeatedly argued for more international monetary policy coordination in the sense that the Fed should internalize the spillovers it emits to the RoW even beyond associated spillbacks (Rajan, 2013, 2016). However, Fed policy spillovers do not necessarily reduce welfare in EMEs. In order for spillovers to be a negative externality for EMEs, they would have to induce policy trade-offs (for an overview see Engel, 2016). We next document that tightenings across all Fed policy measures entail trade-offs for EME monetary policy.

We explore two types of potential trade-offs for EME central banks conditional on changes in Fed policy: (i) between output and price stabilization; (ii) between macroeconomic stabilization in terms of real activity and consumer prices on the one hand and preserving financial stability in terms of capital inflows on the other hand.

Figure 15: Effects of US monetary policy shocks on EME variables



Note: See the note to Figure 3.

Figure 15 presents the effects of Fed policy on EME real activity, consumer prices as well as portfolio and other investment inflows. The first two rows inform about trade-offs between output and prices, and all three rows together about trade-offs between macroeconomic stabilization and preserving financial stability.

The results in Figure 15 show that EME output and consumer prices both fall in response to conventional policy, forward guidance and LSAP tightenings, and that they both rise in response to Fed tightenings due to CBI effects. As output and prices move in the same direction, no monetary policy trade-offs in terms of stabilizing output or prices emerges in EMEs conditional on Fed policy tightenings. This finding is noteworthy as EMEs tend to exhibit large degrees of US dollar invoicing of imports, which—all else equal—implies upward pressures on import and hence consumer prices in response to a local exchange rate depreciation. Our results suggest that if such a mechanism is present in the data, it is overcompensated by a fall in marginal costs due to the slowdown in real activity.

The last row in Figure 15 shows that EME inflows fall in response to conventional policy, forward guidance and LSAP tightenings, and that they rise in response to Fed tightenings due to CBI effects. Thus, while our results suggest Fed policy does not entail a trade-off for EME monetary policy between stabilizing output or prices, it does entail a trade-off between macroeconomic stabilization and preserving financial stability: If EME monetary policy were to loosen in order to dampen the contractionary effects on real activity and consumer prices, this might discourage foreign investors and exacerbate the drop in EME inflows.

We conclude that spillovers from Fed tightenings give rise to trade-offs for EME monetary policy regardless of the measure in question or whether it is due to CBI effects. It should be clear that given we consider aggregates for a broad range of countries our findings do not imply trade-offs exist uniformly across all EMEs. In fact, the incidence of trade-offs is likely to vary with open-economy characteristics such as the exchange rate regime, financial openness or macro-financial vulnerabilities (for an analysis see for example Degasperi et al., 2020; Ahmed et al., 2021).

5 Conclusion

We examine global spillovers from conventional and unconventional policy measures in the Fed's toolkit while accounting for the possible presence of residual endogenous monetary policy components in high-frequency asset-price surprises used for identification. We contribute several findings to the literature: (i) Fed conventional policy, forward guidance and LSAPs all trigger large spillovers; (ii) spillovers transmit about as much through trade as through financial channels; (iii) LSAPs trigger immediate international portfolio re-balancing between US and foreign bonds that are relatively close substitutes to US Treasury securities, but generally entail only limited term premium spillovers; (iv) all Fed policy measures entail trade-offs for emerging-market monetary policy between stabilizing output and prices on the one hand and ensuring financial stability in terms of capital inflows on the other hand.

References

Adrian, T., Crump, R., Moench, E., 2013. Pricing the Term Structure with Linear Regressions. Journal of Financial Economics 110 (1), 110–138.

Ahmed, S., Akinci, O., Queralto, A., 2021. U.S. Monetary Policy Spillovers to Emerging Markets: Both Shocks and Vulnerabilities Matter. Federal Reserve Bank of New York Staff Report 972.

Akinci, O., Benigno, G., Pelin, S., Turek, J., 2024. The Dollar's Imperial Circle. IMF Economic Review 72 (2), 653–700.

Akinci, O., Queralto, A., 2024. Exchange Rate Dynamics and Monetary Spillovers with Imperfect Financial Markets. Review of Financial Studies 37 (2), 309–355.

Alpanda, S., Kabaca, S., 2020. International Spillovers of Large-Scale Asset Purchases. Journal of the European Economic Association 18 (1), 342–391.

Arteta, C., Kamin, S., Ruch, F., 2022. How Do Rising U.S. Interest Rates Affect Emerging and Developing Economies? It Depends. Policy Research Working Paper 10258.

Avdjiev, S., Bruno, V., Koch, C., Shin, H.-S., 2019a. The Dollar Exchange Rate as a Global Risk Factor: Evidence from Investment. IMF Economic Review 67 (1), 151–173.

Avdjiev, S., Du, W., Koch, C., Shin, H.-S., 2019b. The Dollar, Bank Leverage, and Deviations from Covered Interest Parity. American Economic Review: Insights 1 (2), 193–208.

Barnichon, R., Brownlees, C., 2019. Impulse Response Estimation by Smooth Local Projections. Review of Economics and Statistics 101 (3), 522–530.

Baumeister, C., Benati, L., 2013. Unconventional Monetary Policy and the Great Recession: Estimating the Macroeconomic Effects of a Spread Compression at the Zero Lower Bound. International Journal of Central Banking 9 (2), 165–212.

Bekaert, G., Engstrom, E., Xu, N. R., 2021. The Time Variation in Risk Appetite and Uncertainty. Management Science 68 (6), 3975–4004.

Benetrix, A., Juvenal, L., Schmitz, M., Gautam, D., 2020. Cross-border Currency Exposures: New Evidence Based on an Enhanced and Updated Dataset. ECB Working Paper 2417.

Benetrix, A. S., Lane, P. R., Shambaugh, J. C., 2015. International Currency Exposures, Valuation Effects and the Global Financial Crisis. Journal of International Economics 96, S98–S109.

Bertaut, C., Bressler, B., Curcuru, S., 2019. Globalization and the Geography of Capital Flows. FEDS Note September.

Bertaut, C., Judson, R., 2014. Estimating U.S. Cross-Border Securities Positions: New Data and New Methods. International Finance Discussion Paper 1113.

Bertaut, C., Judson, R., 2022. Estimating U.S. Cross-Border Securities Flows: Ten Years of the TIC SLT. FEDS Note February.

Bertaut, C., Tryon, R., 2007. Monthly Estimates of U.S. Cross-border Securities Positions. International Finance Discussion Paper 910.

Bhattarai, S., Chatterjee, A., Park, W., 2021. Effects of US Quantitative Easing on Emerging Market Economies. Journal of Economics Dynamics and Control 122.

Bhattarai, S., Neely, C., 2022. An Analysis of the Literature on International Unconventional Monetary Policy. Journal of Economic Literature 60 (2), 527–97.

Böck, M., Mori, L., forthcoming. Has Globalization Changed the International Transmission of US Monetary Policy? Journal of International Economics.

Boz, E., Casas, C., Georgiadis, G., Gopinath, G., Le Mezo, H., Mehl, A., Nguyen, T., 2022. Invoicing Currency Patterns in Global Trade: New Evidence. Journal of International Economics 136.

Bruno, V., Shin, H.-S., 2023. Dollar and Exports. Review of Financial Studies 36 (8), 2963–2996.

Bräuning, F., Sheremirov, V., 2019. Output Spillovers from U.S. Monetary Policy: The Role of International Trade and Financial Linkages. Federal Reserve Bank of Boston Working Paper 19-15.

Camara, S., forthcoming. Spillovers of US Interest Rates: Monetary Policy & Information Effects. Journal of International Economics.

Campbell, J., Evans, C., Fisher, J., Justiniano, A., 2012. Macroeconomic Effects of Federal Reserve Forward Guidance. Brookings Papers on Economic Activity 43 (1), 1–80.

Casella, B., Bolwijn, R., Moran, D., Kanemoto, K., 2019. Improving the analysis of global value chains: the UNCTAD-Eora Database. Transnational Corporations 26 (3).

Cesa-Bianchi, A., Sokol, A., 2022. Financial shocks, credit spreads, and the international credit channel. Journal of International Economics 135, 103543.

Chari, A., Stedman, K. D., Lundblad, C., Karolyi, A., 2021. Taper Tantrums: Quantitative Easing, Its Aftermath, and Emerging Market Capital Flows. Review of Financial Studies 34 (3), 1445–1508.

Chinn, M., Ito, H., 2006. What Matters for Financial Development? Capital Controls, Institutions, and Interactions. Journal of Development Economics 81 (1), 163–192.

Chitu, L., Quint, D., 2018. Emerging Market Vulnerabilities – A Comparison with Previous Crises. ECB Economic Bulletin 8.

Ciminelli, G., Rogers, J., Wu, W., 2022. The Effects of U.S. Monetary Policy on International Mutual Fund Investment. Journal of International Money and Finance 127.

Cristi, J., Kalemli-Özcan, S., Sans, M., Unsal, F., 2024. Global Spillovers from FED Hikes and a Strong Dollar: The Risk Channel. AEA Papers and Proceedings 2024 114, 157–162.

Curcuru, S., De Pooter, M., Eckerd, G., 2018. Measuring Monetary Policy Spillovers between U.S. and German Bond Yields. International Finance Discussion Paper 1226.

Curcuru, S., Kamin, S., Li, C., del Giudice Rodriguez, M., 2023. International Spillovers of Monetary Policy: Conventional Policy vs. Quantitative Easing. International Journal of Central Banking 77 (3).

Dahlhaus, T., Vasishtha, G., 2020. Monetary Policy News in the US: Effects on Emerging Market Capital Flows. Journal of International Money and Finance 109 (C).

D'Amico, S., Kim, D., Wei, M., 2018. Tips from TIPS: The Informational Content of Treasury Inflation-Protected Security Prices. Journal of Financial and Quantitative Analysis 53 (1), 395–436.

De Leo, P., Gopinath, G., ebnem Kalemli-Özcan, 2022. Monetary Policy and the Short-Rate Disconnect in Emerging Economies 30458.

Dedola, L., Rivolta, G., Stracca, L., 2017. When the Fed Sneezes, Who Gets a Cold? Journal of International Economics S1 (108), S23–S41.

Dees, S., Galesi, A., 2021. The Global Financial Cycle and US Monetary Policy in an Interconnected World. Journal of International Money and Finance 115.

Degasperi, R., Hong, S., Ricco, G., 2020. The Global Transmission of US Monetary Policy. Warwick Economics Research Paper Series 1257.

Diebold, F., Rudebusch, G., Boragan Aruoba, S., 2006. The Macroeconomy and the Yield Curve: A Dynamic Latent Factor Approach. Journal of Econometrics 131 (1-2), 309–338.

Engel, C., 2016. International Coordination of Central Bank Policy. Journal of International Money and Finance 67 (C), 13–24.

Favara, G., Gilchrist, S., Lewis, K., Zakrajsek, E., 2016. Updating the Recession Risk and the Excess Bond Premium. FEDS Note October.

Fernández, A., Klein, M. W., Rebucci, A., Schindler, M., Uribe, M., 2016. Capital Control Measures: A New Dataset. IMF Economic Review 64 (3), 548–574.

Gai, P., Tong, E., 2022. Information Spillovers of US Monetary Policy. Journal of Macroeconomics 72 (C).

Gambacorta, L., Hofmann, B., Peersman, G., 2014. The Effectiveness of Unconventional Monetary Policy at the Zero Lower Bound: A Cross-Country Analysis. Journal of Money, Credit and Banking 46 (4), 615–642.

Georgiadis, G., 2016. Determinants of Global Spillovers from US Monetary Policy. Journal of International Money and Finance 67, 41–61.

Georgiadis, G., Jarociński, M., 2023. Global Spillovers from Multi-dimensional US Monetary Policy. ECB Working Paper 2881.

Georgiadis, G., Müller, G., Schumann, B., 2023. Dollar Trinity and the Global Financial Cycle. CEPR Discussion Paper 18427.

Georgiadis, G., Schumann, B., 2021. Dominant-currency Pricing and the Global Output Spillovers from US Dollar Appreciation. Journal of International Economics 133.

Gilchrist, S., Zakrajsek, E., 2012. Credit Spreads and Business Cycle Fluctuations. American Economic Review 102 (4), 1692–1720.

Goncalves, S., Herrera, A., Kilian, L., Pesavento, E., 2024. State-dependent local projections. Journal of Econometrics.

Gopinath, G., Boz, E., Casas, C., Diez, F., Gourinchas, P.-O., Plagborg-Moller, M., 2020. Dominant Currency Paradigm. American Economic Review 110 (3), 677–719.

Gourinchas, P.-O., Ray, W., Vayanos, D., 2022. A Preferred-Habitat Model of Term Premia, Exchange Rates, and Monetary Policy Spillovers. CEPR Discussion Paper 17119.

Greenwood, R., Hanson, S., Stein, J., Sunderam, A., 2023. A Quantity-driven Theory of Term Premia and Exchange Rates. Quarterly Journal of Economics 138 (4), 2327–2389.

Grossman, V., Mack, A., García, E. M., 2013. Database of Global Economic Indicators (DGEI): A Methodological Note. Federal Reserve Bank of Dallas Globalization Institute Working Paper 166.

Grossman, V., Mack, A., Martinez-Garcia, E., 2014. A New Database of Global Economic Indicators. Journal of Economic and Social Measurement (3), 163–197.

Gürkaynak, R., Sack, B., Swanson, E., 2005. The Sensitivity of Long-term Interest Rates to Economic News: Evidence and Implications for Macroeconomic Models. American Economic Review 95 (1), 425–436.

Hofmann, B., Park, T., December 2024. The Broad Dollar Exchange Rate as an EME Risk Factor. BIS Quarterly Review.

Hofmann, B., Shim, I., Shin, H.-S., 2020. Bond Risk Premia and the Exchange Rate. Journal of Money, Credit and Banking 52 (S2), 497–520.

Iacoviello, M., Navarro, G., 2019. Foreign Effects of Higher US Interest Rates. Journal of International Money and Finance 95, 232–250.

IMF, October 2016. World Economic Outlook.

IMF, 2020. Toward an Integrated Policy Framework. IMF Policy Paper 2020/046.

Jarociński, M., Karadi, P., 2025a. Disentangling Monetary Policy, Central Bank Information, and Fed Response to News Shocks. CEPR Discussion Paper 19923.

Jarociński, M., Karadi, P., 2025b. The Macroeconomic Effects of the Fed's Unconventional Policy Shocks. manuscript.

Jarociński, M., 2022. Central Bank Information Effects and Transatlantic Spillovers. Journal of International Economics 139 (C).

Jarociński, M., 2024. Estimating the Fed's Unconventional Policy Shocks. Journal of Monetary Economics 144.

Jiang, Z., Krishnamurthy, A., Lustig, H., 2023. Dollar Safety and the Global Financial Cycle. Review of Economic Studies.

Kalemli-Özcan, S., 2019. U.S. Monetary Policy and International Risk Spillovers. Proceedings of the Jackson Hole Symposium.

Kalemli-Özcan, S., Unsal, F., 2023. Global Transmission of FED Hikes: The Role of Policy Credibility and Balance Sheets. Brookings Papers on Economic Activity, 169–225.

Kearns, J., Schrimpf, P., Xia, D., 2023. Explaining Monetary Spillovers: The Matrix Reloaded. Journal of Money, Credit and Banking 5 (6), 1535–1568.

Kolasa, M., Wesołowski, G., 2020. International Spillovers of Quantitative Easing. Journal of International Economics 126 (C).

Krishnamurthy, A., 2022. QE: What Have We Learned? Presentation at the Princeton Online Seminar, Markus' Academy, March 24, 2022, Stanford University GSB.

Kroencke, T., Schmeling, M., Schrimpf, A., 2021. The FOMC Risk Shift. Journal of Monetary Economics 120 (C), 21–39.

Li, D., Plagborg-Moller, M., Wolf, C., 2024. Local Projections vs. VARs: Lessons From Thousands of DGPs. Journal of Econometrics.

Lunsford, K., 2020. Policy Language and Information Effects in the Early Days of Federal Reserve Forward Guidance. American Economic Review 110 (9), 2899–2934.

Miranda-Agrippino, S., Nenova, T., 2022. A Tale of Two Global Monetary Policies. Journal of International Economics 136.

Miranda-Agrippino, S., Nenova, T., Rey, H., 2020. Global Footprints of Monetary Policy. CEPR Discussion Paper 13853.

Miranda-Agrippino, S., Rey, H., 2020a. The Global Financial Cycle after Lehman. AEA Papers and Proceedings 110, 523–528.

Miranda-Agrippino, S., Rey, H., 2020b. U.S. Monetary Policy and the Global Financial Cycle. Review of Economic Studies 87 (6), 2754–2776.

Nakamura, E., Steinsson, J., 2018. High-Frequency Identification of Monetary Non-Neutrality: The Information Effect. Quarterly Journal of Economics 133 (3), 1283–1330.

Panetta, F., 2021. Monetary Autonomy in a Globalised World. Welcome address at the 2021 joint BIS, BoE, ECB and IMF "Conference on "Spillovers in a "Post-pandemic, Low-for-long World".

Pinchetti, M., Szczepaniak, A., 2024. Global Spillovers of the Fed Information Effect. IMF Economic Review 72 (2), 773–819.

Plagborg-Møller, M., Wolf, C., 2021. Local Projections and VARs Estimate the Same Impulse Responses. Econometrica 89 (2), 955–980.

Rajan, R., 2013. A Step in the Dark: Unconventional Monetary Policy After the Crisis. BIS Andrew Crockett Memorial Lecture, 23 June 2013.

Rajan, R., 2016. Towards Rules of the Monetary Game. Speech at the IMF/Government of India Conference on "Advancing Asia: Investing for the Future", New Delhi, 12 March.

Reis, R., McMahon, M., Ellison, M., Ilzetzki, E., Den Haan, W., 2016. The Future Role of Unconventional Monetary Policy: CFM Survey Results. VoxEU Column May.

Rigobon, R., 2003. Identification Through Heteroskedasticity. Review of Economics and Statistics 85 (4), 777–792.

Rogers, J., Scotti, C., Wright, J., 2018. Unconventional Monetary Policy and International Risk Premia. Journal of Money, Credit and Banking 50 (8), 1827–1850.

Romer, D. H., Romer, C. D., June 2000. Federal Reserve Information and the Behavior of Interest Rates. American Economic Review 90 (3), 429–457.

Swanson, E., forthcoming. The Macroeconomic Effects of the Federal Reserve's Conventional and Unconventional Monetary Policies. IMF Economic Review.

Swanson, E., Jayawickrema, V., 2023. Speeches by the Fed Chair Are More Important than FOMC Announcenments: An Improved High-Frequency Measure of U.S. Monetary Policy Shocks. manuscript.

Tabova, A., Warnock, F., 2021. Foreign Investors and US Treasuries. NBER Working Paper 29313.

Tillmann, P., 2016. Unconventional Monetary Policy and the Spillovers to Emerging Markets. Journal of International Money and Finance 66 (C), 136–156.

Uribe, M., 2022. The Neo-Fisher Effect: Econometric Evidence from Empirical and Optimizing Models. American Economic Journal: Macroeconomics 14 (3), 133–162.

Weale, M., Wieladek, T., 2016. What Are the Macroeconomic Effects of Asset Purchases? Journal of Monetary Economics 79 (C), 81–93.

A Additional tables

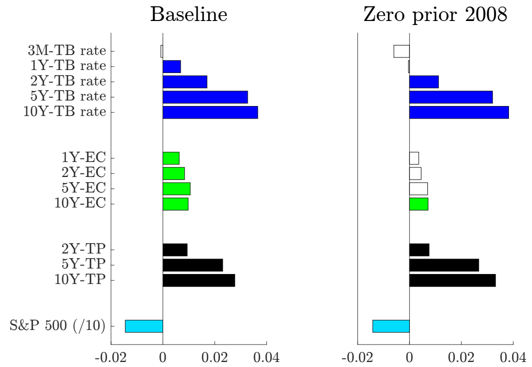
Table A.1: Data description for daily time series

Variable	Description	Source	Coverage
Federal funds rate	Effective Federal funds rate	Federal Reserve Board/Haver	1/1/1990 - 31/12/2019
Treasury yields	Treasury Bill/Note yields, constant maturity	Federal Reserve Board/Haver	1/1/1990 - 31/12/2019
Treasury expectations components	Risk-neutral yield	Adrian et al. (2013), Haver	1/1/1990 - 31/12/2019
Treasury term premia	Term premium	Adrian et al. (2013), Haver	1/1/1990 - 31/12/2019
S&P 500	S&P 500 Composite	S&P/Haver	1/1/1990 - 31/12/2019
US dollar NEERs	Nominal broad/AFE/EME trade-weighted dollar index	Federal Reserve Board/Haver	1/1/1990 - 31/12/2019
Germany 10Y yield	10Y government bold yield	Refinitiv/Haver	10/1/1994 - 31/12/2019
UK 10Y yield	10Y government securities Par yield	Bank of England/Haver	1/1/1990 - 31/12/2019
Sweden 10Y yield	10Y government securities yield	Sveriges Riksbank/Haver	1/1/1990 - 31/12/2019
Canada 10Y yield	10Y benchmark bond yield	Bank of Canada/Haver	1/1/1990 - 31/12/2019
Japan 10Y yield	10Y benchmark government bond yield	Ministry of Finance/Haver	1/1/1990 - 31/12/2019
Australia 10Y yield	10Y Treasury bond	Reserve Bank of Australia/Haver	1/1/1990 - 31/12/2019
Non-US 10Y expectations components	Dynamic-Siegel model decomposition	ECB calculations	4/9/1990 - 31/12/2019
Non-US 10Y term premia	Dynamic-Siegel model decomposition	ECB calculations	4/9/1990 - 31/12/2019
Germany equity prices	Frankfurt Xetra DAX	Deutsche Boerse/Haver	1/1/1990 - 31/12/2019
UK equity prices	London Financial Times All share	Financial Times/Haver	1/1/1990 - 31/12/2019
Sweden equity prices	Stockholm Affersvalden	OMX Nordic Exchange/Haver	1/1/1990 - 31/12/2019
Canada equity prices	S&P TSX Composite Index	Toronto Stock Exchange/Haver	1/1/1990 - 31/12/2019
Japan equity prices	Nikkei 225 Average	Financial Times/Haver	1/1/1990 - 31/12/2019
Australia equity prices	Stock Price Index All Ordinaries	S&P/Haver	1/1/1990 - 31/12/2019

Notes: The table provides information on the daily data used in the estimations.

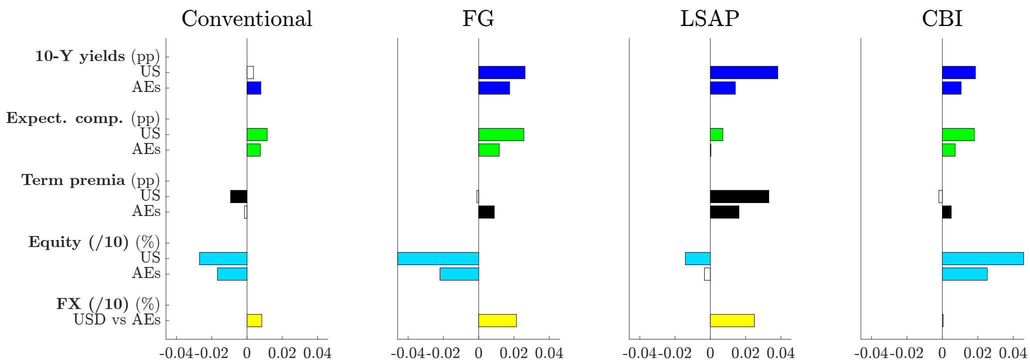
B Additional figures

Figure B.1: Robustness for daily US financial market impact effects of the LSAP shocks



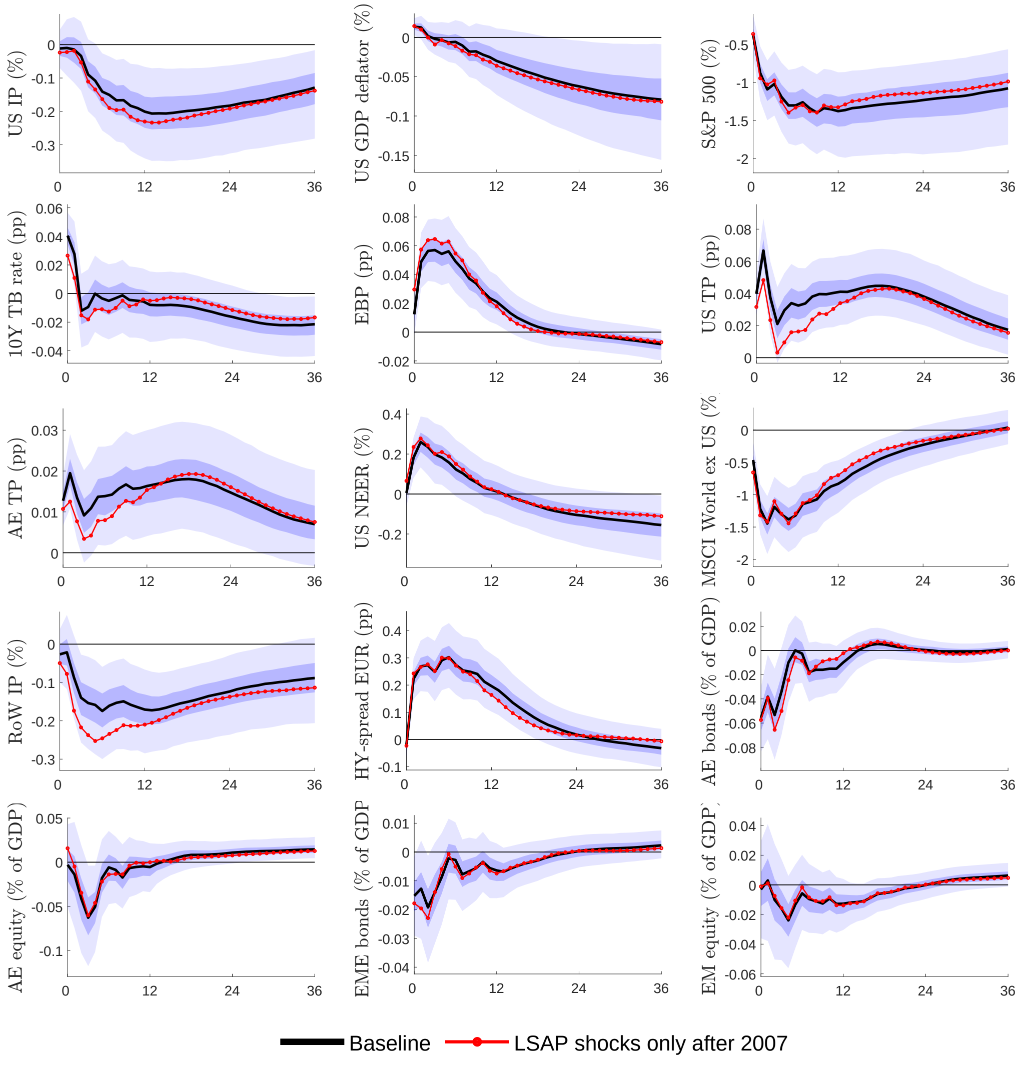
Note: The left panel depicts the baseline results from Figure 1 and the right panel those from an alternative specification in which LSAP shocks are set to zero prior to 2008. See also the notes to Figure 1.

Figure B.2: Daily impact effects on global interest rates, stock prices and exchange rates (using post-GFC LSAP shocks)



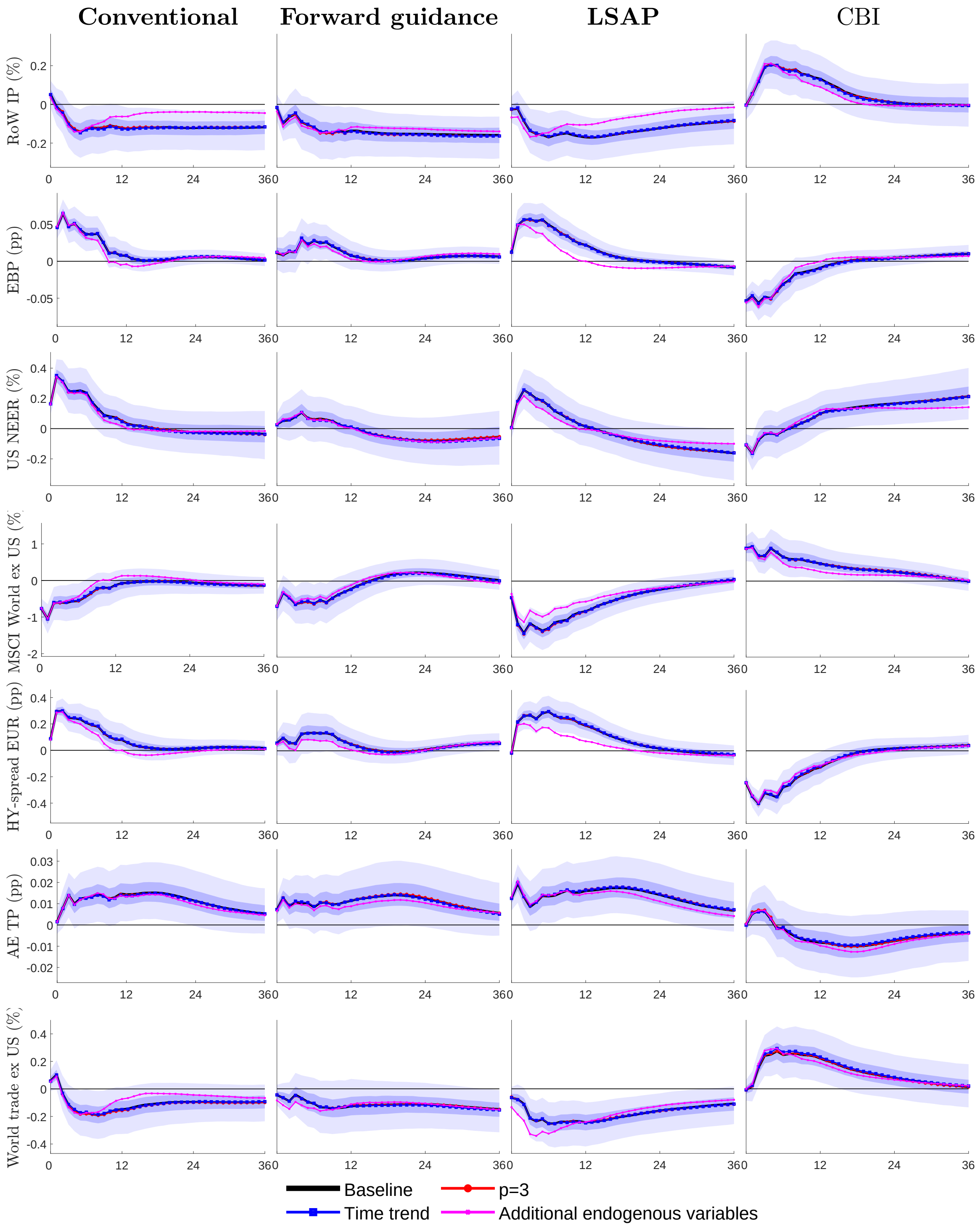
Note: The figure shows results from estimations in which the LSAP shocks are set to zero before 2008. See also the notes to Figure 2.

Figure B.3: Robustness of LSAP effects



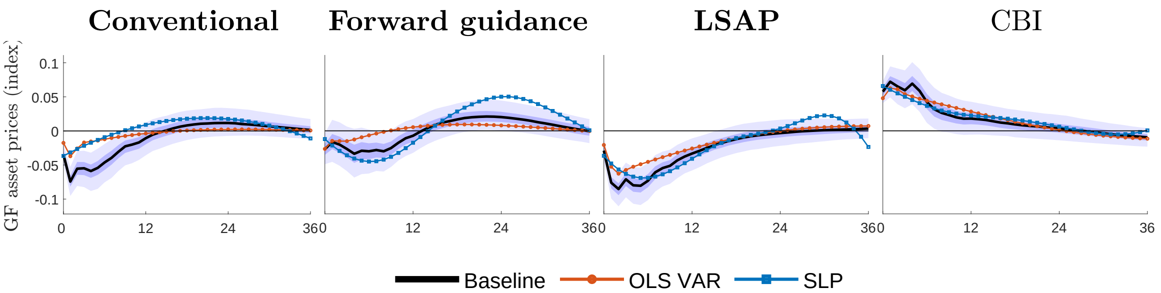
Note: The red circled line depicts results from estimations in which the LSAP shocks are set to zero before 2008. See also the notes to Figure 3.

Figure B.4: Effects of US monetary policy shocks estimated for alternative BVAR specifications



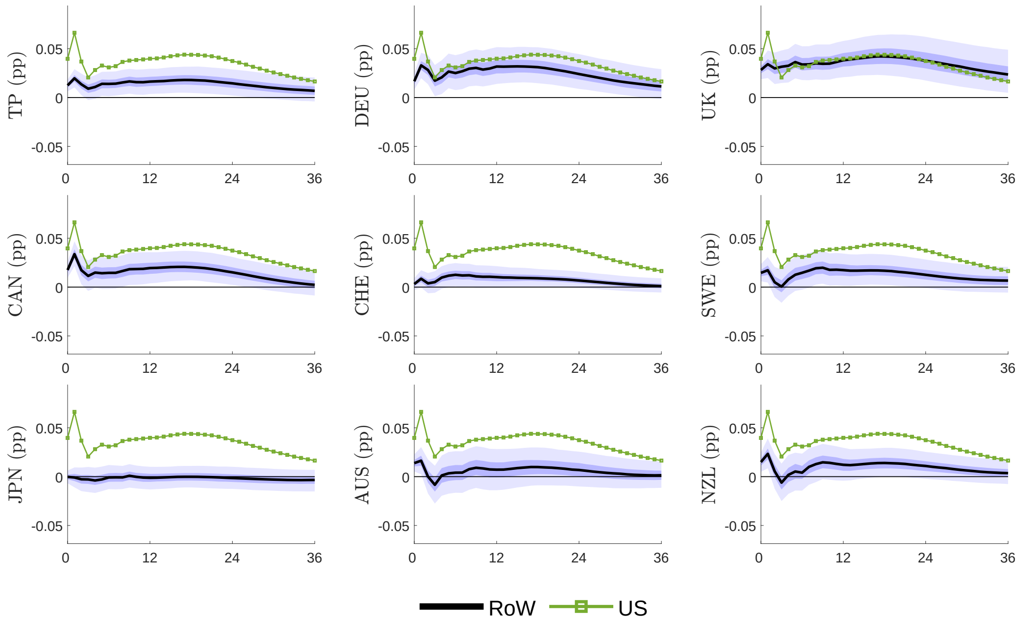
Note: See the notes to Figure 3.

Figure B.5: Effects of US monetary policy on global factor in risky asset prices



Note: See the notes to Figure 3.

Figure B.6: Effects of LSAP shocks on US and AE term premia



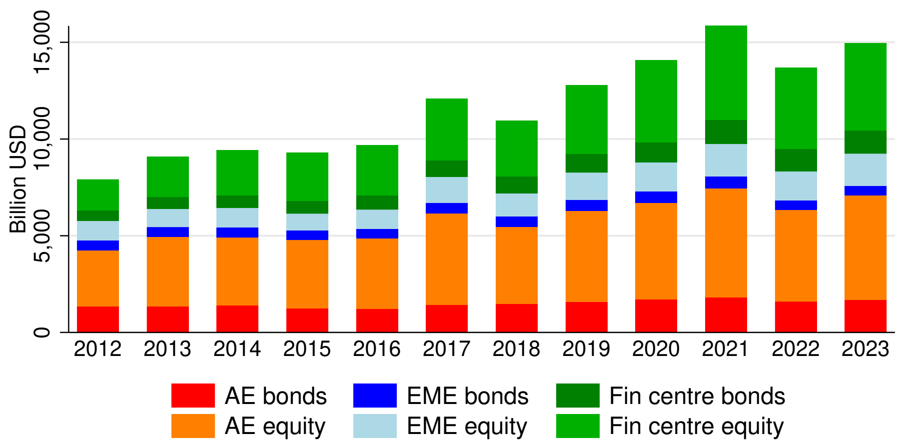
Note: The term premia refer to 10-year bonds and are taken from the estimation of the models of D'Amico et al. (2018) and Diebold et al. (2006). The AE term premium is calculated as a GDP-weighted average across Japan, Germany, Switzerland, the UK, Australia, Sweden, Canada and New Zealand. See also the notes to Figure 3.

Table A.2: Data description for monthly time series

Variable	Description	Source	Coverage
US real GDP	IHS Markit's monthly GDP (SAAR, bil. chnd. 2012 US$)	Macroeconomic Advisors/Haver	1992m1 - 2024m6
US nominal GDP	S&P Global US monthly nominal GDP (saar)	S&P/Haver	1992m1 - 2024m6
US CPI	US consumer price index (sa)	BLS/Haver	1991m1 - 2024m6
US IP	Industrial production excl. construction	Dallas Fed Global Economic Indicators/Haver	1992m1 - 2024m6
US EBP	Excess bond premium	See Favara et al. (2016)	1990m1 - 2024m6
S&P 500	S&P 500 Composite (eop)	S&P/Haver	1990m1 - 2024m6
US dollar NEER	Nominal broad/EME/AFE trade-weighted dollar index	FRB/Haver	1990m1 - 2024m6
RoW real GDP	RoW real GDP, interpolated	Dallas Fed Global Economic Indicators/Haver (Grossman et al., 2014)	1990q1 - 2024q2
RoW/AE/EME IP	RoW/AE/EME industrial production	Dallas Fed Global Economic Indicators/Haver (Grossman et al., 2014)	1990m1 - 2024m6
EME CPI	EME consumer price index	Dallas Fed Global Economic Indicators/Haver (Grossman et al., 2014)	1990m1 - 2024m6
MSCI World excl. US	MXWOU Index: MSCI World excluding US (eop)	MSCI/Bloomberg	1990m1 - 2024m6
AE/EME inflows	Inflows, portfolio and other investment, interpolated	IMF BoP	1995q1-2024q2
US inflows, outflows	Net purchases of US/foreign securities by foreign/US residents	Bertaut and Judson (2014, 2022)	1990m1-2024m6
US/EUR (EME) HY-spread	ICE BofA US/EUR (EME) High Yield (Corporate Plus) Index Option-Adjusted Spread	FRED	1996m12/1997m12 (1998m12)-2024m6
GF risky asset prices	Global factor in risky asset prices	Miranda-Agrippino et al. (2020)	1990m1 - 2019m4
US exports/imports	Exports/imports of goods (sa)	Census Bureau/Haver	1991m1 - 2024m6
World trade ex US	World excl. US trade volume (sa)	CBP/Haver	1991m1 - 2024m6
CRB	Commodity price index	Commodity Research Bureau/Bloomberg	1990m1 - 2024m6

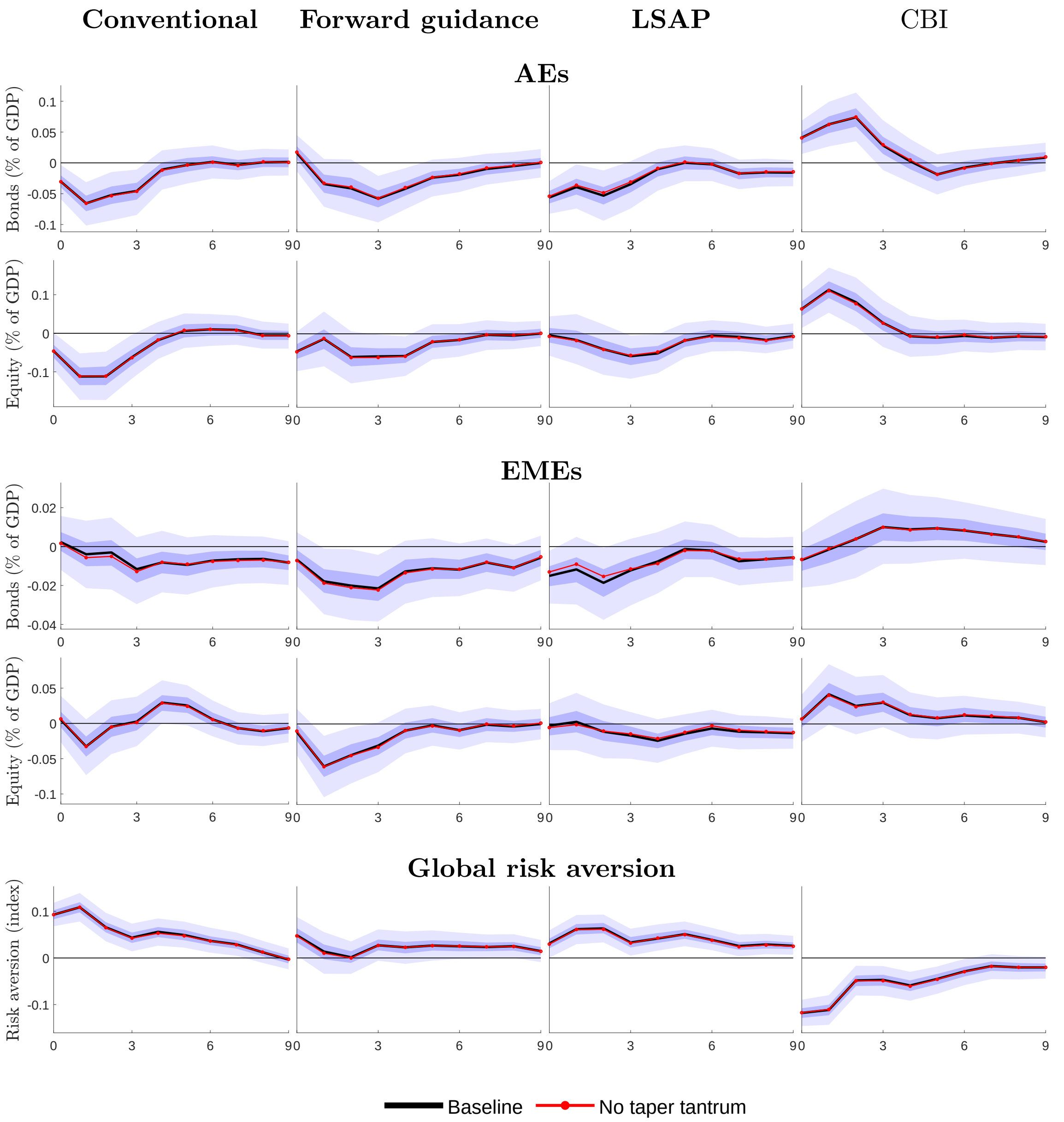
Notes: BLS stands for Bureau of Labour Statistics, FRB for Federal Reserve Board, NBEPA for Netherlands Bureau for Economic Policy Analysis, TIC for Treasury International Capital, and FRED for Federal Reserve Economic Data.

Figure B.7: Evolution of US holdings of foreign portfolio bond and equity



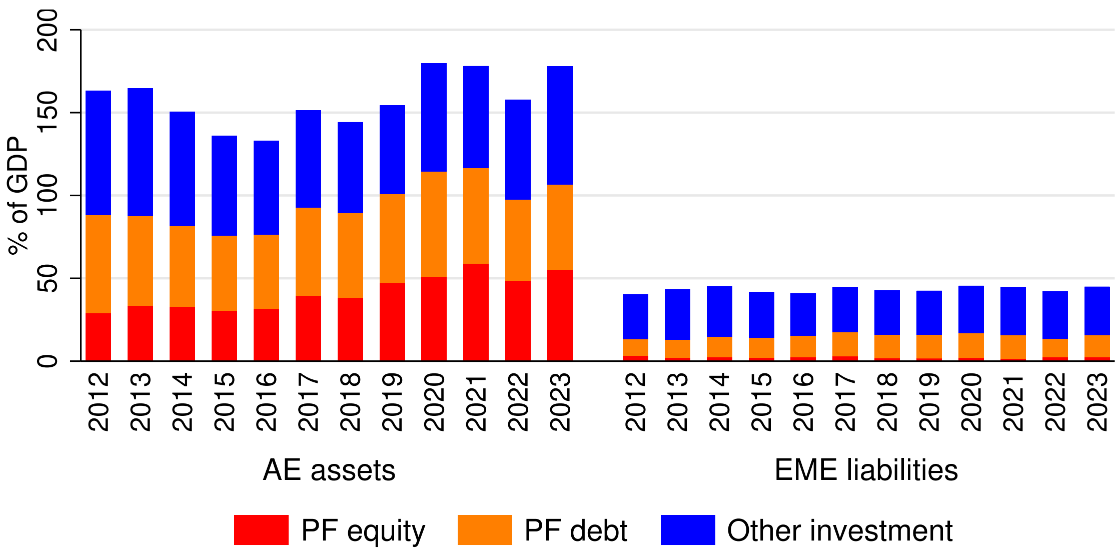
Note: Data are taken from US TIC and Bertaut and Judson (2022). Financial centers are as defined by Bertaut et al. (2019).

Figure B.8: Effects of US monetary policy shocks on US capital flows estimated without taper tantrum events



Note: See the notes to Figure 3.

Figure B.9: Evolution of AE (EME) foreign assets (liabilities)



Note: Data are taken from IMF International Investment Position Database and World Bank World Development Indicators. Bars indicate median values across countries.