

# What explains international interest rate co-movement?<sup>\*</sup>

Annika Camehl<sup>†</sup> Gregor von Schweinitz<sup>†</sup>

September 22, 2025

## Abstract

This paper decomposes international interest rate co-movement into contributions of global and domestic supply, demand, and monetary policy shocks across seven advanced economies. We develop a Bayesian structural panel vector autoregression with informative priors, homogeneity restrictions on contemporaneous relations, a hierarchical Minnesota prior with cross-sectional shrinkage, and a factor structure for structural shocks. We show that monetary policy follows traditional domestic mandates as central banks adjust policy rates in response to domestic output gaps and inflation. The observed co-movement of interest rates across countries arises because business-cycle fluctuations – driven largely by demand-type shocks – are correlated internationally.

*Keywords:* *Spillovers, Structural vector autoregressions, Panel vector autoregressions, Informative priors*

*JEL-Codes:* *C11, C30, E52, F42*

---

<sup>\*</sup>We are indebted to the editor, Marco Del Negro, and five referees for their valuable and insightful remarks and suggestions. We thank Christiane Baumeister, Jesus Crespo-Cuaresma, Domenico Giannone, Michele Piffer, Malte Rieth, Peter Tillmann, Samad Sarferaz, Roland Winkler, participants of the SEM 2023, the CEF 2023, the German Economic Association 2023, Seminars at Singapore Management University, Monash University and the IWH for useful comments and suggestions. We are also grateful to Helmut Lütkepohl and Marek Jarocinski for their constructive remarks on an earlier version of this paper.

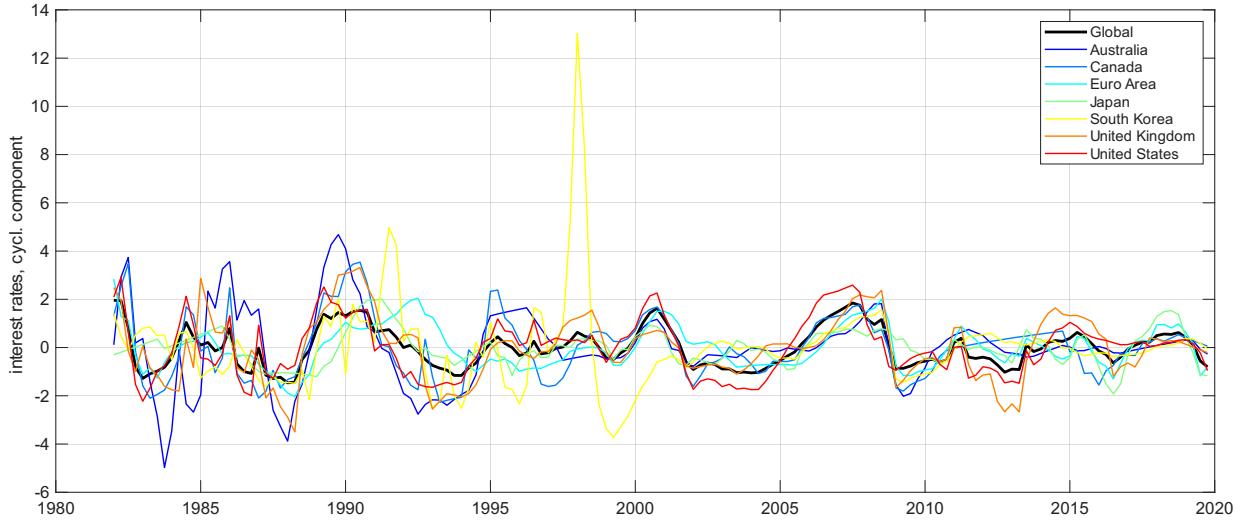
<sup>†</sup>Department of Econometrics, Erasmus University Rotterdam, Burgemeester Oudlaan 50, 3062 PA Rotterdam, The Netherlands, camehl@ese.eur.nl. Declarations of interest: none

<sup>‡</sup>Corvinus University and Halle Institute for Economic Research, Fövam Tér 8, H-1093-Budapest, Gregor.vonSchweinitz@uni-corvinus.hu. Declarations of interest: none

# 1 Introduction

Over the past four decades, fluctuations in central bank policy rates exhibit strong international co-movement. Correlations between national interest rates (or shadow rates during zero-lower-bound periods) from seven major economies and a global GDP-weighted average are substantial. They range from around 80% in South Korea to 95% in the United States. These patterns are not only driven by a common downward trend, but also reflected in common cyclical fluctuations of interest rates displayed in Figure 1.

**Figure 1:** Co-movement of the cyclical component of interest rates



NOTES: The figure shows HP-filtered nominal policy interest rates, spliced with shadow rates (Krippner, 2013) during zero lower bound periods. We add a HP-filtered global interest rate (black line), calculated as the GDP-weighted average of the individual interest rates.

These high correlations raise a central policy question: Why do interest rates move together? Do foreign shocks, in particular monetary policy shocks, spill over across borders, or do central banks systematically respond to domestic business cycles that are correlated across countries? Previous research has studied alternative explanations for correlated interest rates in isolation. One part of the literature focuses on spillovers of structural shocks from a single large country like the US (see Kim, 2001; Maćkowiak, 2007; Dedola et al., 2017), another on monetary policy shock spillovers between a group of countries (see Gambacorta et al., 2014; De Santis and Zimic, 2022), while yet another investigates the role of global factors (see Mumtaz and Surico, 2009; Charnavoki and Dolado, 2014; Forbes

et al., 2024).

We jointly quantify the contribution of a broad set of structural shocks behind international interest rate co-movements using a Bayesian structural panel vector autoregressive (PVAR) model. These shocks are domestic, foreign, and global shocks to country-specific supply, demand, monetary policy, and exchange rate equations. In our framework, co-movement across countries can arise from foreign shocks, which capture country-specific events that spill over to other economies, or from global shocks, which reflect unexpected worldwide developments or correlated common shocks. Comparing the relative strength of alternative explanations allows us to identify their quantitative importance. If monetary policy shocks contribute more to the correlation than other structural shocks, this would be evidence of direct cross-country spillovers. We also estimate monetary policy rules across countries, showing whether systematic interest rate responses focus exclusively on domestic variables or also include foreign ones.

Our model combines data at business-cycle frequencies from seven advanced economies: Australia (AU), Canada (CA), the Euro area (EA), Japan (JP), South Korea (KO), the United Kingdom (UK), and the United States (US). We use data on output gaps, inflation, shadow rates, and real effective exchange rates between 1980:Q3 and 2019:Q4.<sup>1</sup> We measure the drivers of interest rate co-movements by estimating the contribution of the structural shocks to (a) the forecast error variance of interest rates and (b) the forecast error correlation between domestic and global interest rates over different horizons.

The central result of our paper is that monetary policy is conducted according to traditional mandates: Central banks react to domestic output gaps and inflation. International co-movement in interest rates arises because business cycle fluctuations – largely driven by demand shocks – are correlated across countries.

We provide four pieces of evidence in support of this result. First, short run variations of interest rates are explained overwhelmingly by domestic monetary policy, domestic demand, and global demand shocks (80%-95%). Among these, global demand shocks are the only

---

<sup>1</sup>We select these advanced economies because they jointly account for a large share of global GDP. For simplicity, we use *currency area* and *country* interchangeably in the following.

shocks that directly generate international spillovers and thus account for immediate cross-country co-movement. The identified national monetary policy rules confirm that central banks in our countries have a strong policy focus on domestic variables.

Second, at medium horizons, domestic, foreign, and global demand shocks remain the dominant drivers of interest rate variation. They generate quasi-synchronous impulse response functions of output gaps and inflation across countries, leading inflation-targeting central banks to adjust policy rates in similar ways. This mechanism explains why business cycle synchronization translates into interest rate co-movement.

Third, direct monetary policy shock spillovers (as an alternative to endogenous reactions to business-cycle co-movement) are limited. Forecast error variance decompositions show that after five years, global and foreign monetary policy shocks jointly explain less than 10% of interest rate variation, respectively. The identified monetary policy rules do not support hypotheses that foreign economic developments might be relevant for domestic interest rate decisions. This indicates that monetary policy in all countries of our sample is conducted to a large extent autonomously, rather than being influenced by a dominant economy, in line with theoretical results such as [Kulish and Rees \(2011\)](#).

Fourth, demand shocks are also the main source of forecast error correlations of interest rates across all horizons. After five years, domestic, foreign, and global demand shocks jointly explain 50–60% of these correlations. International interest rate co-movement reflects the fact that inflation-targeting central banks respond in similar ways to common demand-driven business cycle fluctuations.

Our findings have important policy implications. International co-movement in interest rates does not signal a loss of monetary sovereignty, because central banks in our sample remain focused on domestic objectives. Thus, their stated mandates are credible.

Our analysis contributes to different strands of the literature on international interest rate co-movements. We complement work on the long-run decline in nominal and real interest rates ([Holston et al., 2017](#); [Del Negro et al., 2019](#)) by adding insights on cyclical co-movements. We extend earlier studies on cross-country transmission, many of which examine only two countries or isolate shocks from a single large economy (e.g., [Kim, 2001](#);

Maćkowiak, 2007; Dees et al., 2007; Georgiadis, 2015). We build on recent papers that estimate multi-country spillovers of monetary policy shocks (Gerko and Rey, 2017; Rogers et al., 2018; Liu et al., 2022), but differ by also accounting for the role of supply and demand shocks, which we find to be more important. Our framework is also related to structural factor models and augmented factor VAR models (Charnavoki and Dolado, 2014; Mumtaz and Surico, 2009; Forbes et al., 2024), which document similar global effects, but do not allow for spillovers of local shocks as we do. Moreover, we contribute to the literature on the international effects of US monetary policy shocks. Our results show that foreign interest rates do not react significantly to a US shock, as in Gerko and Rey (2017); Liu et al. (2022).<sup>2</sup> While a dominant transmitter role of the US is stressed in the literature (such as Miranda-Agrippino and Rey, 2020; Rey, 2016; De Santis and Zimic, 2022), our results give a more diverse picture, as they highlight the role of global shocks as well as the differences of responses to shocks originating in other countries. These reactions should caution against block-exogeneity assumptions in VAR models. Finally, our results relate to studies reporting similarities in spillover effects and mutual reactions caused by unconventional monetary policy shocks of the Fed and ECB (such as Curcuru et al., 2018; Miranda-Agrippino and Nenova, 2022; Jarociński, 2022).

Our Bayesian structural PVAR model introduces a coherent framework for structural multi-country models which integrates (1) informative priors, (2) homogeneity restrictions on the contemporaneous relations inspired by global VAR models, (3) hierarchical Minnesota prior with extra shrinkage on the cross-sectional dimension, and (4) a factor structure for structural shocks.

Informative priors on structural contemporaneous relationships, i.e. short-run elasticities and semi-elasticities (Baumeister and Hamilton, 2015, 2018), incorporate identification uncertainty around restrictions. Thereby, they account for a lack of conclusive theoretical evidence which is especially appealing in multi-country models.<sup>3</sup> We derive priors from

---

<sup>2</sup>Some studies do find significant spillovers but disagree on the sign (Feldkircher and Huber, 2016; Dedola et al., 2017; Rogers et al., 2018; Crespo Cuaresma et al., 2019; De Santis and Zimic, 2022).

<sup>3</sup>Informative priors avoid recursive structures (as in Chen et al., 2016; Bluwstein and Canova, 2016, where the order of countries matters) or block-exogeneity (as in Kim and Roubini, 2000; Kim, 2001; Maćkowiak, 2007) that are hard to justify. Compared to studies applying sign and/or magnitude restrictions

the open-economy model of [Lubik and Schorfheide \(2007\)](#). This theoretical model allows us additionally to impose economically meaningful exclusion and homogeneity restrictions on structural contemporaneous coefficients associated with foreign terms. Homogeneity restrictions discipline cross-country spillovers. They are akin to, but not equivalent, to those in global VARs, and arguably have stronger theoretical justification.

To account for potential differences across countries in our model, we rely on a hierarchical prior set-up which adds flexibility in estimating prior variances as in [Giannone et al. \(2015\)](#), and impose extra shrinkage by letting the prior variance of autoregressive parameter decrease with country-specific GDP weights. We extend the model further and impose a factor structure in the spirit of [Stock and Watson \(2005\)](#). This allows us to differentiate between country-specific and latent global supply, demand, and monetary policy shocks in our model. We identify factors through zero and sign restrictions on the factor loadings as in [Korobilis \(2022\)](#). Global supply shocks capture both commodity-driven disruptions, such as oil price fluctuations, and broader structural changes, such as China's accession to the WTO. Global demand shocks are related to global disturbances in the financial sector. We include global monetary policy shocks to allow for coordinated policy actions.

We present our model and discuss identification challenges in detail in section 2. The results section 3 provides additional details on the main results mentioned above, discusses the nature of global shocks and investigates the monetary policy rules identified by our model. Section 4 concludes the paper.

---

in multi-country models ([Gambacorta et al., 2014](#); [Liu et al., 2022](#); [De Santis and Zimic, 2022](#)), we clearly acknowledge the uncertainty around restrictions and avoid controversial restrictions on foreign responses.

## 2 Bayesian structural PVAR model

The Bayesian structural PVAR model combines  $J$  equations per country, for  $C$  countries. In matrix form, it is given by

$$\mathbf{Ay}_t = \mathbf{Bx}_{t-1} + \chi \mathbf{u}_{gt} + \mathbf{u}_t \quad (1)$$

$$\mathbf{u}_t \sim \mathcal{N}(\mathbf{0}, \mathbf{D}), \quad \mathbf{u}_{gt} \sim \mathcal{N}(\mathbf{0}, \mathbf{I}_G).$$

The endogenous variables are captured in the  $(n \times 1)$  vector  $\mathbf{y}_t = (\mathbf{y}_{1t}, \dots, \mathbf{y}_{Ct})'$  with  $\mathbf{y}_{ct}$  containing the  $J$  endogenous variables of country  $c$ , and  $n = CJ$ . The right-hand-side variables include  $p$  lags and a constant collected in the  $(k \times 1)$  vector  $\mathbf{x}_{t-1}$ , with  $k = CJp + 1$ . The main results hold for models with alternative lag structures and with a deterministic trend, Online Appendix Figure E.4.

The  $(n \times n)$ -matrix  $\mathbf{A}$  contains structural contemporaneous parameters, which can be interpreted as semi-elasticities and elasticities. We impose three types of restrictions on the contemporaneous coefficients: (1) trade-weighted homogeneity restrictions on some foreign terms, (2) exclusion restrictions mostly on the remaining foreign terms, and (3) informative prior distributions (Baumeister and Hamilton, 2018). We discuss the specific model equation and identification restrictions in subsection 2.1. The  $(n \times k)$ -matrix  $\mathbf{B}$  contains the structural lag coefficients. We use hierarchical shrinkage priors (Giannone et al., 2015), where the degree of shrinkage depends on GDP weights, to deal with the large numbers of autoregressive parameters. The prior setting is discussed in subsection 2.2.1.

We allow for “combined” structural shocks,  $\chi \mathbf{u}_{gt} + \mathbf{u}_t$ , which consist of structural country-specific shocks and global shocks. The  $(n \times 1)$  vector of structural country-specific shocks  $\mathbf{u}_t$  jointly follows a normal distribution with mean zero and diagonal variance matrix  $\mathbf{D}$ . These shocks are uncorrelated across equations and countries. We capture potential correlation across countries through  $G$  structural global shocks  $\mathbf{u}_{gt}$ . The global shocks independently follow a standard-normal distribution and load onto each country according

to the  $(n \times G)$ -dimensional loading matrix  $\chi$ , which collects the country- and shock-specific loadings  $\chi_c^j$ . The loading matrix is identified through economically motivated zero and sign restrictions (Korobilis, 2022), as described in subsection 2.2.

Our specification ensures that contemporaneous co-movement across countries can materialize via the effect of domestic shocks on foreign countries or through global shocks. Switching perspectives, we refer to the former as foreign country-specific events spilling over to other countries. Global shocks induce economic fluctuations that are common across countries. These shocks reflect either unpredictable changes in global developments outside our model, or shocks that are common for all the countries in our sample. For example, they can be driven by so-called “primitive” shocks (as defined in e.g., Ramey, 2016) such as natural disasters or geopolitical events having a worldwide effect, or by co-ordinated monetary policy shocks leading to all central banks jointly changing their policy rates (Georgiadis and Jančoková, 2020).

## 2.1 Structural contemporaneous relations

We use the structural PVAR model to investigate the correlation of interest rates for Australia, Canada, the Euro Area, Japan, South Korea, the United Kingdom and the United States; this set of countries represents around 54% of the world’s economic activity as of 2019. For each country  $c \in \{1, \dots, C\}$ , we include the output gap ( $y_{ct}$ ) as a measure of economic activity, year-on-year inflation rates ( $\pi_{ct}$ ), Krippner-shadow interest rates ( $r_{ct}$ ) – which capture both conventional and unconventional monetary policy actions (Krippner, 2013) – and year-on-year growth rates of the real effective exchange rates ( $q_{ct}$ ), all collected in  $\mathbf{y}_{ct} = (y_{ct}, \pi_{ct}, r_{ct}, q_{ct})'$ . The real effective exchange rates are defined such that an increase in  $q_{ct}$  indicates an increase in competitiveness. Our sample spans quarterly data from 1980:Q3 to 2019:Q4.<sup>4</sup> Our main results are qualitatively robust to variations in the data sample and choice of variables.

---

<sup>4</sup>Online Appendix A explains the data in more detail. Two country selections deserve note. First, we rely on constructed data (provided by Eurostat, the ECB and Oxford Economics) for a counterfactual Euro Area between 1980 and 1999. Second, we exclude China because, especially for the first part of our sample, there are issues with the availability and quality of Chinese data.

The structural relations between endogenous variables are derived from theoretical open-economy models such as Lubik and Schorfheide (2007). Specifically, we formulate an empirical open economy Phillips curve (labeled “s”), IS curve (“d”), monetary policy rule (“m”), and an exchange rate equation (“er”). We index the type of structural equation with superscript  $j \in \{s, d, m, er\}$  for each country  $c$  in our sample:

$$y_{ct} = \alpha^{c,\pi} \pi_{ct} + \alpha^{c,q} q_{ct} + \text{lag terms} + \chi_c^s u_{gt}^s + u_{ct}^s \quad (\text{s})$$

$$y_{ct} = \beta^{c,r} r_{ct} + \beta^{c,\pi} \pi_{ct} + \beta^{c,q} q_{ct} + \beta^{c,y^*} y_{ct}^* + \text{lag terms} + \chi_c^d u_{gt}^d + u_{ct}^d \quad (\text{d})$$

$$r_{ct} = (1 - \rho^c) (\psi^{c,\pi} \pi_{ct} + \psi^{c,y} y_{ct} + \psi^{c,q} (q_{ct} - \pi_{ct}^*)) + \text{lag terms} + \chi_c^m u_{gt}^m + u_{ct}^m \quad (\text{m})$$

$$q_{ct} = \theta^{c,y} (y_{ct} - y_{ct}^*) + \text{lag terms} + u_{ct}^q. \quad (\text{er})$$

The “lag terms” contain  $p = 4$  lags and a constant. We model common economic fluctuations through  $G = 3$  global shocks in the supply, demand and monetary policy equation. We exclude a global exchange rate shock in our baseline model, since the currencies in our analysis are the overwhelmingly dominant currencies in the world during the time of our analysis.

The  $\alpha, \beta, \psi, \theta$ -coefficients are the (semi-)elasticities of the structural equations (s) to (er). The structural coefficients  $\beta^{c,y^*}, \psi^{c,q}, \theta^{c,y}$  capture spillovers from foreign endogenous variables. Based on theoretical open-economy models, we add real effective exchange rate growth to both the supply and demand curve, and include foreign output gaps in the demand curve. The monetary policy rule follows an open-economy version of the standard Taylor rule. Here, the monetary policy authority can also set interest rates in relation to changes in nominal exchange rate fluctuations. Finally, the exchange rate equation is introduced under the assumption of purchasing power parity and relates changes in the real exchange rate to differences in foreign and domestic output. Using the theoretical model, this implies a dependence of real exchange rates on changes in the terms of trade.

With these structural relations, we impose three different types of restrictions on the contemporaneous relations in  $\mathbf{A}$ : homogeneity restrictions on the foreign terms, exclusion restrictions, and informative prior distributions.

### 2.1.1 Homogeneity and exclusion restrictions

Homogeneity restrictions on the foreign terms allow us to aggregate foreign terms into a single variable and coefficient. All aggregated contemporaneous foreign variables  $(y_{ct}^*, \pi_{ct}^*)$  are trade-weighted averages of country-specific terms.<sup>5</sup> As an example,  $\beta^{c,y^*}$  is the demand elasticity of country  $c$  with respect to foreign output gaps. The homogeneity restriction implies that the demand elasticity with respect to output gaps from country  $c', c \neq c'$  is  $\beta^{c,y_{c'}} = w_{cc'}\beta^{c,y^*}$ . That is, the elasticities scale with the importance of the foreign country  $c'$  in the trade basket of country  $c$ . The restriction allows us to identify the  $C - 1$  coefficients  $\beta^{c,y_{c'}}$  through a single parameter  $\beta^{c,y^*}$ . This effectively removes the curse of dimensionality for  $\mathbf{A}$  arising from the panel dimension of the model. We do not impose homogeneity restrictions on lag coefficients.

While the homogeneity restrictions are comparable to those used in GVAR models (see, e.g., [Dees et al., 2007](#); [Feldkircher and Huber, 2016](#); [Crespo Cuaresma et al., 2019](#)), we set them on the structural contemporaneous coefficients instead of the reduced from parameters and covariance, since the former matches theoretical considerations. The two alternatives are not equivalent: homogeneity restrictions on the reduced form place the restrictions on the inverse of  $\mathbf{A}$ . That is, GVAR models usually assume that the impact of *foreign shocks*, instead of *elasticities* as in our case, scales with the amount of trade with the country of origin.

As a second restriction, the structural relations formulated in equations [\(s\)](#) to [\(er\)](#) exclude contemporaneous relations among some variables, directly reducing the number of coefficients to be identified. For example, the Phillips curve does not contain an interest rate term, or any foreign terms. The exclusion restrictions are uncontroversial, as they apply mostly to the role of foreign variables. Yet, we show that our results are robust if we deviate from some of them, for example, by including interest rate differentials and inflation differentials in the exchange rate equation to allow for uncovered interest rate parity.

---

<sup>5</sup>We derive bilateral trade weights  $w_{c,c'}$  from the BIS. In our sample period, the BIS reports 3-year averages of bilateral trade weights for their “narrow basket” real effective exchange rates. We average these weights and normalize them such that they sum up to 1.

**Table 1:** Prior on contemporaneous parameters for country  $c$

Parameter	Prior mode	Prior scale	Restrictions
<i>Parameters set as in Baumeister and Hamilton (2018)</i>			
Student-t distribution with 3 degrees of freedom			
$\alpha^{c,\pi}$	2	0.4	$\geq 0$
$\beta^{c,r}$	-1	0.4	$\leq 0$
$\beta^{c,\pi}$	0.75	0.4	
$\psi^{c,\pi}$	1.5	0.4	$\geq 0$
$\psi^{c,y}$	0.5	0.4	$\geq 0$
<i>Beta(2.6,2.6)</i>			
$\rho^c$	0.5	0.2	$0 \leq \rho^c \leq 1$
<i>Additional parameters in open-economy model</i>			
Student-t distribution with 3 degrees of freedom			
$\alpha^{c,q}$	-0.5	0.4	
$\beta^{c,q}$	0.2	0.4	
$\beta^{c,y^*}$	0.5	0.4	$\geq 0$
$\psi^{c,q}$	0	0.4	
$\theta^{c,y}$	1	0.4	$\geq 0$

Notes: We choose prior distribution families (incl. degrees of freedom and scales) as in [Baumeister and Hamilton \(2018\)](#). The mode and sign restrictions for parameters referring to domestic coefficients (upper panel) are set as in [Baumeister and Hamilton \(2018\)](#). The mode and restrictions for the remaining parameters (lower panel) are derived from the small open economy model of [Lubik and Schorfheide \(2007\)](#).

### 2.1.2 Informative priors on contemporaneous parameters

We implement prior beliefs on the structural contemporaneous coefficients as in [Baumeister and Hamilton \(2018\)](#). We set a  $t$ -distribution with a prior scale of 0.4 and three degrees of freedom for the majority of parameters, allowing for heavier tails compared to a normal distribution. We follow [Baumeister and Hamilton \(2018\)](#) in the prior specifications for the parameters of their closed-economy model,  $(\alpha^{c,\pi}, \beta^{c,r}, \beta^{c,\pi}, \psi^{c,\pi}, \psi^{c,y}, \rho^c)_{c=1}^C$ , shown in the upper block of Table 1. We refer the reader to their paper for a detailed discussion on these prior beliefs.

The prior specifications of the the remaining structural contemporaneous coefficients,  $(\alpha^{c,q}, \beta^{c,q}, \beta^{c,y^*}, \psi^{c,q}, \theta^{c,y})_{c=1}^C$ , are given in the lower block of Table 1. We derive our informative prior beliefs based on theoretical insights, mainly from the New-Keynesian small open

economy model of Lubik and Schorfheide (2007). To do this, we express each parameter as a function of deep structural parameters from a theoretical model, and determine the prior mode based on common values of these parameters from the literature.<sup>6</sup> Note that we do not differentiate priors across different countries. However, we provide robustness checks where we check the sensitivity of results to our prior choices, see Online Appendix Figure E.2.

In equation (s), the parameter  $\alpha^{c,q}$  measures the elasticity of supply to real effective exchange growth rates. In Lubik and Schorfheide (2007), this elasticity depends on the import share, the intertemporal substitution elasticity, discount rate and the slope coefficient of the Phillips curve. We set the import share to 0.2. To avoid singularities in the theoretical model, intertemporal substitution elasticities are commonly restricted to be larger than zero and smaller than one (Lubik and Schorfheide, 2007; Justiniano and Preston, 2010). We follow Lubik and Schorfheide (2007) and settle for a mean of 0.5. As in Baumeister and Hamilton (2018) we assume a discount rate of zero and a slope coefficient of 0.25. Similarly, Lubik and Schorfheide (2004) set a prior for the slope coefficients allowing for a wide range between 0 and 1. Last, as in Baumeister and Hamilton (2018), we replace expected values in the theoretical model with autoregressive forecasts from an AR(1) process with autoregressive parameter of 0.75. Based on these values we choose a prior mode for  $\alpha^{c,q}$  of -0.5.

In the open economy IS curve, the parameter  $\beta^{c,q}$  measures the dependence of aggregate demand on competitiveness. It combines the weight of the forward-looking component of the IS curve (for which we assume a value of 0.67) with the import share and the intertemporal substitution elasticity. Our choices for these three parameters follow Baumeister and Hamilton (2018); Lubik and Schorfheide (2007) and imply a prior mode of 0.2 for  $\beta^{c,q}$ .

We set a positive prior mode of 0.5 for  $\beta^{c,y^*}$ . The value results from the relation of the impact of foreign output on domestic output to the forward-looking component of output in the IS curve, import share, and the intertemporal substitution elasticity. By allowing

---

<sup>6</sup>Online Appendix B provides the exact relations of the coefficients in the SVAR model and the theoretical model of Lubik and Schorfheide (2007).

for global shocks, we intentionally weaken shock transmission via the aggregate demand channel described by  $\beta^{c,y*}$ . To limit this weakening effect, we introduce a sign restriction on  $\beta^{c,y*}$ .

We assume that the monetary policy authority can set interest rates according to a generalized Taylor rule in line with the specification in [Lubik and Schorfheide \(2007\)](#), [Adolfson et al. \(2007\)](#), and [Justiniano and Preston \(2010\)](#), which lets the central bank react to nominal exchange rates. This implies that the coefficient on foreign inflation is  $-\psi^{c,q}$ , the negative of the coefficient on domestic real effective exchange rate growth. We set the prior mode of this coefficient to zero (as in [Adolfson et al., 2007](#)), as the countries in our sample are characterized by flexible exchange rate regimes.

Equation (er) determines exchange rates as a function of contemporaneous domestic and foreign output as well as foreign exchange rates. We assume that purchasing power parity holds, which implies that  $q_{ct}$  directly relates to the terms of trade. As in [Lubik and Schorfheide \(2007\)](#), the difference in domestic and foreign demand growth thus determines the terms of trades endogenously, such that growth in domestic and foreign demand balances out. We hence apply  $\theta^{c,y}$  to the difference between domestic and foreign output gaps. A prior mode of one is based on the relation of import shares and intertemporal substitution elasticity.

Following [Baumeister and Hamilton \(2018\)](#), we impose three additional sets of priors related to impact responses to economic shocks. For these priors, we use non-dogmatic asymmetric  $t$ -distributions with location parameter  $\mu$ , scale parameter  $\sigma$ , degrees of freedom  $\nu$ , and shape parameter  $\lambda$ , the latter one controlling the degree of asymmetry. First, we assume for every country that the output response to a contractionary monetary policy shock is smaller than the interest rate response ( $\mu = -0.3; \sigma = 0.5; \nu = 3; \lambda = -2$ ). This prior leaves 12.5% chance that the output reaction is (in absolute terms) larger than the interest rate response, and a 4.5% chance that it is positive. Second, we assume a positive output response to aggregate supply shocks ( $\mu = 0.3; \sigma = 0.5; \nu = 3; \lambda = 2$ ), which leaves a 4.5% chance of a negative output reaction. Third, we set as prior distribution on  $\beta^{d,c\pi} - \beta^{d,cr}(1 - \rho^c)\psi^{c\pi}$  as in [Baumeister and Hamilton \(2018\)](#). In a New-Keynesian model,

this element describes the slope of the IS curve after replacing nominal interest rates by the monetary policy rule. Because we assume a negative slope, we use an asymmetric t-distribution with mode  $\mu = -0.1$ , scale  $\sigma = 1$ , degrees of freedom  $\eta = 3$  and asymmetry parameter  $\lambda = -4$ , allowing for a 6.5% chance of a positive slope.

## 2.2 Remaining priors, and posterior inference

### 2.2.1 A flexible Minnesota prior for structural variances and lag coefficients

[Baumeister and Hamilton \(2018\)](#) condition a Minnesota prior for  $\mathbf{B}$  and an inverse gamma prior for  $\mathbf{D}$  on structural contemporaneous coefficients  $\mathbf{A}$ . We follow their strategy, with two main differences, which are explained in more detail in [Online Appendix C.3](#).

First, we use hierarchical priors for the overall scaling parameter of the Minnesota prior,  $\lambda_0$ , and the variance component related to individual variables  $i$  in country  $c$ ,  $\mathbf{s} = \{s_c^i\}_{\substack{i \in \{y, \pi, r, q\} \\ c \in \{1, \dots, C\}}}$ . Following [Giannone et al. \(2015\)](#), we set a gamma distribution as prior for  $\lambda_0$  and an inverse gamma distribution for  $s_c^i$ :

$$p(\lambda_0) = \gamma(\lambda_0; \kappa_{\lambda_0}, \tau_{\lambda_0}), \quad \text{and} \quad p(s_c^i) = \gamma((s_c^i)^{-1}; \kappa_{s_c^i}, \tau_{s_c^i}).$$

For  $\lambda_0$  we choose a mode of 0.2 and standard deviation of 0.4. For  $s_c^i$ , we set a shape of 0.1, and a scale of 0.05 for  $i \in \{y, \pi, r\}$ , and a scale of 2 for  $i = q$ . This distribution has a mode close to the variance of an AR(4) process of the corresponding variable. At the same time, it is very dispersed, without a finite variance or mean.

The hierarchical priors give more flexibility to the prior of structural variances  $\mathbf{D}$ , where each element  $d_c^j$  follows an inverse gamma distribution with shape  $\kappa = 2$  and a scale  $\tau_c^j$  that depends on draws of  $\mathbf{A}$ ,  $\mathbf{s}$  and the (fixed) correlation of residuals from AR(4) processes estimated for each endogenous variable:

$$p(d_c^j | \mathbf{A}, \mathbf{s}) = \gamma((d_c^j)^{-1}; \kappa, \tau_c^j(\mathbf{A}, \mathbf{s})).$$

As a second difference to [Baumeister and Hamilton \(2018\)](#), we set tighter priors for

lag coefficients on variables from countries with a smaller GDP. This approach embodies our belief that past developments from smaller countries may be less important, while simultaneously addressing the curse of dimensionality in the structural lag coefficients. A model without size-dependent shrinkage (i.e., with a standard Minnesota prior) produces nearly identical median results, see Figure E.4 in the Online Appendix, but with higher uncertainty.<sup>7</sup>

The conditional distribution of  $p(\mathbf{B}|\mathbf{A}, \lambda_0, \mathbf{s}, \mathbf{D})$  is a normal distribution for each  $\mathbf{b}_c^j$ :

$$p(\mathbf{b}_c^j|\mathbf{A}, \lambda_0, \mathbf{s}, d_c^j) = \phi(\mathbf{b}; \mathbf{m}_c^j(\mathbf{A}), d_c^j \mathbf{M}_c^j(\lambda_0, \mathbf{s})).$$

The prior mean,  $\mathbf{m}_c^j(\mathbf{A})$ , multiplies the belief that each data series follows an AR(1)-process with coefficient 0.75 with  $\mathbf{A}$ . The prior variance of lag  $l$  of variable  $i$  in country  $c'$  for structural equation  $j$  in country  $c$  is

$$d_c^j \lambda_0^2 \frac{\omega_{c'}^2}{l^2 s_{c'}^i},$$

where  $\omega_{c'}$  is the GDP weight of country  $c'$ . Hence, the prior precision depends on the variance ratio  $d_c^j/s_{c'}^i$ , scales with  $\lambda_0^2$ , and is increasing with the lag length and inverse GDP weights. We use fairly uninformative priors on the constant terms, with a variance of  $100\lambda_0^2$ . We account for interest rate smoothing in the monetary policy equation through an additional prior on the lagged coefficients of the monetary policy rate of country  $c$  (Baumeister and Hamilton, 2018). This prior is a multivariate normal distribution with mean zero with the exception of the coefficient on  $r_{c,t-1}$ , for which we set a mean of  $\rho^c$ , and variance  $0.1d_c^m$ .

---

<sup>7</sup>Canova and Ciccarelli (2004); Koop and Korobilis (2016); Korobilis (2016); Koop and Korobilis (2019); Camehl (2023), for example, develop alternative ways to estimate *reduced form* PVAR models albeit without addressing structural identification.

### 2.2.2 A structural prior for global shocks and their loadings

We assume that our combined structural shocks,  $\chi \mathbf{u}_{gt} + \mathbf{u}_t$ , follow a static factor structure. To obtain global shocks  $\mathbf{u}_{gt}$  and their loadings  $\chi_c^j$  we follow [Korobilis \(2022\)](#), who assumes a similar structure for the reduced form residuals and imposes sign restrictions on the factor loadings. Because global shocks only load onto one type of structural equation, we only have a single loading per equation. We assume that global supply shocks and demand shocks are expansionary, and that global monetary policy shocks are contractionary in all countries of our sample, hence,  $\chi_c^j \geq 0, \forall c \in \{1, \dots, C\}, j \in \{s, d, m\}$ . We set normal prior distributions truncated at zero for the loadings  $\chi_c^j$  with a large prior variance, and standard-normally distributed global shocks  $u_{gt}^j$ :

$$\begin{aligned} p(u_{gt}^j) &= \mathcal{N}(0, 1), & j \in \{s, d, m\} \\ p(\chi_c^j | \mathbf{D}) &= \mathcal{T}\mathcal{N}_{\chi_c^j \geq 0}(0, d_c^j V_\chi), & V_\chi = 100. \end{aligned}$$

### 2.2.3 Drawing from the posterior distribution

In summary, the joint prior distribution of the model is

$$p(\mathbf{A}, \lambda_0, \mathbf{s}, \mathbf{B}, \mathbf{D}, \chi, \mathbf{U}_{gt}) = p(\mathbf{A})p(\lambda_0)p(\mathbf{s})p(\mathbf{D}|\mathbf{A}, \mathbf{s})p(\mathbf{B}|\mathbf{A}, \mathbf{D}, \lambda_0, \mathbf{s})p(\chi|\mathbf{D})p(\mathbf{U}_{gt}), \quad (2)$$

where the  $(T \times G)$  matrix  $\mathbf{U}_{gt} = [\mathbf{u}'_{g1}, \dots, \mathbf{u}'_{gT}]'$  combines all structural global shocks. Combining the prior distributions in Equation (2) with the data likelihood gives the posterior distribution. We use a Gibbs sampler with three main parts to sample from the posterior. In the first part, we use a Metropolis-Hastings step to sample from the conditional distribution  $p(\mathbf{A}, \lambda_0, \mathbf{s} | \mathbf{Y}_T, \chi, \mathbf{U}_{gt})$ . In the Online Appendix, we show that [Baumeister and Hamilton \(2015\)](#) and [Giannone et al. \(2015\)](#) use the same type of marginal likelihood, allowing us to combine  $(\mathbf{A}, \lambda_0, \mathbf{s})$  in a single step, where global shocks and loadings can be treated as part of the data. In the second part, we draw structural variances  $\mathbf{D}$  and lag coefficients  $\mathbf{B}$  from the usual normal-inverse gamma model. In the third step, we draw loadings from truncated normal distributions, and normally distributed global shocks as in

Korobilis (2022). Details are described in Online Appendix C.4.

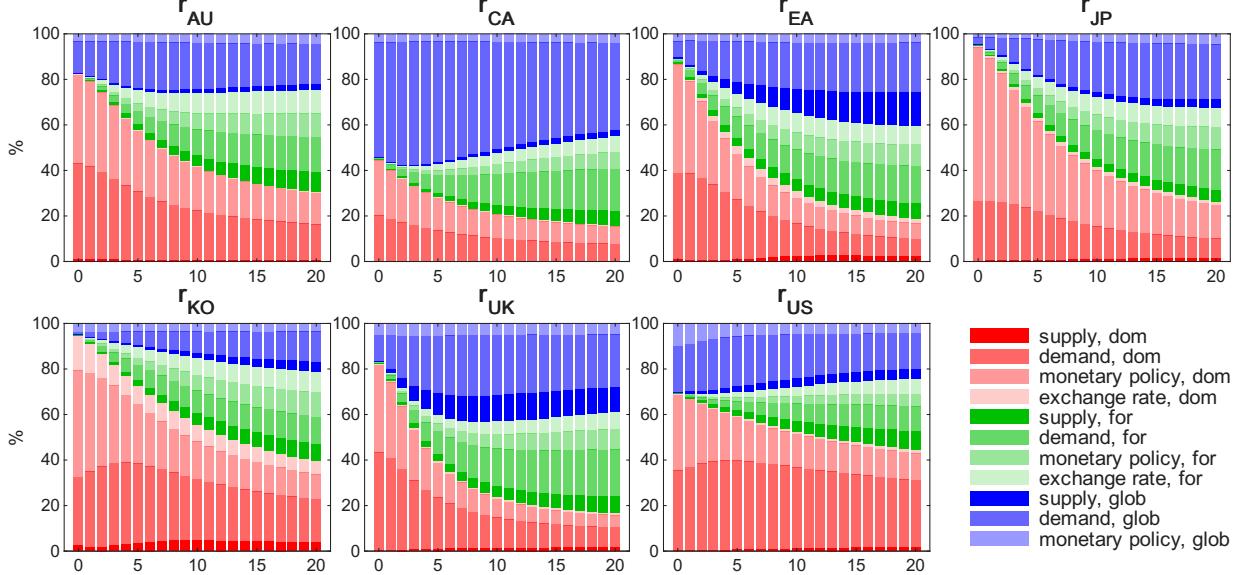
The posterior distributions of the structural contemporaneous coefficients  $\mathbf{A}$  converge, see Online Appendix C.5. They clearly update the informative priors, see Online Appendix Figures D.5 to D.7. The only exception are the slope of the Phillips curve  $\alpha^{c,\pi}$  and the elasticity of growth rates of real effective exchange rates with respect to output growth differentials,  $\theta^{c,y}$ . However, a robustness check with larger prior scales (1 instead of 0.4) on these two parameters results in posteriors that are very close to our baseline model. This indicates that the information in the data merely confirms the prior, see Figure E.2 in the Online Appendix.

### 3 Results

In this section, we discuss our central result: monetary policy follows traditional domestic mandates as central banks adjust policy rates in response to domestic output gaps and inflation. The international co-movement of interest rates reflects correlated business-cycle fluctuations, largely driven by demand shocks.

We support this finding with four pieces of empirical evidence. Section 3.1 shows that in the short run, domestic and global demand shocks, along with domestic monetary policy shocks, dominate the forecast error variance of interest rates. At medium horizons, the influence of domestic monetary policy shocks diminishes, while foreign demand shocks gain importance. Section 3.2 demonstrates that medium-run variation is therefore mainly driven by shocks that generate internationally correlated business cycles. Section 3.3 shows that direct spillovers from monetary policy shocks are limited, as central banks in our sample largely follow rules tied to domestic inflation and output gaps. Section 3.4 analyzes correlations in interest rate forecast errors, highlighting demand shocks as their primary source. Finally, Section 3.5 provides a detailed discussion of global shocks in our model.

**Figure 2:** Forecast error variance decomposition of interest rates



NOTES: The figure shows the forecast error variance decomposition of country-specific interest rates (in subplots) to domestic (dom) and foreign (for) supply, demand, monetary policy and exchange rate shocks and global (glob) supply, demand and monetary policy shocks over 20 quarters.

### 3.1 Short-run drivers of interest rates

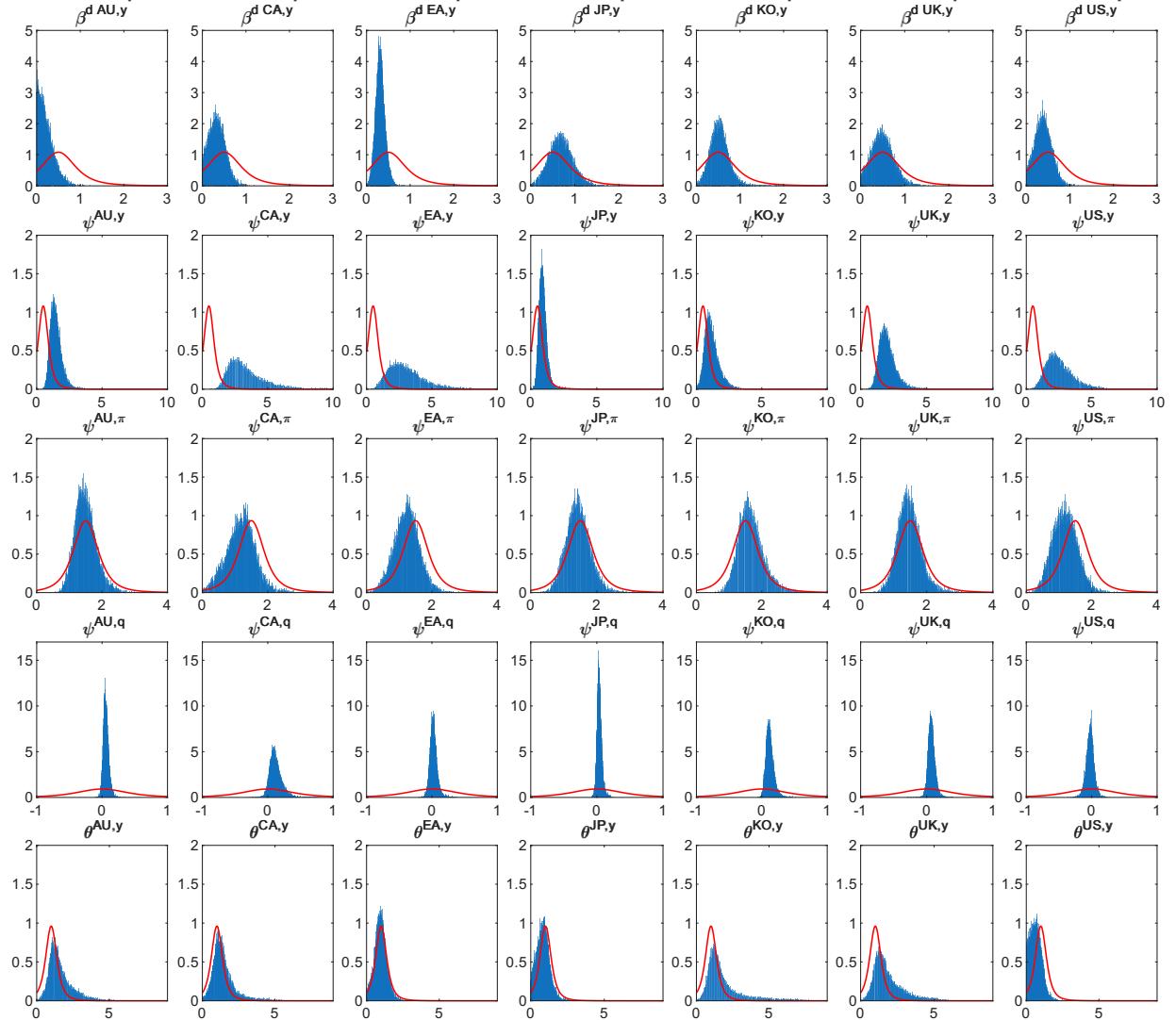
Our first key piece of evidence is that short-term interest rate fluctuations are overwhelmingly driven by domestic monetary policy shocks, domestic demand shocks, and global demand shocks. The latter ones play a distinctive role because they directly generate international spillovers as they can have an immediate impact on output gaps of all countries. This makes them the main source of cross-country interest rate co-movement on impact.

We demonstrate this using the median forecast error variance decomposition (FEVD) for interest rates at short horizons in Figure 2.<sup>8</sup> Shocks are grouped by equation (supply, demand, monetary policy, exchange rate) and by origin (domestic – red, foreign – green, global – blue). Together, domestic monetary policy, domestic demand, and global demand shocks explain about 95% of short-run interest rate variation (80% in Korea, 90% in the United States).<sup>9</sup> This dominant role is consistent with the monetary policy rule coefficients. Figure 3 shows positive posterior estimates for output gaps ( $\psi^{c,y}$ ) and inflation ( $\psi^{c,\pi}$ ).

<sup>8</sup>Contributions sum to 100 for each posterior draw but not necessarily for the median; we normalize to 100, though differences are negligible.

<sup>9</sup>The remaining variation is explained by global monetary policy shocks and, for Korea, by exchange rate shocks. Korea's monetary authority reacted strongly to exchange rate movements, particularly during the East Asian crisis (see coefficient  $\psi^{KO,q} > 0$  in Figure 3 and Online Appendix Figure D.22).

**Figure 3:** Posterior distributions of structural contemporaneous coefficients, monetary policy rule and foreign variables

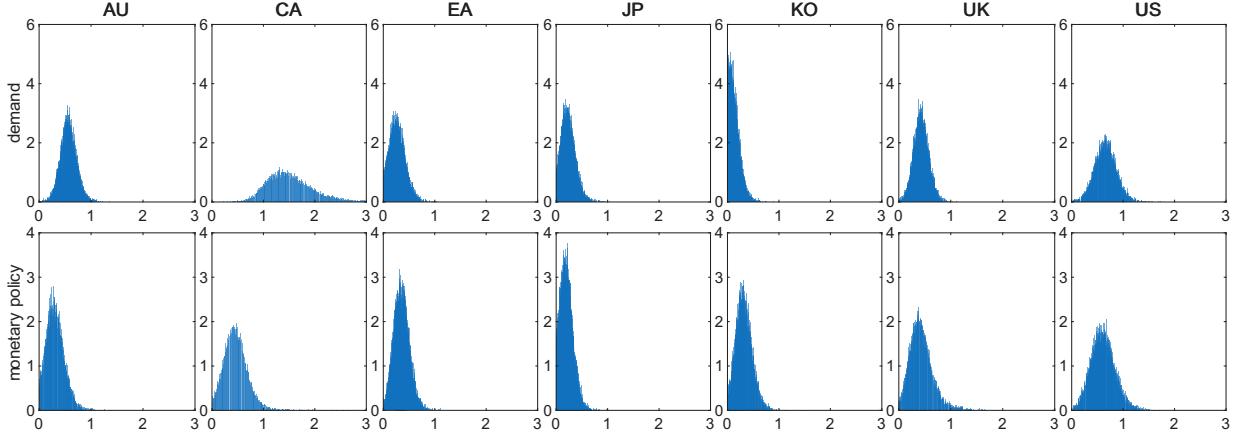


NOTES: The histograms show the posterior distribution of structural contemporaneous coefficients (blue bars; monetary policy equation, and coefficients on foreign variables) and the prior distribution (red line).

Thus, demand shocks that move output and inflation procyclically trigger systematic policy responses.

On impact, domestic shocks explain a larger share of the short-run variation in interest rates than global shocks in all countries except Canada. Foreign shocks do not generate immediate effects. That is, country-specific shocks do not generate direct spillovers. Despite this, we observe large cross-sectional interest rate correlations in the data. This hints at two interpretations. First, even relatively small contributions of global shocks can trigger simultaneous interest rate movements across countries. Second, the dominance of domestic

**Figure 4:** Relative shock sizes, global versus domestic



NOTES: The histograms show the posterior distribution of the ratio between global shock loadings and the standard deviation of the corresponding domestic shock,  $\chi_c^j / \sqrt{d_c^j}$ .

shocks suggests that spillovers take time to materialize – a point we return to in Section 3.2.

The forecast error variance decompositions and shock loadings support this view. Global shocks explain the minority (5% in Korea – 30% in the US, with the exception of Canada) of the FEVD of interest rates on impact. This is reflected in global shock loadings, which are generally smaller than the standard deviations of the corresponding domestic shocks (Figure 4). The ratio of global to domestic parameters is below one for demand and monetary policy shocks, especially in less globally exposed economies such as Korea and Japan. The notable exception is Canada (second column, first row), where global demand shocks alone explain more than 50% of the FEVD, reflecting its commodity-exporting status and strong trade integration.

The small cross-border spillovers reflect the structure of the model. Spillovers operate mainly through aggregate foreign output gaps  $y_t^*$  in the demand and exchange rate equations. Because foreign shocks affect only a single country, their impact on aggregate foreign output gaps is much smaller than that of global shocks. Moreover, the posterior estimates of the structural coefficients confirm the existence of a positive aggregate demand and a negative exchange rate channel. Higher foreign output gaps raise domestic demand, see the positive coefficient on foreign output in the demand equation ( $\beta^{c,y^*}$ , first row of Figure 3). The central banks in our sample react systematically to the resulting boom by increasing

interest rates. At the same time, they reduce competitiveness ( $\theta^{c,y}$  in the last row is applied to the difference between domestic and foreign output gaps), which induces most central banks to lower interest rates.

In sum, central banks in our sample respond in the short run to domestic inflation and output gaps, consistent with traditional mandates. Global monetary policy shocks play little role, while global demand shocks are the only ones that matter both for short-run variation and for generating international business-cycle dynamics. Section 3.4 shows they also dominate short-run interest rate correlations.

### 3.2 Interest rate fluctuations in the medium run

Our second key finding is that medium-run interest rate variation is primarily driven by shocks that synchronize business cycles, especially the three types of demand shocks. International interest rate co-movement thus reflects correlated business cycles across countries.

This is evident, first, from the contribution of shocks to medium-run interest rate variation. Demand shocks are the dominant drivers, accounting for 40–60% of the forecast error variance after 20 quarters, see Figure 2. Their growing importance reflects that they need some time to propagate across borders. Global and foreign demand shocks explain between 25% (Korea and United States) and 55% (Canada). By contrast, global and foreign monetary policy shocks contribute less than 10% at any horizon. The contribution of domestic shocks declines quickly, reaching between 15% (Canada, second subplot in Figure 2) and 45% (US, last subplot) after 20 quarters, consistent with [De Santis and Zimic \(2022\)](#).

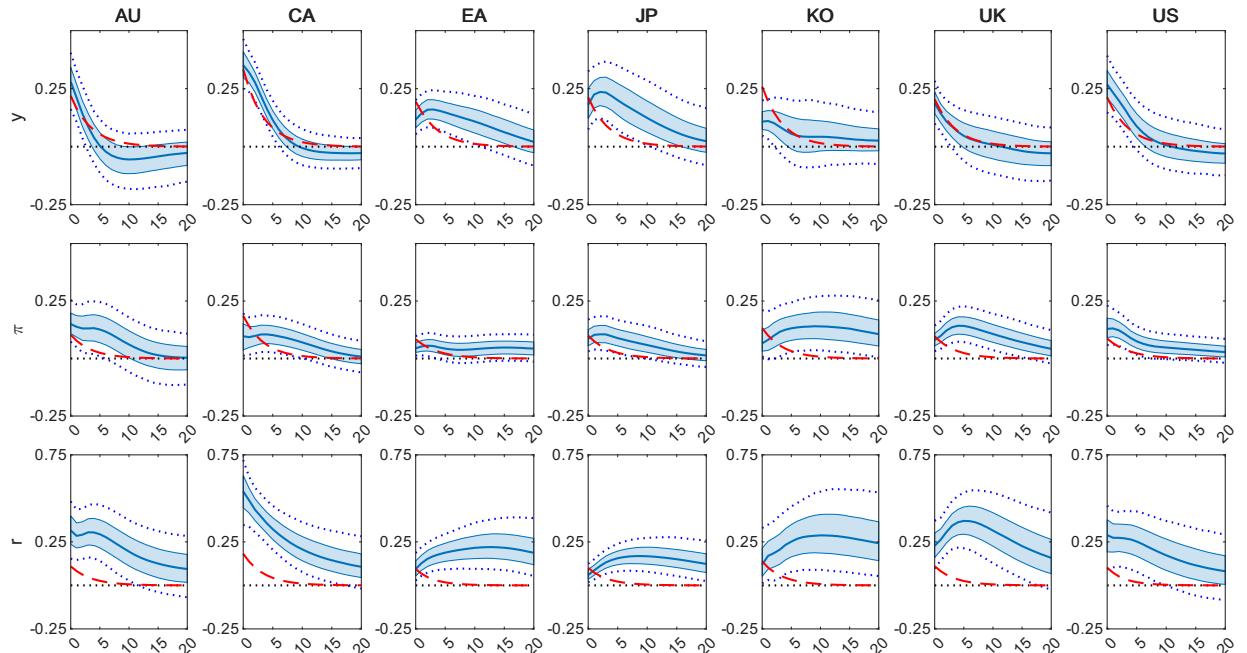
Second, the impulse response functions (IRFs) show that spillovers occur mainly through demand channels. We present IRFs to a selection of structural shocks in three figures. We always present IRFs for 20 quarters and plot 68% and 95% posterior credibility sets (shaded area and dotted lines) together with median prior responses (dashed red lines).<sup>10</sup> Figure 5 reports responses of output gaps, inflation and interest rates (variable in rows, countries in columns) to global demand shocks for 20 quarters, with the 68% and 95% posterior

---

<sup>10</sup>Additional IRFs can be found in Online Appendix Figures D.9 to D.21.

credibility sets (shaded area and dotted lines) and median prior responses (dashed red lines). Figure 6 reports interest rate responses (columns) to US and EA demand shocks (rows). Figure 7 covers interest rate responses (columns) to domestic demand, supply, and monetary policy shocks (rows). Across all cases, posterior dynamics are far more persistent than the prior, especially for foreign and global shocks, underscoring the informativeness of the data.

**Figure 5:** Impulse responses of interest rates to global demand shocks



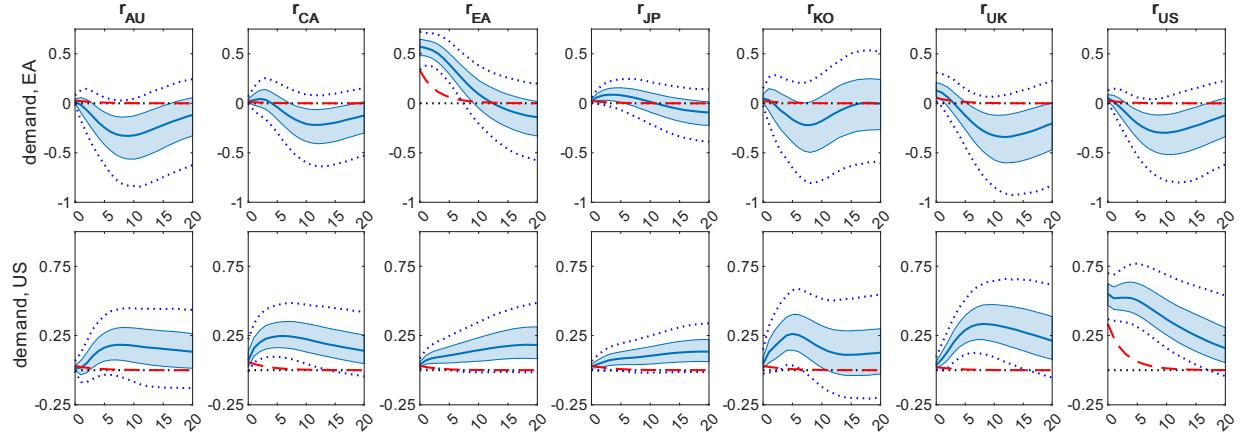
NOTES: The solid lines in the figure show median impulse responses of country-specific output gaps (first row), inflation (second row) and interest rates (third row) to global demand shocks over 20 quarters. The shaded areas (dotted lines) show the 68% (95%) posterior credibility sets. Dashed red lines show prior median response. The posterior shocks have size of one unit. Prior IRFs are scaled for comparison.

Global demand shocks drive co-movements in interest rates through monetary policy responses to common shifts in output and inflation. Output gaps and inflation rise on impact and remain elevated for at least five quarters, see Figure 5. The interest rate response reflects both domestic channels, which dominate in the short run, and cross-country spillovers, which become more relevant over the medium run. Central banks raise rates quickly and keep them elevated, most notably in Canada, where global demand shocks matter most. These findings align with [Mumtaz and Surico \(2009\)](#) and [Charnavoki and Dolado \(2014\)](#) who document similar dynamics of global supply and demand shocks on

activity, inflation, and commodity prices using structural factor models.

The medium-run contribution of global supply and monetary policy shocks is substantially smaller than for global demand shocks because of small or heterogeneous IRFs. Interest rate responses to global supply shocks (first row in Figure D.13) are hump-shaped. Initially, domestic supply effects dominate, but in the medium run, spillovers through aggregate demand emerge. Higher foreign output raises domestic demand, prompting monetary tightening. Credibility sets mostly include zero, except for the EA and UK, where global supply shocks also account for about 10% of the FEVD. We discuss the IRFs to global monetary policy shocks separately in section 3.3, where we document that direct monetary policy spillovers play a limited role for international interest rate co-movements.

**Figure 6:** Impulse responses of interest rates to EA and US demand shocks

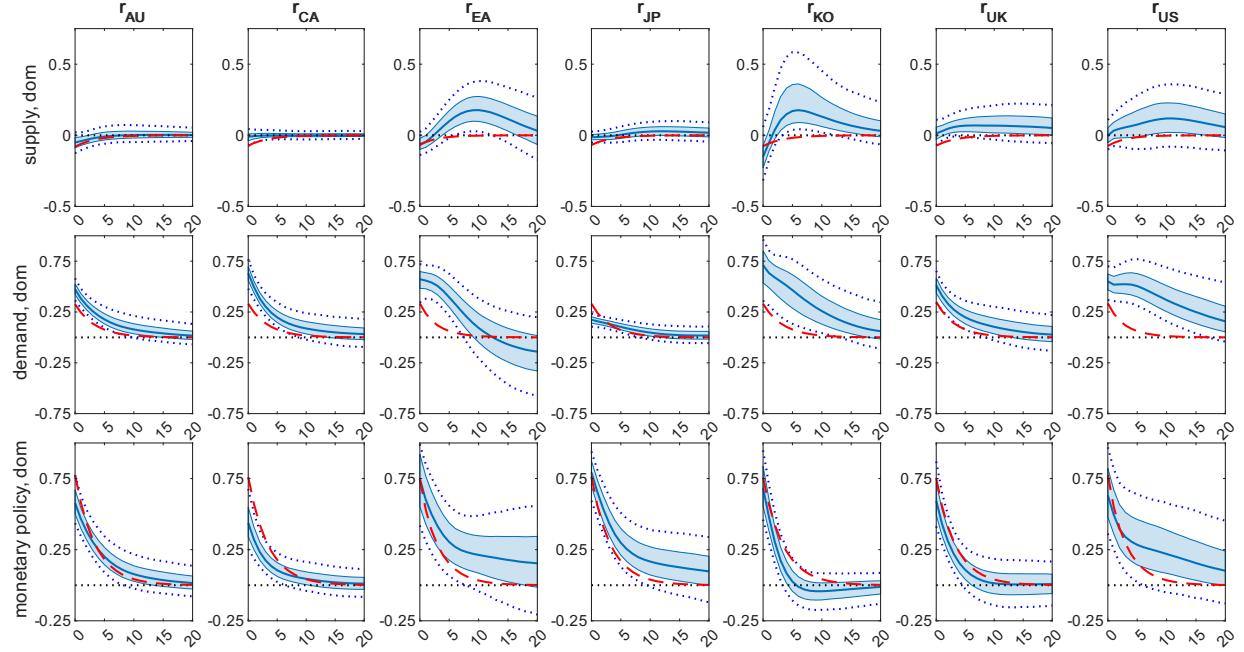


NOTES: The third (seventh) column in the first (last) two rows show *domestic* responses, the other ones *foreign* responses. The solid lines in the figure show median impulse responses of country-specific interest rates (in columns) to EA and US demand shocks (in rows) over 20 quarters. The shaded areas (dotted lines) show the 68% (95%) posterior credibility sets. Dashed red lines show prior median response. The shocks have size of one unit.

We next focus on EA and US demand shocks. Foreign interest rates respond to both, but in opposite directions, see Figure 6. US shocks raise foreign interest rates after a short delay by about as much as global demand shocks. After five quarters, foreign interest rates increase by around 0.25 percentage points, with zero outside the 95% credibility sets in all countries except Australia. In contrast, EA demand shocks reduce foreign rates in the medium run, of similar size but less statistical credibility. The sign difference reflects divergent effects on inflation and output. US shocks increase inflation (almost everywhere)

and output (in most cases), while EA shocks depress foreign output in the medium run (see Online Appendix Figures D.17 and D.18).

**Figure 7:** Impulse responses of interest rates to domestic shocks



NOTES: The solid lines in the figure show median impulse responses of country-specific interest rates (in columns) to country-specific demand, supply and monetary policy shocks (in rows) over 20 quarters. The shaded areas (dotted lines) show the 68% (95%) posterior credibility sets. Dashed red lines show prior median response. To make them economically comparable, the shocks are normalized a size of one unit. Differences across shock variances are shown in Application Figure D.22.

Domestic IRFs (Figure 7) explain the declining role of domestic shocks in the FEVD. Domestic demand and monetary policy shocks drive large short-run fluctuations in interest rates, inflation, and output – larger than global shocks – hence their dominance at short horizons. But their effects fade quickly, reducing long-run importance. Domestic demand shocks (second row) raise interest rates everywhere, peaking within a year. Unexpected monetary tightening (third row) produces an immediate spike. Domestic supply shocks (first row) generate smaller and mostly insignificant responses. These patterns mirror the FEVDs: e.g., responses to Korean demand shock (fifth column) are more persistent than to monetary policy shocks, matching their different medium-run contributions to the FEVD.

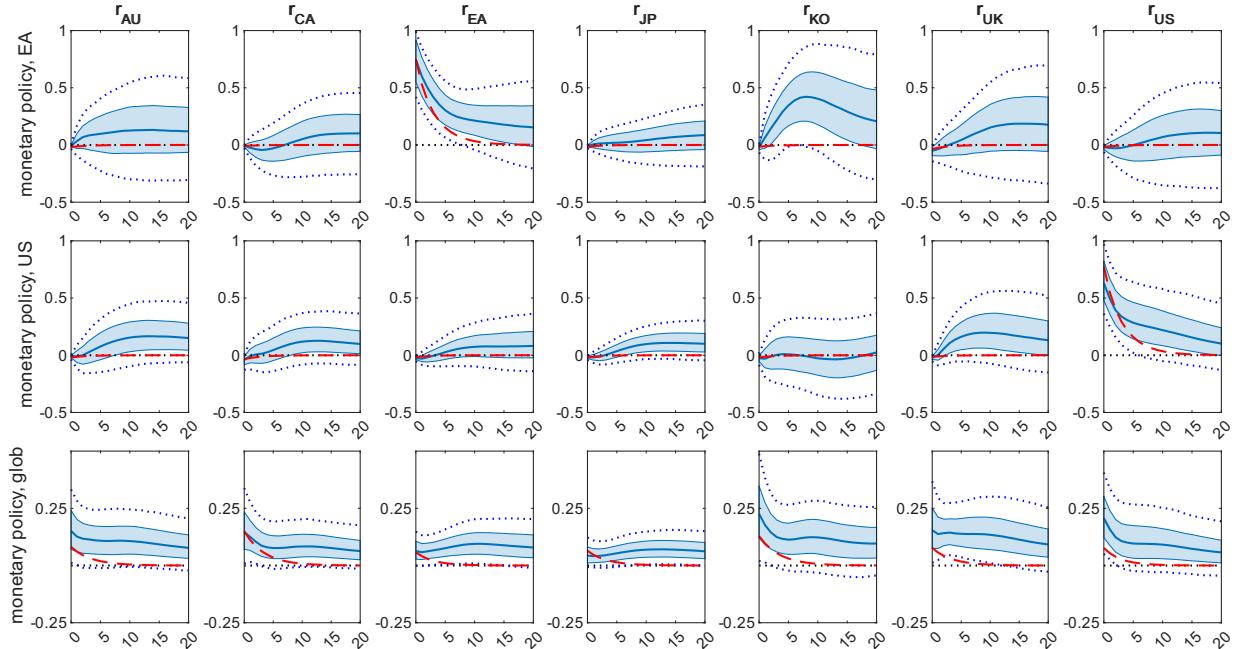
In sum, demand shocks – domestic, foreign, and global – are the primary drivers of common interest rate variation. They generate international co-movement in interest rates

as central banks endogenously react to changes in inflation and output.

### 3.3 The role of monetary policy shocks

Our third key piece of evidence concerns spillovers from global and foreign monetary policy shocks. Their contribution to international interest rate co-movement is small: forecast error variance decompositions attribute only about 10% of interest rate variation across countries and horizons to these shocks (Figure 2), and cross-country spillovers are limited.

**Figure 8:** Impulse responses of interest rates to EA, and US and global monetary policy shocks



NOTES: The solid lines in the figure show median impulse responses of country-specific interest rates to EA (first row), US (second row), and global (third row) monetary policy shocks over 20 quarters. The shaded areas (dotted lines) show the 68% (95%) posterior credibility sets. Dashed red lines show prior median response. The posterior shocks have size of one unit. Prior IRFs are scaled for comparison.

The impulse response functions illustrate how these shocks transmit across borders. Contractionary global monetary policy shocks (first row in Figure 8) generate positive and persistent co-movement in interest rates. But the effects are weak. Credibility sets often include zero, in some cases already on impact (EA and Japan). The same holds for responses of output gaps and inflation (see Online Appendix Figure D.15). Foreign monetary policy shocks from the EA and US show no robust international spillovers (second and third row in Figure 8). Responses are positive but statistically insignificant, with especially high

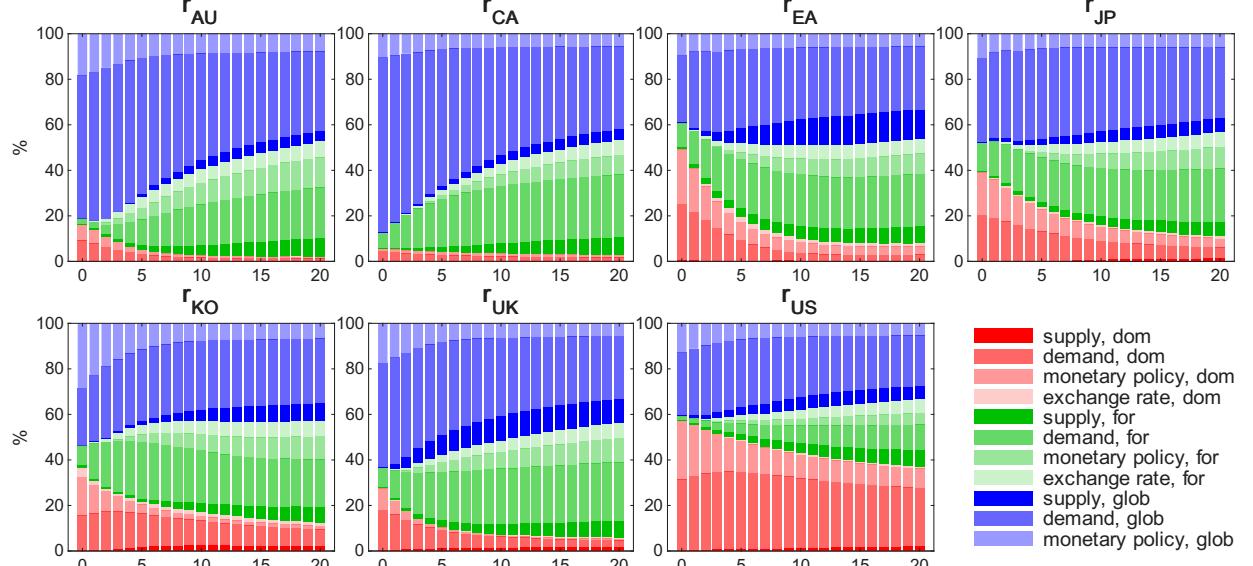
uncertainty for EA shocks. Output gaps in the EA and US recover quickly, dampening spillovers and even producing small temporary booms abroad after one to three years.

Our monetary policy rule estimates confirm this picture. Central banks act almost exclusively on domestic output and inflation, see the second and third row of Figure 3. Across all countries, the weight on output gaps is larger than assumed a priori. The Taylor principle holds in approximately 80% of the draws, and more frequently if the output gap coefficient is small. Exchange rate coefficients (fourth row) are nonzero in all countries except the EA and US, but they remain small, consistent with the muted exchange rate responses to monetary policy shocks (Online Appendix Figures D.12, D.15, D.19).

[Miranda-Agrifino and Rey \(2020\)](#) argue that central banks raise domestic rates to prevent capital outflows after foreign tightening, which implies relevant direct spillovers of monetary policy shocks. We test this by extending monetary policy rules to include either aggregate foreign interest rates or US rates. In an even broader specification, we allow for a potentially greater role of all contemporaneous foreign fundamentals and simultaneously include foreign interest rates, inflation, and output gaps. The robustness checks show that monetary authorities in some economies (notably Canada, Japan and UK) react modestly to foreign interest rate changes, with a small but positive coefficient on foreign interest rates. By contrast, the coefficients on foreign inflation and output gaps remain tightly estimated around zero. These short-lived reactions do not change our main results, see Online Appendix Figure E.1.

Taken together, our findings show that international monetary policy spillovers are limited. We interpret the small role of global and foreign monetary policy shocks as evidence of substantial monetary policy autonomy: central banks are largely shielded from foreign influence. However, these results may not generalize to other currency areas. Emerging economies, where exchange rate regimes and capital controls matter more, could display very different dynamics.

**Figure 9:** Detailed forecast error correlation decomposition between global and country-specific interest rates



NOTES: The figure shows median forecast error correlation decomposition between global (GDP weighted) and country-specific interest rates (in subplots) to domestic (dom) and foreign (for) supply, demand, monetary policy and exchange rate shocks and global (glob) supply, demand and monetary policy shocks over 20 quarters.

### 3.4 What drives interest rate correlations?

We now examine a more direct measure of international co-movement: the correlation of forecast errors between country-specific and global interest rates. These results build on our earlier findings on the importance of global and foreign shocks in driving interest rate dynamics and the aggregate demand channels as the key spillover mechanism.

Figure 9 quantifies co-movement by decomposing these correlations. We compute global interest rates as the GDP-weighted average of country-specific rates. Adapting the standard formula for the forecast error variance decomposition, the contribution of shock  $k$  to the covariance of forecast errors between the interest rates of country  $c$  and the global interest rate at horizon  $H$  is

$$FECorD(c, g, k, h) = 100 \times \frac{\sum_{h=0}^{H-1} \theta_{ck,h} \theta_{gk,h} d_k}{\sum_{k=1}^n \sum_{h=0}^{H-1} \theta_{ck,h} \theta_{gk,h} d_k}$$

where  $\theta_{ck,h}$  is the impulse-response of interest rates of country  $c$  to shock  $k$  at horizons  $h = \{0, \dots, H-1\}$  and  $\theta_{gk,h}$  the response of the global interest rate.

Our fourth piece of evidence shows that demand shocks (mainly global and foreign) account for most of the unexplained component of interest rate correlations. The three types of demand shocks together explain 45% and 85% to the correlation on impact and 50-60% after 20 quarters, see Figure 9, exceeding their contribution to the FEVD. Their stronger influence reflects synchronized business cycle fluctuations that translate into interest rate co-movements. They are also the only shocks for which the 95% credibility sets of foreign and global shocks regularly exclude zero, see Online Appendix Table D.1.

Monetary policy shocks explain less – 10-40% on impact and 15-20% at long horizons. Distinguishing types reveals a contrast: global monetary policy shocks are on average as important as domestic ones for forecast error correlations, even though they contribute little to the forecast error variances in Figure 2. This supports our earlier argument that country-specific monetary policy shocks generate only weak spillover dynamics.

The importance of domestic monetary policy shocks partly reflects country size, as the global rate is a GDP-weighted average. Yet, size alone cannot explain cross-country differences. Domestic shocks are as important in Japan and Korea (fourth and fifth subplot) as in the EA (third subplot). This points to openness as another factor. Larger, more closed economies are less exposed to global and foreign shocks. For of the US, domestic shocks dominate, explaining 60% on impact and 35% at long horizons. By contrast, in smaller and more open economies (Australia and Canada), global and foreign shocks account for nearly all the correlation after 20 quarters (around 95%, with demand shocks alone above 50%).

To isolate the “mechanical” part of the correlation, we replace the global interest rate with the US rate. In this setup, domestic shocks explain correlations almost exclusively for the US (Online Appendix Figure D.4). Yet, the FECorDs based on US rates still support our main conclusion, demand shocks remain the dominant contributors.

A further difference between the decomposition of forecast error correlations in Figure 9 and variances in Figure 2 concerns foreign shocks. While their overall role is limited, they affect short-run correlations. In particular, foreign demand shocks matter more for correlations than for variances. The impulse responses in Figure 6 show that they generate

common business cycle fluctuations that synchronize interest rate movements. Other foreign shocks, by contrast, yield more heterogeneous responses and thus weaker co-movement.

In sum, our results reinforce the papers' core insight. International interest rate correlations arise because inflation-targeting central banks respond in similar ways to common fluctuations in prices and output. These are mainly caused by demand shocks.

### 3.5 What are global shocks?

Global shocks are essential drivers of economic fluctuations in our model. To underline their crucial role, we evaluate whether the data support their inclusion. Specifically, we compare the fit of the baseline model with global shocks against a restricted version without them, using the Savage-Dickey density ratio ([Verdinelli and Wasserman, 1995](#)). In this restricted model, the restrictions imply  $\chi_c^j = 0$  for all countries and equations. As in [Chan \(2018\)](#) the Bayes factor supporting the unrestricted model is given by the log Savage-Dickey density ratio as:

$$\log(SDDR) = \log \left( \frac{p(\chi = \mathbf{0})}{p(\chi = \mathbf{0} | \mathbf{Y}_T)} \right),$$

defined as the marginal prior density relative to the marginal posterior density evaluated at the restriction. The majority of loadings are clearly different from zero, see also the ratios of loadings over domestic shock standard deviations in [Figure 4](#). Accordingly, we find  $\log(SDDR) = 638$ , strongly supporting including global shocks.

How should we interpret these global shocks? Global supply shocks are linked to oil supply disruptions but also capture global supply disturbances. Examples include the Venezuela oil strike (December 2002), the start of the Iraq War (March 2003), and the Libyan Civil War (February 2011), all associated with negative global supply shocks ([Online Appendix Figure D.23](#)). Other episodes – such as China's WTO accession and the Fukushima nuclear disaster with its disruption of global supply chains – coincide with significant global supply shocks.

Global demand shocks can also be linked to specific events. The Chernobyl nuclear disaster (April 1986) and the September 11 terrorist attacks coincide with strong negative

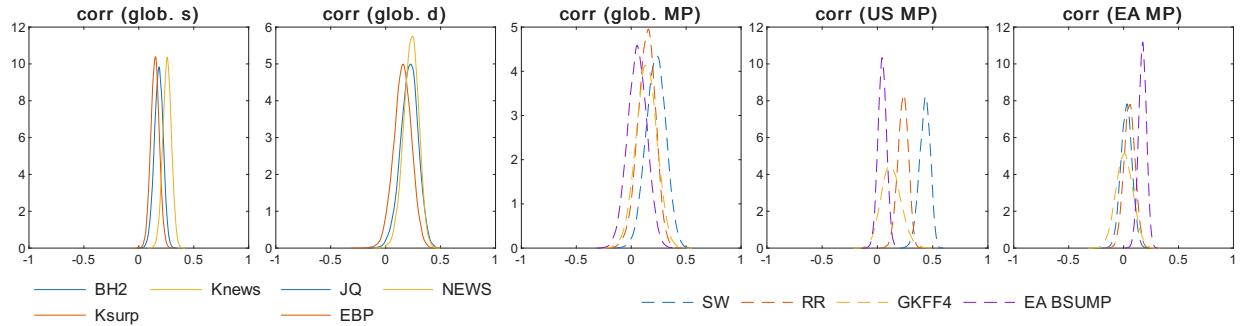
demand shocks. A sequence of large negative global demand shocks begins with the collapse of Lehman Brothers (September 2008), peaking during the 2009 global financial crisis. These patterns suggest that major uncertainty and credit supply shocks disrupting financial markets manifest in our model as negative global demand shock. This result is robust across different model specifications.

We include global monetary policy shocks because monetary policy shocks may be internationally correlated ([Georgiadis and Jančoková, 2020](#)). These shocks improve the statistical fit of the model, with a log SDDR of about 50. However, their 95% credibility sets rarely exclude zero, so evidence for unexpected joint monetary policy action is weak. Two episodes stand out. First, the unexpected global stock market crash on October 19, 1987, coincides with a negative global monetary policy shock. Second, on October 8, 2008, central banks (Bank of Canada, the Bank of England, the European Central Bank, the Federal Reserve, Sveriges Riksbank, and the Swiss National Bank, with support of Bank of Japan) issued a joint policy statement and cut interest rates by 50 basis points ([Badinger and Schiman, 2023](#)). Yet at the quarterly frequency, interest rates in all countries fell much more (between 1 and 2 percentage points in most countries, except Japan). This quarter coincides with the height of the financial crisis, which is better captured by a global demand shock.

To further assess these links, we compute correlations (at each posterior draw) between global supply shocks and established instruments for oil supply shocks (Figure 10, first subplot). Global supply shocks correlate positively with exogenous expansions of oil supply. Similarly, global demand shock are positively correlated to proxies of expansionary credit supply shocks from the literature (second subplot). Yet correlations never exceed 0.5, indicating that our global shocks also capture broader worldwide developments.

The last three subplots in Figure 10 display correlations of global, US and EA monetary policy shocks with standard monetary policy instruments (three for the US, one for the EA). Domestic shocks show the expected correlation. Global monetary policy shocks are only positively correlated to US shocks from the DSGE-model of [Smets and Wouters \(2007\)](#) (blue dashed line), but the correlation is much smaller than for direct US shocks. Moreover,

**Figure 10:** Correlation of global shocks, and US and EA monetary policy shocks with common shock proxies from the literature



NOTES: The histograms show the correlation of the posterior draws of the global shocks with various shock proxies from the literature, always multiplied such that the proxy is expansionary. *BH2*: oil supply shocks of [Baumeister and Hamilton \(2019\)](#); *Ksurp*: oil supply expectation shocks of [Kängig \(2021\)](#); *Knews*: oil supply news instrument of [Kängig \(2021\)](#) based on high-frequency changes in oil futures prices around OPEC production announcements; *JQ*: innovations to the financial conditions index of [Jermann and Quadrini \(2012\)](#); *EBP*: excess bond premium of [Gilchrist and Zakrajšek \(2012\)](#); *NEWS*: textual proxy series of [Mumtaz et al. \(2018\)](#) counting the words “credit crunch” and “tight credit” in nine US newspapers; *SW*: monetary policy shocks from the DSGE model of [Smets and Wouters \(2007\)](#); *RR*: Romer-Romer-type instrument provided by [Coibion et al. \(2017\)](#); *GKFF4*: high-frequency instrument from [Gertler and Karadi \(2015\)](#); *EA BSUMP*: EA monetary policy shocks identified through narrative sign restrictions in [Badinger and Schiman \(2023\)](#).

that model assumes a closed economy and thus does not distinguish between global and local shocks as we do ([Georgiadis and Jančoková, 2020](#)).

### 3.5.1 Differences to the global financial cycle

Our global demand shocks are related to worldwide financial disruptions. ([Rey, 2015](#); [Miranda-Agrippino and Rey, 2020, 2022](#)), among others, highlights such disturbances as drivers of risky asset co-movements, labeled the “global financial cycle” (GFC). This raises the question whether our model shifts co-movements in financial variables into the global demand shock. We find otherwise: residuals from an AR(4) model of the GFC factor show no correlation with global shocks, but are negatively correlated with US monetary policy shocks.

To test this formally, we augment the baseline model with the GFC factor from [Miranda-Agrippino and Rey \(2020\)](#) as an additional endogenous variable to isolate the influence of the global financial cycle on country-specific developments.<sup>11</sup> Two pieces of evidence in-

<sup>11</sup>We use the quarterly average of the GFC factor updated to 2019Q1, as provided on <http://>

dicate that while both our global demand shocks and the GFC are related to financial disturbances, the two are not equivalent as the global demand shock captures demand disruptions more broadly. First, a residual shock to the GFC factor has hardly any contribution to the forecast error correlations of interest rates to the global interest rate after five years. Moreover, the country-specific loadings of the global demand shock are of similar size compared to the model without the GFC factor, Online Appendix Figure E.7. Second, the impulse response functions to a residual GFC shock are not consistent with a global demand shock, see Online Appendix Figure E.8. Growth rates of real effective exchange rates fall strongly on impact in almost all countries. Most other responses are zero or contain zero in their credibility sets. The exception is the US, where output increases and inflation falls on impact.

### 3.5.2 Differences to US shocks

The economic size and importance of the US begs the question whether our global shocks are simply observationally indistinguishable US shocks. To investigate this, we consider three alternative specifications where we attribute a special role to the US.

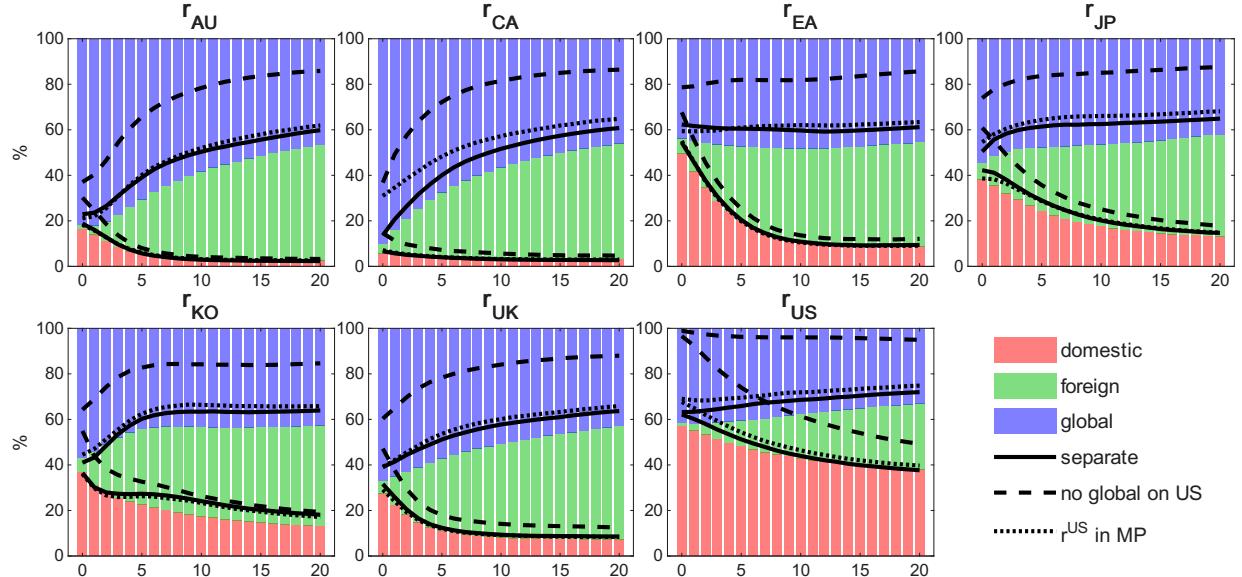
First, we relax the homogeneity assumption and allow structural coefficients  $\mathbf{A}$  on US variables to be different from other foreign variables. We find that allowing for a unique role of direct spillovers from the US to other countries does not change the importance of global shocks, see solid lines labeled *separate* in Figure 11.

Second, we assume that global shocks do not directly influence US developments, by setting US loadings to zero. This implies, conversely, that unexpected US developments are not contained in global shocks. By construction the contribution of global shocks to the correlation of global and US interest rates is extremely close to zero, as they affect the US economy only through their influence on foreign economic development. For the remaining countries foreign shocks gain importance while global shocks loose compared to the baseline

---

[silviamirandaagrippino.com/code-data](http://silviamirandaagrippino.com/code-data) [accessed 26 June 2023]. The GFC factor enters contemporaneously into all baseline equations, while all variables contemporaneously affect the GFC factor in the new equation. Priors on the additional contemporaneous parameters are wide (Student  $t$  priors with mode zero and scale one).

**Figure 11:** Forecast error correlation decomposition between global and country-specific interest rates for alternative US specifications



NOTES: Figure shows the forecast error correlation decomposition between global and country-specific interest rates for the baseline model (bars) together with three alternative US specifications (lines).

model, see the dark dash-dotted lines in Figure 11, labeled *no global on US*. It shows that our global shocks are not only driven by US developments but are less important as the part of the US shocks correlated with other countries' shocks contributes strongly to the global shocks. Removing US loadings does not nullify the importance of global shocks, as the posterior distributions of other loadings are all positive, with posterior mass not pressed against zero.

Third, we allow for a dominant US central bank by including US interest rates directly in the policy rules of other countries, thus allowing for an additional direct spillover channel. The prior distribution of the new structural parameter  $\psi^{c,r^{US}}$  follows a t-distribution with mean zero, scale 0.4 and 3 degrees of freedom. More than 80% of the posterior mass of this coefficient is negative for the EA, consistent with monetary policy anticipating a cooling of the economy after an interest rate increase in the US. Above 90% of the posterior is positive for CA, implying a central bank reaction more in-line with capital flow pressures. For AU, JP, KO, and UK, the coefficient is centered around zero. The contribution to the forecast error correlations of interest rates is nearly identical to the baseline, indicating robustness of our model in that regard, see dark dotted lines in Figure 11 labeled *r<sup>US</sup> in MP*.

Overall, our tests indicate that US developments are important parts of identified global shocks due to its sheer size, but that the US is not “special” enough to be treated differently from the other countries in our sample.

### 3.6 Further robustness checks

We check robustness to alternative specifications of aggregate supply and the exchange rate equations in Online Appendix [E.1](#). To that end, we first add foreign output gaps in the supply equation, restricting the coefficient to be positive. Second, we adjust the exchange rate equation such that interest rate differential enter. Hence, we model directly the uncovered interest rates parity such that differences in interest rates between the countries should equalize relative changes in exchange rates, potentially strengthening the exchange rate channel for the transmission of monetary policy shocks. Results do not change considerably: the role of global shocks decreases marginally, when we include foreign output in the supply curve, and increases slightly under the assumption of UIP. Once we restrict our sample to the 21st century (following a recent argument of [Engel and Wu, 2024](#)), global shocks become much more important, decreasing the contribution of domestic shocks.

We also test whether global supply and demand shocks create additional spillovers in commodity exporters (Australia and Canada, in our sample) through exchange rate movements, see Online Appendix Section [E.2](#). Specifically, we let these two shocks load positively (supply) and negatively (demand) on the exchange rate equation. The new loadings are significantly different from zero. The importance of global shocks goes down at the expense of foreign shocks. Other basic results remain qualitatively unchanged.

Moreover, our results remain the same for changes in the model-set up, shown in Online Appendix [E.3](#). Our findings are not sensitive to the use of shadow rates in two robustness check that (a) use data only until 2007:Q3 only and (b) additionally exclude Japan, which hit the zero lower bound already in 1995Q3. We also test whether using log differences of real GDP instead of output gaps changes our main findings. It does so marginally, lowering the contribution of foreign shocks and increasing the importance of global shocks.

Finally, we run a robustness check starting only in 1999, and find that global shocks become significantly more important, mostly at the expense of domestic shocks.

Our results are also robust to the explicit inclusion of a fifth variable capturing financial transmission channels. We discuss this in Online Appendix Section [E.4](#).

## 4 Conclusion

Central bank interest rates are internationally correlated. These correlations may stem from direct spillovers of monetary policy shocks from a dominant economy. Alternatively, monetary policy may respond systematically to common business cycle fluctuations, consistent with mandates focused on domestic inflation and output gaps.

To quantify the drivers of interest rate forecast error variance and cross-country correlations, we develop a flexible Bayesian structural panel VAR model. Our framework includes supply, demand, monetary policy, and exchange rate equations for seven advanced economies, with informative priors on contemporaneous coefficients. Country-specific policy rule parameters provide evidence on the systematic, rule-based conduct of monetary policy. We extend the model using a factor structure to distinguish between domestic, foreign, and global structural shocks. The relative importance of monetary policy shocks informs the question of whether direct spillovers are present.

Our results provide evidence that interest rates move together internationally because central banks systematically respond to correlated domestic fluctuations. These fluctuations are predominantly driven by domestic, foreign, and global demand shocks. Monetary policy does not respond directly to foreign monetary policy shocks. Hence, our findings imply that central banks in the economies of our sample act autonomously.

## References

- Adolfson, M., Laseen, S., Lindé, J., Villani, M., 2007. Bayesian Estimation of an Open Economy DSGE Model with Incomplete Pass-Through. *Journal of International Economics* 72, 481–511.
- Antolín-Díaz, J., Rubio-Ramírez, J.F., 2018. Narrative Sign Restrictions for SVARs. *American Economic Review* 108, 2802–29.
- Badinger, H., Schiman, S., 2023. Measuring Monetary Policy in the Euro Area Using SVARs with Residual Restrictions. *American Economic Journal: Macroeconomics* 15, 279–305.
- Bauer, M., Neely, C., 2014. International Channels of the Fed’s Unconventional Monetary Policy. *Journal of International Money and Finance* 44, 24–46.
- Baumeister, C., Hamilton, J.D., 2015. Sign Restrictions, Structural Vector Autoregressions, and Useful Prior Information. *Econometrica* 83, 1963–1999.
- Baumeister, C., Hamilton, J.D., 2018. Inference in Structural Vector Autoregressions When the Identifying Assumptions are not Fully Believed: Re-Evaluating the Role of Monetary Policy in Economic Fluctuations. *Journal of Monetary Economics* 100, 48–65.
- Baumeister, C., Hamilton, J.D., 2019. Structural Interpretation of Vector Autoregressions with Incomplete Identification: Revisiting the Role of Oil Supply and Demand Shocks. *American Economic Review* 109, 1873–1910.
- Bluwstein, K., Canova, F., 2016. Beggar-Thy-Neighbor? The International Effects of ECB Unconventional Monetary Policy Measures. *International Journal of Central Banking* 12, 69–120.
- Camehl, A., 2023. Penalized Estimation of Panel Vector Autoregressive Models: A Panel LASSO Approach. *International Journal of Forecasting* 39, 1185–1204.

- Canova, F., Ciccarelli, M., 2004. Forecasting and Turning Point Predictions in a Bayesian Panel VAR Model. *Journal of Econometrics* 120, 327–359.
- Chan, J.C.C., 2018. Specification Tests for Time-Varying Parameter Models with Stochastic Volatility. *Econometric Reviews* 37, 807–823.
- Charnavoki, V., Dolado, J.J., 2014. The Effects of Global Shocks on Small Commodity-Exporting Economies: Lessons from Canada. *American Economic Journal: Macroeconomics* 6, 207–37.
- Chen, Q., Filardo, A., He, D., Zhu, F., 2016. Financial Crisis, US Unconventional Monetary Policy and International Spillovers. *Journal of International Money and Finance* 67, 62–81.
- Coibion, O., Gorodnichenko, Y., Kueng, L., Silvia, J., 2017. Innocent Bystanders? Monetary Policy and Inequality. *Journal of Monetary Economics* 88, 70–89.
- Crespo Cuaresma, J., Doppelhofer, G., Feldkircher, M., Huber, F., 2019. Spillovers from US Monetary Policy: Evidence from a Time Varying Parameter Global Vector Auto-Regressive Model. *Journal of the Royal Statistical Society Series A: Statistics in Society* 182, 831–861.
- Curcuru, S.E., Pooter, M.D., Eckerd, G., 2018. Measuring Monetary Policy Spillovers between U.S. and German Bond Yields. *International Finance Discussion Papers* 1226. Board of Governors of the Federal Reserve System (U.S.).
- De Santis, R.A., Zimic, S., 2022. Interest Rates and Foreign Spillovers. *European Economic Review* 144, 104043.
- Dedola, L., Rivolta, G., Stracca, L., 2017. If the Fed sneezes, who catches a cold? *Journal of International Economics* 108, S23–S41.
- Dees, S., di Mauro, F., Smith, L.V., Pesaran, M.H., 2007. Exploring the International Linkages of the Euro Area: A Global VAR Analysis. *Journal of Applied Econometrics* 22, 1–38.

Del Negro, M., Giannone, D., Giannoni, M.P., Tambalotti, A., 2019. Global trends in interest rates. *Journal of International Economics* 118, 248–262.

Engel, C., Wu, S.P.Y., 2024. Exchange Rate Models are Better than You Think, and Why They Didn't Work in the Old Days. NBER Working paper 32808.

Feldkircher, M., Huber, F., 2016. The International Transmission of US Shocks - Evidence from Bayesian Global Vector Autoregressions. *European Economic Review* 81, 167 – 188.

Forbes, K., Ha, J., Kose, M.A., 2024. Rate Cycles. CEPR Discussion Papers 19272. C.E.P.R. Discussion Papers.

Fratzscher, M., Duca, M.L., Straub, R., 2018. On the International Spillovers of US Quantitative Easing. *Economic Journal* 128, 330–377.

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, 615–642.

Georgiadis, G., 2015. Examining Asymmetries in the Transmission of Monetary Policy in the Euro Area: Evidence from a Mixed Cross-Section Global VAR Model. *European Economic Review* 75, 195–215.

Georgiadis, G., Jančoková, M., 2020. Financial Globalisation, Monetary Policy Spillovers and Macro-Modelling: Tales from 1001 Shocks. *Journal of Economic Dynamics and Control* 121, 104025.

Gerko, E., Rey, H., 2017. Monetary Policy in the Capitals of Capital. *Journal of the European Economic Association* 15, 721–745.

Gertler, M., Karadi, P., 2015. Monetary Policy Surprises, Credit Costs, and Economic Activity. *American Economic Journal: Macroeconomics* 7, 44–76.

- Geweke, J., 1992. Evaluating the Accuracy of Sampling-Based Approaches to the Calculation of Posterior Moments, in: Bayesian Statistics 4: Proceedings of the Fourth Valencia International Meeting, Dedicated to the memory of Morris H. DeGroot, 1931–1989. Oxford University Press.
- Giannone, D., Lenza, M., Primiceri, G.E., 2015. Prior Selection for Vector Autoregressions. *The Review of Economics and Statistics* 97, 436–451.
- Gilchrist, S., Zakrjšek, E., 2012. Credit Spreads and Business Cycle Fluctuations. *American Economic Review* 102, 1692–1720.
- Holston, K., Laubach, T., Williams, J.C., 2017. Measuring the natural rate of interest: International trends and determinants. *Journal of International Economics* 108, S59–S75.
- Jarociński, M., 2022. Central Bank Information Effects and Transatlantic Spillovers. *Journal of International Economics* 139, 103683.
- Jermann, U., Quadrini, V., 2012. Macroeconomic Effects of Financial Shocks. *American Economic Review* 102, 238–71.
- Justiniano, A., Preston, B., 2010. Monetary Policy and Uncertainty in an Empirical Small Open-Economy Model. *Journal of Applied Econometrics* 25, 93–128.
- Käenzig, D.R., 2021. The Macroeconomic Effects of Oil Supply News: Evidence from OPEC Announcements. *American Economic Review* 111, 1092–1125.
- Kim, S., 2001. International Transmission of U.S. Monetary Policy Shocks: Evidence from VAR's. *Journal of Monetary Economics* 48, 339–372.
- Kim, S., Roubini, N., 2000. Exchange Rate Anomalies in the Industrial Countries: A Solution with a Structural VAR Approach. *Journal of Monetary Economics* 45, 561–586.
- Koop, G., Korobilis, D., 2016. Model Uncertainty in Panel Vector Autoregressive Models. *European Economic Review* 81, 115–131.

- Koop, G., Korobilis, D., 2019. Forecasting with High-Dimensional Panel VARs. *Oxford Bulletin of Economics and Statistics* 81, 937–959.
- Korobilis, D., 2016. Prior Selection for Panel Vector Autoregressions. *Computational Statistics and Data Analysis* 101, 110–120.
- Korobilis, D., 2022. A New Algorithm for Structural Restrictions in Bayesian Vector Autoregressions. *European Economic Review* 148, 104241.
- Krippner, L., 2013. Measuring the Stance of Monetary Policy in Zero Lower Bound Environments. *Economics Letters* 118, 135–138.
- Kulish, M., Rees, D., 2011. The yield curve in a small open economy. *Journal of International Economics* 85, 268–279.
- Liu, L., Matthes, C., Petrova, K., 2022. Monetary Policy across Space and Time, in: Essays in Honour of Fabio Canova. Emerald Publishing Limited. volume 44B of *Advances in Econometrics*, pp. 37–64.
- Lubik, T.A., Schorfheide, F., 2004. Testing for Indeterminacy: An Application to U.S. Monetary Policy. *American Economic Review* 94, 190–217.
- Lubik, T.A., Schorfheide, F., 2007. Do Central Banks Respond to Exchange Rate Movements? A Structural Investigation. *Journal of Monetary Economics* 54, 1069–1087.
- Maćkowiak, B., 2007. External Shocks, U.S. Monetary Policy and Macroeconomic Fluctuations in Emerging Markets. *Journal of Monetary Economics* 54, 2512–2520.
- Miranda-Agrippino, S., Nenova, T., 2022. A tale of two global monetary policies. *Journal of International Economics* 136, 103606.
- Miranda-Agrippino, S., Rey, H., 2020. US Monetary Policy and the Global Financial Cycle. *The Review of Economic Studies* 87, 2754–2776.
- Miranda-Agrippino, S., Rey, H., 2022. The Global Financial Cycle. *Handbook of International Economics* 6, 1–43.

- Mumtaz, H., Pinter, G., Theodoridis, K., 2018. What Do VARs Tell Us about the Impact of a Credit Supply Shock? *International Economic Review* 59, 625–646.
- Mumtaz, H., Surico, P., 2009. The Transmission of International Shocks: A Factor-Augmented VAR Approach. *Journal of Money, Credit and Banking* 41, 71–100.
- Neely, C.J., 2015. Unconventional Monetary Policy Had Large International Effects. *Journal of Banking & Finance* 52, 101–111.
- Ramey, V.A., 2016. Macroeconomic Shocks and their Propagation. *Handbook of Macroeconomics* 2, 71–162.
- Rey, H., 2015. Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence. NBER Working Papers 21162.
- Rey, H., 2016. International Channels of Transmission of Monetary Policy and the Mundelian Trilemma. *IMF Economic Review* 64, 6–35.
- Rogers, J.H., Scotti, C., Wright, J.H., 2018. Unconventional Monetary Policy and International Risk Premia. *Journal of Money, Credit and Banking* 50, 1827–1850.
- Romer, C.D., Romer, D.H., 2004. A New Measure of Monetary Shocks: Derivation and Implications. *American Economic Review* 94, 1055–1084.
- Sims, C.A., Zha, T., 1998. Bayesian Methods for Dynamic Multivariate Models. *International Economic Review* 39, 949–68.
- Smets, F., Wouters, R., 2007. Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach. *American Economic Review* 97, 586–606.
- Stock, J.H., Watson, M.W., 2005. Understanding Changes in International Business Cycle Dynamics. *Journal of the European Economic Association* 3, 968–1006.
- Verdinelli, I., Wasserman, L., 1995. Computing Bayes Factors Using a Generalization of the Savage-Dickey Density Ratio. *Journal of the American Statistical Association* 90, 614–618.

# Online Appendix to “What explains international interest rate co-movement?”

Annika Camehl Gregor von Schweinitz

September 22, 2025

# A Data

**Table A.1:** Data

Variable	Description
baseline VAR variables	
$y$	output gap; source: Oxford Economics, datastream codes AUXOGAP.R, CNXOGAP.R, EKXOGAP.R, JPXOGAP.R, KOXOGAP.R, UKXOGAP.R, USXOGAP.R
$\pi$	year-on-year inflation rate calculated from consumer prices (all items); source: IMF-IFS and Eurostat, Datastream codes AUI64...F, CNI64...F, EMCONPRCF, JPI64...F, KOI64...F, UKI64...F, USI64...F
$r$	quarterly average of monthly policy rates and Krippner shadow rates; sources: <a href="https://www.ljkmfa.com/">https://www.ljkmfa.com/</a> and national central banks, Datastream codes (dates of shadow rate) AUPRATE., CNB14044, EMREPO.. (02/2009-12/2019), JPPRATE. (09/1995-12/2019), KOI60B.., UKPRATE. (12/2008-10/2017), FREFEDFD (11/2008-07/2016)
$q$	real effective exchange rate (narrow), defined as nominal effective exchange rate times the ratio of a weighted sum of foreign price indices relative to a domestic price index; source: BIS (we are using the inverse of the data), <a href="https://www.bis.org/statistics/eer.htm">https://www.bis.org/statistics/eer.htm</a>
Variables for VAR extensions	
$sp$	stock prices, yoy growth rates; source: Thomson Reuters, Datastream codes: AUSHRPRCF, CN-SHRPRCF, EMSHRPRCF, JPSHRPRCF, KOSHPRRCF, UKSHRPRCF, USSHRPRCF
$ts$	term spread, long-term bond yields minus $r$ ; source (bond yields): Thomson Reuters, Datastream codes AUGBOND., CNGBOND., EMGBOND., JPGBOND., KOGBOND., UKGBOND., USGBOND.
$GDP(real)$	use to calculate <i>output growth</i> and <i>GDP weights</i> ; source: OECD Quarterly National Accounts, Oxford Economics, Datastream codes: AUOEXP03D, CNOEXP03D, EKXGDSA.D, JPOEXP03D, KOOEXP03D, UKOEXP03D, USOEXP03D
External instruments, used to cross-check with global shocks	
BH2	Median of oil supply shocks identified from <a href="#">Baumeister and Hamilton (2019)</a> , updated to December 2022, <a href="https://sites.google.com/site/cjsbaumeister/research">https://sites.google.com/site/cjsbaumeister/research</a>
Ksurp	monthly oil supply surprise shocks from <a href="#">Käenzig (2021)</a> , updated to December 2022, <a href="https://github.com/dkaenzig/oilsupplynews">https://github.com/dkaenzig/oilsupplynews</a>
Knews	monthly oil supply news shocks from <a href="#">Käenzig (2021)</a> , updated to December 2022, <a href="https://github.com/dkaenzig/oilsupplynews">https://github.com/dkaenzig/oilsupplynews</a>
JQ	Innovations to the financial conditions index of <a href="#">Jermann and Quadrini (2012)</a> as used in <a href="#">Mumtaz et al. (2018)</a>
EBP	Excess bond premium of <a href="#">Gilchrist and Zakrajšek (2012)</a> as used in <a href="#">Mumtaz et al. (2018)</a>
NEWS	Textual proxy for credit supply shocks, from <a href="#">Mumtaz et al. (2018)</a>
SW	US Monetary policy shocks from <a href="#">Smets and Wouters (2007)</a>
RR	US Romer-Romer monetary policy shocks, <a href="#">Romer and Romer (2004)</a>
GKFF4	US High-frequency monetary policy shocks from <a href="#">Gertler and Karadi (2015)</a>
EA BSUMP	EA High-frequency and narrative monetary policy shocks, <a href="#">Badinger and Schiman (2023)</a>

## B Theoretical model for identifying restrictions

Following [Lubik and Schorfheide \(2007\)](#), we consider a model with an international Phillips curve, IS curve, monetary policy rule, and (real) exchange rate equation, to which we add common shifts of country-specific supply and demand curves in the form of global supply and demand shocks. The set of equations for country  $c \in \{1, \dots, C\}$  is given by:

$$y_{ct} = \frac{\tilde{\tau}^c}{\kappa^c} \left[ \mu^{c,s} + \pi_{ct} - \beta^c E[\pi_{ct+1}] + \frac{\alpha^c \beta^c}{1 - \alpha^c} E[q_{ct+1}] - \frac{\alpha^c}{1 - \alpha^c} q_{ct} \right] + \chi_c^s u_{gt}^s + u_{ct}^s \quad (\text{B.1})$$

$$y_{ct} = \mu^{c,d} + E[y_{ct+1}] - \tilde{\tau}^c (r_{ct} - E[\pi_{ct+1}]) + \alpha^c (2 - \alpha^c) \frac{1 - \tau^c}{\tau^c} E[y_{ct+1}^*] + \dots \quad (\text{B.2})$$

$$+ \frac{\alpha^c \tilde{\tau}^c}{1 - \alpha^c} E[q_{ct+1}] + \chi_c^d u_{gt}^d + u_{ct}^d$$

$$r_{ct} = \rho^c r_{it-1} + (1 - \rho^c) [(\psi^{c,1} + \psi^{c,3}) \pi_{ct} + \psi^{c,2} y_{ct} + \psi^{c,3} (q_{ct} - \pi_{ct}^*)] + \chi_c^m u_{gt}^m + u_{ct}^m \quad (\text{B.3})$$

$$q_{ct} = \mu^{c,q} - \frac{1 - \alpha^c}{\tilde{\tau}^c} (y_{ct}^* - y_{ct}) + u_{ct}^q \quad (\text{B.4})$$

with

$$\tilde{\tau}^c = \tau^c + \alpha^c (2 - \alpha^c) (1 - \tau^c), \quad y_{ct}^* = \sum_{c^* \neq c} w_{cc^*} y_{c^*t}, \quad \pi_{ct}^* = \sum_{c^* \neq c} w_{cc^*} \pi_{c^*t},$$

Equation (B.1) expresses the open economy Phillips curve. Supply depends on inflation and changes in the exchange rate. The parameter  $\alpha^c$ ,  $0 < \alpha^c < 1$ , measures the import share. When  $\alpha^c = 0$ , the model reduces to a closed economy set-up.  $\tau^c$  gives the intertemporal substitution elasticity,  $\beta^c$  the discount factor, and  $\kappa^c$  the slope coefficient of the Phillips curve.

Equation (B.2) models the open economy IS curve. Demand is expressed as a function of interest rates, inflation, foreign output, and changes in the exchange rate. We substitute expectations in equations (B.1) and (B.2) with simple autoregressive forecasts, following [Baumeister and Hamilton \(2018\)](#). We model the expected value of a variable  $z$  as  $z_{t+1|t} = c^z + \phi^z z_{t|t}$ . We set the autoregressive parameter equal for all variables, as  $\phi^c = 0.75$ .<sup>1</sup> The term  $c^z$  is absorbed in the constant terms. The parameter  $\zeta^c$  weights expected output in the IS curve. The Phillips and IS curve can then be expressed as

$$y_{ct} = \frac{\tilde{\tau}^c}{\kappa^c} \left[ \mu^{c,s} + (1 - \beta^c \phi^c) \left[ \pi_{ct} - \frac{\alpha^c}{1 - \alpha^c} q_{ct} \right] \right] + u_{ct}^s \quad (\text{B.5})$$

$$y_{ct} = \frac{1}{1 - \zeta^c \phi^c} \left[ \mu^{c,d} - \tilde{\tau}^c (r_{ct} - \phi^c \pi_{ct}) + \alpha^c (2 - \alpha^c) \frac{1 - \tau^c}{\tau^c} (\phi^c - 1) y_{ct}^* + \frac{\alpha^c \tilde{\tau}^c \phi^c}{1 - \alpha^c} q_{ct} \right] + u_{ct}^d \quad (\text{B.6})$$

<sup>1</sup>Note that [Lubik and Schorfheide \(2007\)](#) include in some equations expected changes in variables (as opposed to expected values of the variables). In such cases, we model the expected value of a change in variable  $z_{t+1}$ , denoted by  $E(\Delta z_{t+1}) = (0.75 - 1)z_t$ .

The monetary policy authority sets interest rates according to the rule given in equation (B.3). The parameter  $\psi^{c,1}$  captures the response of the monetary policy authority to changes in inflation,  $\psi^{c,2}$  reflects the reaction to output, and  $\psi^{c,3}$  to changes in the nominal exchange rate.  $\rho^c$  is a smoothing parameter, smoothing the implementation of monetary policy over time. Equation (B.4) relates changes in the exchange rate to differences in foreign and domestic output. We use that under PPP [Lubik and Schorfheide \(2007\)](#) express inflation as  $\pi_{ct} = ex_{ct} + (1 - \alpha^c)tot_{ct} + \pi_{ct}^*$  where  $ex_{ct}$  are changes in the nominal exchange rate and  $tot_{ct}$  changes in terms of trade. Thus, the real exchange rate relates to terms of trades as  $tot_{ct} = -\frac{1}{1-\alpha^c}q_{ct}$ .

Our coefficients in the panel SVAR model given in equations (s) to (er) are related to the structural parameters in the theoretical model in the following way:

$$\begin{aligned}\alpha^{c,\pi} &= \frac{\tilde{\tau}^c}{\kappa^c}(1 - \beta^c\phi^c), \quad \alpha^{c,q} = -\frac{\tilde{\tau}^c}{\kappa^c}(1 - \beta^c\phi^c)\frac{\alpha^c}{1 - \alpha^c} \\ \beta^{c,r} &= -\frac{1}{1 - \zeta^c\phi^c}\tilde{\tau}^c, \quad \beta^{c,\pi} = \frac{1}{1 - \zeta^c\phi^c}\tilde{\tau}^c\phi^c \\ \beta^{c,y*} &= \frac{1}{1 - \zeta^c\phi^c}\alpha^c(2 - \alpha^c)\frac{1 - \tau^c}{\tau^c}(\phi^c - 1), \quad \beta^{c,q} = \frac{1}{1 - \zeta^c\phi^c}\frac{\alpha^c\tilde{\tau}^c\phi^c}{1 - \alpha^c} \\ \psi^{c,\pi} &= \psi^{c,1} + \psi^{c,3}, \quad \psi^{c,y} = \psi^{c,2}, \quad \psi^{c,q} = \psi^{c,3} \\ \theta^{c,y} &= \frac{1 - \alpha^c}{\tilde{\tau}^c}.\end{aligned}$$

## C Econometric model

In this Appendix, we describe our econometric approach, and our algorithm (Metropolis-within-Gibbs) in more detail. First, we show how homogeneity restrictions simplify identification of the matrix of structural contemporaneous coefficients  $\mathbf{A}$ . Second, we explain the flexibility on the prior structure that we gain through hierarchical priors for structural variances  $\mathbf{D}$  ([Giannone et al., 2015](#)). We can draw from the hierarchical priors using the same Metropolis-Hastings-Algorithm as the elements of  $\mathbf{A}$ , which simplifies our algorithm significantly. Third, we show how global shocks and their loadings can be included in the Gibbs sampler as in [Korobilis \(2022\)](#).

For ease of reading, we repeat the mathematical notation. As our baseline, we estimate a Bayesian structural panel VAR with global shocks using  $J = 4$  variables from a panel of  $C = 7$  countries. In matrix notation, our model is

$$\begin{aligned}\mathbf{A}\mathbf{y}_t &= \mathbf{B}\mathbf{x}_{t-1} + \chi\mathbf{u}_{gt} + \mathbf{u}_t \\ \mathbf{u}_t &\sim \mathcal{N}(\mathbf{0}, \mathbf{D}), \quad \mathbf{u}_{gt} \sim \mathcal{N}(\mathbf{0}, \mathbf{I}_G).\end{aligned}$$

The model has  $n = CJ$  equations, jointly indexed by subscript  $c \in \{1, \dots, C\}$  and superscript  $j \in \{s, d, m, er\}$ . Variables are indexed by  $i \in \{y, \pi, r, q\}$ . The  $[G \times 1]$  vector

$\mathbf{u}_{gt} = (u_{gt}^s, u_{gt}^d, u_{gt}^m)$  contains global supply, demand and monetary policy shocks. The loadings  $\chi_c^j$  for structural equation  $j$  in country  $c$  are stacked in the  $[n \times G]$  loading matrix  $\chi$ :

$$\chi = \begin{bmatrix} \left( \text{diag}(\chi_1) \right)' & \left( \text{diag}(\chi_2) \right)' & \dots & \left( \text{diag}(\chi_G) \right)' \\ \mathbf{0}_{J-G \times G} & \mathbf{0}_{J-G \times G} & & \mathbf{0}_{J-G \times G} \end{bmatrix}'$$

with  $\chi_c = (\chi_c^s, \chi_c^d, \chi_c^m)$ .

Because the structural shocks of the model are assumed to be mutually independent (i.e.,  $\mathbf{D}$  is assumed to be diagonal), it is worthwhile to write down the individual structural equations. Let  $\mathbf{a}_c^j$  and  $\mathbf{b}_c^j$  be the  $(1 \times n)$ - and  $(1 \times k)$ -dimensional row vectors of structural coefficients (contemporaneous and lagged) in structural equation  $j$  of country  $c$ , and  $d_c^j$  the variance of the corresponding structural domestic shocks. Differentiating between equations with and without global shocks, the structural equation  $j$  in country  $c$  is

$$\mathbf{a}_c^j \mathbf{y}_t = \begin{cases} \mathbf{b}_c^j \mathbf{x}_{t-1} + \chi_c^j u_{gt}^j + u_{ct}^j, & u_{ct}^j \sim \mathcal{N}(0, d_c^j), \quad u_{gt}^j \sim \mathcal{N}(0, 1) \quad , \text{ if } j \in \{s, d, m\} \\ \mathbf{b}_c^j \mathbf{x}_{t-1} + u_{ct}^j, & u_{ct}^j \sim \mathcal{N}(0, d_c^j) \quad , \text{ if } j \in \{er\} \end{cases}.$$

## C.1 Identification of the global shocks

Conditional on  $\mathbf{A}$ , we assume that the structural shocks have a “combined” representation  $\check{u}_{ct}^j = \chi_c^j u_{gt}^j + u_{ct}^j$ . To identify the latent global shocks,  $u_{gt}^j$ , and their loadings,  $\chi_c^j$ , we assume the following. First, we let  $u_{gt}^j$  follow a standard normal distribution and restrict the correlation across global shocks to be zero (as done in static factor models). Second, following [Korobilis \(2022\)](#), we impose sign restrictions on loadings  $\chi_c^j > 0$ , which are used to identify economically interpretable global shocks, and make the structural factor model more explicit.

In the reduced form the combined shocks  $\check{u}_{ct}^j$  feature a full covariance matrix,

$$\mathbf{A}^{-1} \chi \chi' (\mathbf{A}^{-1})' + \mathbf{A}^{-1} \mathbf{D} (\mathbf{A}^{-1})'.$$

In order to identify global shocks in the reduced form, one would usually need sign restrictions on all reduced-form loadings  $\mathbf{A}^{-1} \chi$ . That requires up to  $n \times G$  restrictions instead of only  $n$  restrictions on the structural model.

## C.2 Homogeneity restrictions on structural contemporaneous parameters

The total number of structural contemporaneous coefficients  $\mathbf{A}$  increases quadratically with the number of countries in the panel. In order to deal with the resulting curse of

dimensionality in the identification of  $\mathbf{A}$ , we assume that the foreign coefficients in the vector  $\mathbf{a}_c^j$  are identical up to a scaling constant  $w_{cc'}$ , which is the average trade share of foreign country  $c'$  in the total trade of country  $c$ . This homogeneity restriction means that we only have to identify posterior distributions for the  $J$  domestic and  $J$  foreign coefficients of structural equation  $j$  in country  $c$ . These coefficients can be summarized in the  $[2J \times 1]$  vector  $\tilde{\mathbf{a}}_c^j$ .

As an example, let us look at the structural contemporaneous coefficients in the first four equations, which correspond to Australia. Combining the four row vectors into one  $4 \times 8$ -matrix  $\tilde{\mathbf{A}}_{AU}$ , our baseline model identifies

$$\tilde{\mathbf{A}}_{AU} = \begin{pmatrix} 1 & -\alpha^{AU,\pi} & 0 & \alpha^{AU,q} & 0 & 0 & 0 & 0 \\ 1 & -\beta^{AU,\pi} & -\beta^{AU,r} & -\beta^{AU,q} & -\beta^{AU,y^*} & 0 & 0 & 0 \\ -(1 - \rho^{AU})\psi^{AU,y} & -(1 - \rho^{AU})\psi^{AU,\pi} & 1 & -(1 - \rho^{AU})\psi^{AU,q} & 0 & (1 - \rho^{AU})\psi^{AU,q} & 0 & 0 \\ -\theta^{AU,y} & 0 & 0 & 1 & \theta^{AU,y} & 0 & 0 & 0 \end{pmatrix}.$$

Returning to individual equations, the full coefficient vector  $\mathbf{a}_c^j$ , and thereby  $\mathbf{A}$ , can be derived from the restricted vector  $\tilde{\mathbf{a}}_c^j$  as

$$\mathbf{a}_c^j = \tilde{\mathbf{a}}_c^j \mathbf{R}_c. \quad (\text{C.1})$$

The  $2J \times n$  restriction matrix  $\mathbf{R}_c$  applies the appropriate scaling and allocates coefficients to the right position in  $\mathbf{a}_c^j$ . It is defined as

$$\mathbf{R}_c = \begin{pmatrix} \mathbf{0}_{J \times J} & \cdots & \mathbf{0}_{J \times J} & \mathbf{I}_J & \mathbf{0}_{J \times J} & \cdots & \mathbf{0}_{J \times J} \\ w_{c,1}\mathbf{I}_J & \cdots & w_{c,c-1}\mathbf{I}_J & \mathbf{0}_{J \times J} & w_{c,c+1}\mathbf{I}_J & \cdots & w_{c,C}\mathbf{I}_J \end{pmatrix}_{(2J \times n)}.$$

### C.3 Prior distributions on lag coefficients and shock variances

Let  $\iota_{r,c}$  be a  $[k \times 1]$ -vector that is one for the first lag of interest rates from country  $c$ , and zero otherwise. Let  $\mathbf{v}_1 = (1/1^2, 1/2^2, \dots, 1/p^2)'$  be a  $(p \times 1)$  vector for lag scaling, and  $\mathbf{v}_2(\mathbf{s}) = (1/s_{AU}^y, 1/s_{AU}^\pi, 1/s_{AU}^r, 1/s_{AU}^q, \dots, 1/s_{US}^q)'$  a  $(CJ \times 1)$  vector of inverse variances given by the  $(CJ \times 1)$  vector  $\mathbf{s}$ . Let  $\hat{\rho}_{cc'}^{ii'}$  be the correlation of residuals  $\hat{\mathbf{e}}_{ct}^i$  and  $\hat{\mathbf{e}}_{c't}^{i'}$  from fourth order univariate regressions of variable  $i$  ( $i'$ ) in country  $c$  ( $c'$ ). Let finally  $\mathbf{S}(\mathbf{s})$  be a prior variance-covariance matrix with entries  $\mathbf{S}_{cc'}^{ii'}(\mathbf{s}) = \sqrt{s_c^i s_{c'}^{i'}} \hat{\rho}_{cc'}^{ii'}$ .

Conditional on  $\mathbf{A}$ , we set the following prior distributions:

$$p(d_c^j | \mathbf{A}, \mathbf{s}) = \gamma((d_c^j)^{-1}; \kappa, \tau_{d_c^j}^j(\mathbf{A}, \mathbf{s})) \quad (\text{C.2})$$

$$p(\mathbf{b}_c^j | \mathbf{A}, \lambda_0, \mathbf{s}, d_c^j) = \phi(\mathbf{b}; \mathbf{m}_c^j(\mathbf{A}), d_c^j \mathbf{M}_c^j(\lambda_0, \mathbf{s})) \quad (\text{C.3})$$

$$p(s_c^i) = \gamma((s_c^i)^{-1}; \kappa_s, \tau_{s_c^i}) \quad (\text{C.4})$$

$$p(\lambda_0) = \gamma(\lambda_0; \kappa_{\lambda_0}, \tau_{\lambda_0}) \quad (\text{C.5})$$

with

$$\begin{aligned}
\tau_c^j(\mathbf{A}, \mathbf{s})) &= \kappa \mathbf{a}_c^j \mathbf{S}(\mathbf{s}) \mathbf{a}_c^{j'} \\
\mathbf{m}_c^j(\mathbf{A}, \mathbf{s}, \lambda_0) &= \begin{cases} \mathbf{M}_c^j(\lambda_0, \mathbf{s}) \left[ (\text{diag}(\mathbf{v}_3(\lambda_0, \mathbf{s})))^{-1} \eta \mathbf{a}_c^{j'} + \left( \frac{\rho_c}{V_\rho} \iota_{r,c} \right)' \right] & j = m \\ \eta \mathbf{a}_c^{j'} & \text{otherwise} \end{cases} \\
\mathbf{M}_c^j(\lambda_0, \mathbf{s}) &= \begin{cases} \left( (\text{diag}(\mathbf{v}_3(\lambda_0, \mathbf{s})))^{-1} + \text{diag}(\frac{1}{V_\rho} \iota_{r,c}) \right)^{-1} & \text{if } j = m \\ \text{diag}(\mathbf{v}_3(\lambda_0, \mathbf{s})) & \text{otherwise} \end{cases} \\
\mathbf{v}_3(\lambda_0, \mathbf{s}) &= \lambda_0^2 \begin{pmatrix} \mathbf{v}_1 \otimes (\text{diag}(\omega \otimes \mathbf{1}_{(J \times 1)}) \mathbf{v}_2(\mathbf{s})) \\ 100^2 \times \mathbf{1}_{(2 \times 1)} \end{pmatrix}
\end{aligned}$$

As in [Baumeister and Hamilton \(2018\)](#), the prior mean of structural lag coefficients distribution combines (a) the prior belief that the data follow an AR(1) process with AR-coefficient  $\phi = 0.75$ , and (b) that the central bank engages in interest-rate smoothing, as described by the structural coefficient  $\rho^c$ . We give this prior a variance of  $V_\rho = 0.1$ .

We increase the tightness of priors on structural lag coefficients considerably in order to deal with the curse-of-dimensionality. We do this by multiplying the prior variance of every coefficient related to a variable from country  $c$  by  $\omega_c^2$ , where  $\omega_c$  is the average share of GDP of country  $c$  in our sample.

We choose  $\kappa_s = 0.1$ . The scale  $\tau_{s_c^i}$  is set to 0.05 for output gaps, inflation and interest rates, and to 2 for real effective exchange rate growth. This ensures that  $\mathbf{E}(1/s_c^i) = \frac{\tau_{s_c^i}}{\kappa_{s_c^i}}$  is roughly similar to the variance of residuals  $\hat{\mathbf{e}}_{ct}^i$ . For  $\lambda_0$ , we use a gamma-distribution with mode 0.2 and standard deviation 0.4 (i.e.,  $\kappa_{\lambda_0} = 1.64$ ,  $\tau_{\lambda_0} = 0.3125$ ) ([Sims and Zha, 1998](#); [Giannone et al., 2015](#)).

## C.4 Posterior distributions and algorithm

### C.4.1 Posterior distributions

Our posterior sample is an extension of the Metropolis-within-Gibbs of [Baumeister and Hamilton \(2015\)](#) that accounts for hyperparameters for the Minnesota prior, as well as global shocks and their loadings. Two things are worthwhile to note before we develop the full sampler. First, we can sample from the known conditional posterior distributions of global shocks and loadings in the Gibbs sampler as in [Korobilis \(2022\)](#). Second, the sampling of hyperparameters in [Giannone et al. \(2015\)](#) requires a Metropolis step that uses the same likelihood kernel as the sampling of structural contemporaneous coefficients  $\mathbf{A}$ . That is, we can sample  $(\mathbf{A}, \lambda_0, \mathbf{s})$  together in the same step, as proven in subsection C.4.2.

Let the  $(T \times n)$ -dimensional matrix  $\mathbf{Y} = (\mathbf{y}_1, \dots, \mathbf{y}_T)'$  and  $(T \times k)$ -dimensional matrix  $\mathbf{X} = (\mathbf{x}_0, \dots, \mathbf{x}_{T-1})'$  collect all observations. For country  $c$  and structural equation  $j$ , we construct extended data  $\tilde{\mathbf{Y}}_c^j$  and  $\tilde{\mathbf{X}}_c^j$  by applying two data modifications. First, we

condition on  $\mathbf{A}$  and hyperparameters  $\lambda_0, \mathbf{s}$ , and append the corresponding normal prior  $\mathcal{N}(\mathbf{m}_c^j, d_c^j \mathbf{M}_c^j)$  as dummy observations (for ease of readability, we drop the dependence of  $\mathbf{m}_c^j$  and  $\mathbf{M}_c^j$  on  $(\mathbf{A}, \lambda_0, \mathbf{s})$ ). Let  $\mathbf{P}_c^j$  be the Cholesky factor of  $(\mathbf{M}_c^j)^{-1}$ , i.e.  $(\mathbf{M}_c^j)^{-1} = \mathbf{P}_c^j \mathbf{P}_c^{j'}$ . Second, we shift global shocks to the left-hand side of the equation such that – conditional on all other parameters of the model – structural lags and variances follow normal-inverse gamma distributions as in [Baumeister and Hamilton \(2018\)](#). The properly augmented data for country  $c$  and structural equation  $j$  are defined as:

$$_{(T+k+1) \times 1} \tilde{\mathbf{Y}}_c^j = \begin{pmatrix} \left( \mathbf{a}_c^j \mathbf{Y}' - \chi_c^j \mathbf{U}_{gT}^{j'} \right)' \\ \mathbf{m}_c^j \mathbf{P}_c^{j'} \end{pmatrix}, \quad _{(T+k+1) \times (k+1)} \tilde{\mathbf{X}}_c^j = \begin{pmatrix} \mathbf{X} \\ \mathbf{P}_c^{j'} \end{pmatrix}$$

Conditional on global shocks  $\mathbf{U}_{gT}$ , these augmented data can be used to derive the posterior distributions of  $\mathbf{A}, \tilde{\mathbf{B}}, \chi, \mathbf{D}$  just as in [Baumeister and Hamilton \(2015\)](#) and [Giannone et al. \(2015\)](#), see also the following subsection [C.4.2](#):

$$p(\mathbf{A}, \lambda_0, \mathbf{s} | \mathbf{Y}_T, \chi, \mathbf{U}_{gT}) \propto p(\mathbf{A}) p(\lambda_0) p(\mathbf{s}) [\det(\mathbf{A} \hat{\Omega} \mathbf{A}') ]^{T/2} \prod_{c=1}^C \prod_{j=1}^J \frac{|\mathbf{M}_c^{j*}|^{1/2}}{|\mathbf{M}_c^j|^{1/2}} \frac{(\tau_c^j)^{\kappa_c^j}}{(2\tau_c^{j*}/T)^{\kappa_c^{j*}}} \frac{\Gamma((\kappa_c^j)^*)}{\Gamma(\kappa_c^j)} \quad (\text{C.6})$$

$$p(\mathbf{D} | \mathbf{A}, \lambda_0, \mathbf{s}, \mathbf{Y}_T, \chi, \mathbf{U}_{gT}) = \prod_{c=1}^C \prod_{j=1}^J \gamma \left( (d_c^j)^{-1}; \kappa_c^{j*}, \tau_c^{j*} \right) \quad (\text{C.7})$$

$$p(\mathbf{B} | \mathbf{A}, \lambda_0, \mathbf{s}, \mathbf{D}, \mathbf{Y}_T, \chi, \mathbf{U}_{gT}) = \prod_{c=1}^C \prod_{j=1}^J \phi(\mathbf{b}_c^j; \mathbf{m}_c^{j*}, \mathbf{M}_c^{j*}) \quad (\text{C.8})$$

with

$$\begin{aligned} \kappa_c^{j*} &= \kappa_c^j + T/2 \\ \tau_c^{j*} &= \tau_c^j + \zeta_c^{j*}/2 \\ \zeta_c^{j*} &= \tilde{\mathbf{Y}}_c^{j'} \tilde{\mathbf{Y}}_c^j - \tilde{\mathbf{Y}}_c^{j'} \tilde{\mathbf{X}}_c^j \left( \tilde{\mathbf{X}}_c^{j'} \tilde{\mathbf{X}}_c^j \right)^{-1} \tilde{\mathbf{X}}_c^{j'} \tilde{\mathbf{Y}}_c^j \\ \mathbf{m}_c^{j*} &= \left[ \left( \tilde{\mathbf{X}}_c^{j'} \tilde{\mathbf{X}}_c^j \right)^{-1} \tilde{\mathbf{X}}_c^{j'} \tilde{\mathbf{Y}}_c^j \right]' \\ \mathbf{M}_c^{j*} &= \left( \tilde{\mathbf{X}}_c^{j'} \tilde{\mathbf{X}}_c^j \right)^{-1}. \end{aligned}$$

Using [Korobilis \(2022\)](#), we can derive the conditional posterior distributions of global shocks and their loadings. This is particularly easy in our baseline case, where each structural equation is affected by at most one global shock.<sup>2</sup>

<sup>2</sup>A possible extension where multiple shocks load onto one equation, such as in a robustness check where global supply and demand shocks load onto exchange rates of commodity-exporting countries, are also easy to derive.

The conditional posterior distributions of loading  $\chi_c^j$  depends on the correlation between global shocks  $\mathbf{u}_{gt}^j$  and combined structural shocks  $\check{\mathbf{u}}_{ct}^j = [\mathbf{a}_c^j \mathbf{Y}'_T - \mathbf{b}_c^j \mathbf{X}'_T]'$ :

$$p(\chi_c^j | \mathbf{A}, \lambda_0, \mathbf{s}, \mathbf{B}, \mathbf{D}, \mathbf{Y}_T, \mathbf{U}_{gt}) = \mathcal{TN}_{\chi_c^j > 0} \left( V_{\chi, c}^{j*} (\mathbf{u}_{gt}^j)' \check{\mathbf{u}}_{ct}^j, d_c^j V_{\chi, c}^{j*} \right) \quad (\text{C.9})$$

$$V_{\chi, c}^{j*} = \left( (\mathbf{u}_{gt}^j)' \mathbf{u}_{gt}^j + V_{\chi}^{-1} \right)^{-1}$$

With  $\check{\mathbf{U}}_T$  the  $(T \times n)$  matrix of correlated structural shocks from all equations, the posterior distribution of global shocks  $\mathbf{U}_{gt}$  is given by:

$$p(\mathbf{U}_{gt} | \mathbf{A}, \lambda_0, \mathbf{s}, \mathbf{B}, \mathbf{D}, \mathbf{Y}_T, \chi) = \mathcal{N} \left( \left( \mathbf{M}_g^* \chi' \mathbf{D}^{-1} \check{\mathbf{U}}_T' \right)', \mathbf{M}_g^* \right) \quad (\text{C.10})$$

$$\mathbf{M}_g^* = \left( I_G + \chi' \mathbf{D}^{-1} \chi \right)^{-1}$$

#### C.4.2 Derivation of equation (C.6)

Considering that the prior distributions  $p(\mathbf{A}, \lambda_0, \mathbf{s})$  are independent, and that the prior distributions of  $p(\mathbf{A}, \lambda_0, \mathbf{s}, \mathbf{B}, \mathbf{D})$  do not depend on global shocks, we have after rearranging:

$$p(\mathbf{Y}_T, \mathbf{A}, \lambda_0, \mathbf{s}, \mathbf{B}, \mathbf{D} | \chi, \mathbf{U}_{gt}) \quad (\text{C.11})$$

$$= p(\mathbf{A}, \lambda_0, \mathbf{s}) p(\mathbf{D} | \mathbf{A}, \lambda_0, \mathbf{s}) p(\mathbf{B} | \mathbf{A}, \lambda_0, \mathbf{s}, \mathbf{D}) p(\mathbf{Y}_T | \mathbf{A}, \lambda_0, \mathbf{s}, \mathbf{B}, \mathbf{D}, \chi, \mathbf{U}_{gt})$$

$$= p(\mathbf{A}) p(\lambda_0) p(\mathbf{s}) (2\pi)^{-Tn/2} |\det(\mathbf{A})|^T$$

$$\times \prod_{c=1}^C \prod_{j=1}^J \left\{ (d_c^j)^{-(\kappa_c^j - 1)} \frac{(\tau_c^j)^{\kappa_c^j}}{\Gamma(\kappa_c^j)} \frac{\Gamma(\kappa_c^{j*})}{(\tau_c^{j*})^{\kappa_c^{j*}}} \frac{(\tau_c^{j*})^{\kappa_c^{j*}}}{\Gamma(\kappa_c^{j*})} (d_c^j)^{-T/2} \exp \left[ -\frac{\tau_c^{j*}}{d_c^j} \right] \right.$$

$$\times \frac{|\mathbf{M}_c^{j*}|^{1/2}}{|\mathbf{M}_c^j|^{1/2}} \frac{1}{(2\pi)^{k/2} |d_c^j \mathbf{M}_c^{j*}|^{1/2}} \exp \left[ -\frac{(\mathbf{b}_c^j - \mathbf{m}_c^{j*})' (\mathbf{M}_c^{j*})^{-1} (\mathbf{b}_c^j - \mathbf{m}_c^{j*})}{2d_c^j} \right] \left. \right\}$$

$$= p(\mathbf{A}) p(\lambda_0) p(\mathbf{s}) (2\pi)^{-Tn/2} |\det(\mathbf{A})|^T$$

$$\times \prod_{c=1}^C \prod_{j=1}^J \left\{ \frac{|\mathbf{M}_c^{j*}|^{1/2}}{|\mathbf{M}_c^j|^{1/2}} \frac{(\tau_c^j)^{\kappa_c^j}}{\Gamma(\kappa_c^j)} \frac{\Gamma(\kappa_c^{j*})}{(\tau_c^{j*})^{\kappa_c^{j*}}} \right\} \gamma \left( (d_c^j)^{-1}; \kappa_c^{j*}, \tau_c^{j*} \right) \phi \left( \mathbf{b}_c^j; \mathbf{m}_c^{j*}, \mathbf{M}_c^{j*} \right)$$

Equation (C.11) means that, conditional on global shocks and their loading, the posterior distribution of  $(\mathbf{A}, \lambda_0, \mathbf{s})$  is proportional to

$$p(\mathbf{A}, \lambda_0, \mathbf{s} | \mathbf{Y}_T, \chi, \mathbf{U}_{gt}) \propto p(\mathbf{A}) p(\lambda_0) p(\mathbf{s}) (2\pi)^{-Tn/2} |\det(\mathbf{A})|^T \prod_{c=1}^C \prod_{j=1}^J \left\{ \frac{|\mathbf{M}_c^{j*}|^{1/2}}{|\mathbf{M}_c^j|^{1/2}} \frac{(\tau_c^j)^{\kappa_c^j}}{\Gamma(\kappa_c^j)} \frac{\Gamma(\kappa_c^{j*})}{(\tau_c^{j*})^{\kappa_c^{j*}}} \right\}.$$

Equation (C.6) can be obtained after removing some constants and multiplying with  $|\hat{\Omega}_T|^{T/2}$ , where  $\hat{\Omega}_T$  is the variance-covariance matrix of reduced-form errors, which does

not depend on any of the model parameters:

$$p(\mathbf{A}, \lambda_0, \mathbf{s} | \mathbf{Y}_T, \chi, \mathbf{U}_{gT}) \propto p(\mathbf{A})p(\lambda_0)p(\mathbf{s}) |\det(\mathbf{A}\hat{\Omega}_T\mathbf{A})|^T \prod_{c=1}^C \prod_{j=1}^J \left\{ \frac{|\mathbf{M}_c^{j*}|^{1/2} (\tau_c^j)^{\kappa_c^j}}{|\mathbf{M}_c^j|^{1/2} \Gamma(\kappa_c^j)} \frac{\Gamma(\kappa_c^{j*})}{(2\tau_c^{j*}/T)^{\kappa_c^{j*}}} \right\}.$$

### C.4.3 Drawing from the posterior distribution

We use a Metropolis-within-Gibbs to generate draws from the posterior distributions in the following sequence:

1. Draw  $(\mathbf{A}, \lambda_0, \mathbf{s})$  from  $p(\mathbf{A}, \lambda_0, \mathbf{s} | \mathbf{Y}_T, \chi, \mathbf{U}_{gT})$ , equation (C.6), in a Metropolis-Hastings step evaluated for  $C + 1$  parameter blocks, namely  $C$  random blocks for coefficients in  $\mathbf{A}$ , followed by a single block for hyperparameters  $(\lambda_0, \mathbf{s})$ .
2. For every country  $c$  and structural equation  $j$ , ...
  - (a) ... draw  $(d_c^j)^{-1}$  from  $p(\mathbf{D} | \mathbf{A}, \lambda_0, \mathbf{s}, \mathbf{Y}_T, \chi, \mathbf{U}_{gT})$ , equation (C.7).
  - (b) ... draw  $\mathbf{b}_c^j$  jointly from  $p(\mathbf{B} | \mathbf{A}, \lambda_0, \mathbf{s}, \mathbf{D}, \mathbf{Y}_T, \chi, \mathbf{U}_{gT})$ , equation (C.8).
  - (c) ... calculate combined structural shocks  $\tilde{\mathbf{u}}_t = \mathbf{A}\mathbf{y}_t - \mathbf{B}\mathbf{x}_{t-1}$ .
3. Draw  $\chi$  from  $p(\chi | \mathbf{A}, \lambda_0, \mathbf{s}, \mathbf{D}, \mathbf{B}, \mathbf{Y}_T, \mathbf{U}_{gT})$ , equation (C.9).
4. Draw  $\mathbf{U}_{gT}$  from  $p(\mathbf{U}_{gT} | \mathbf{A}, \lambda_0, \mathbf{s}, \mathbf{D}, \mathbf{B}, \mathbf{Y}_T, \chi)$ , equations (C.10).

Following [Baumeister and Hamilton \(2015\)](#), we calculate the mode of the posterior likelihood  $p(\mathbf{A}, \lambda_0, \mathbf{s} | \mathbf{Y}_T, \mathbf{0}_{n \times G}, \mathbf{U}_{gT})$ , albeit at loadings of zero. We take the parameters  $(\mathbf{A}, \lambda_0, \mathbf{s})$  at the mode as initial draws, and their Hessian as the most promising search direction for the Metropolis-Hastings steps.

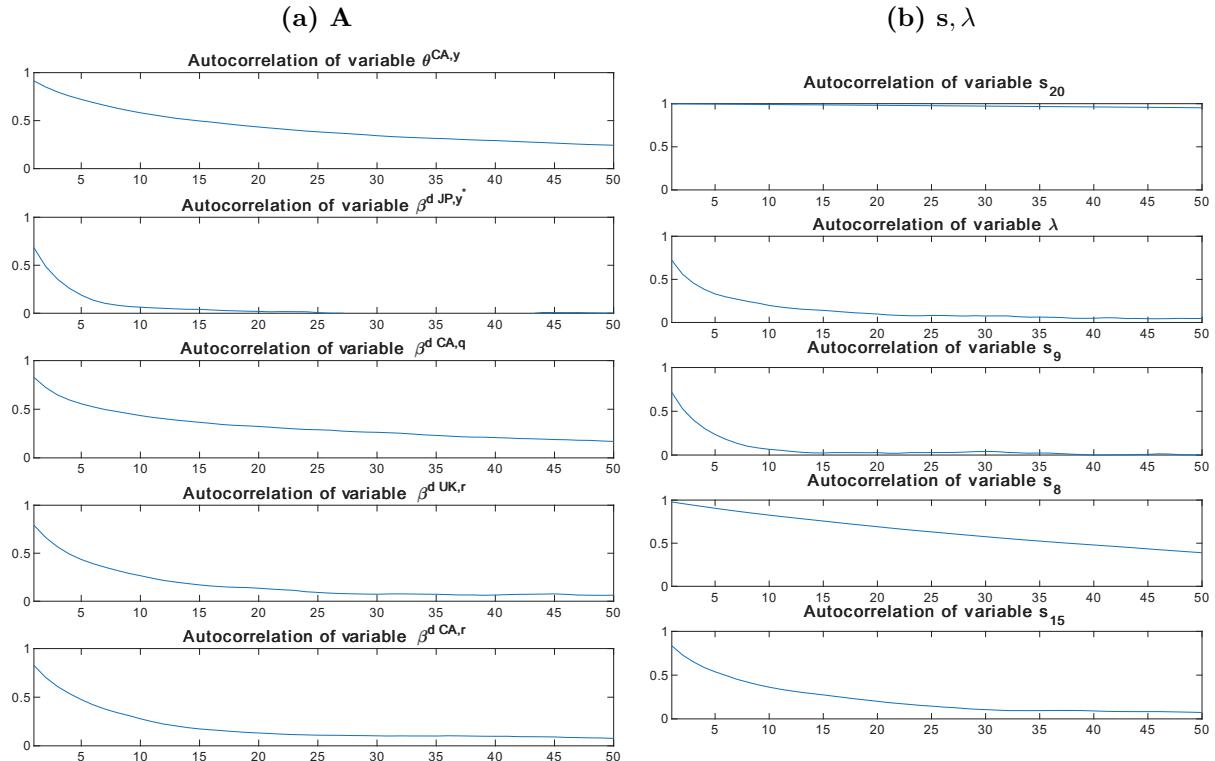
Because of global shocks, we want to fine-tune this initial draw further. Thus, we run a pre-sampling such that we obtain twice as many draws as the number of free parameters of  $\mathbf{A}$  after 400'000 burn-in and thinning of 500 draws (total chain length of baseline model: 484'000 draws). Taking the median retained draw as starting point, and the variance-covariance of the retained draws as search direction, the main algorithm keeps a total of 20'000 retained draws after a burn-in of 200,000 draws and thinning of 50 draws (total chain length: 1'200'000). For the prior distribution and robustness checks, we reduce the number of retained draws to 5'000. This “thins” out posterior distributions of structural coefficients, but does not materially affect the quantile-based results for forecast-error-variance decompositions and impulse-response-functions. We adapt the step-size during the burn-in phase to achieve an acceptance probability of 30% for the Metropolis-Hastings step.

## C.5 Convergence statistics

Figure C.1 and C.2 plot the autocorrelation across draws (after burn-in) and all draws for the four chains exemplary for the coefficients which have the weakest convergence statistics according to [Geweke \(1992\)](#) test for equality in means. These coefficients have by far the lowest p-values, mostly between 0.01 and 0.05. Across the 106 coefficients drawn in the Metropolis-Hastings step, only 10 have a p-value below 0.05, which is only marginally larger than the share one would expect from multiple testing.

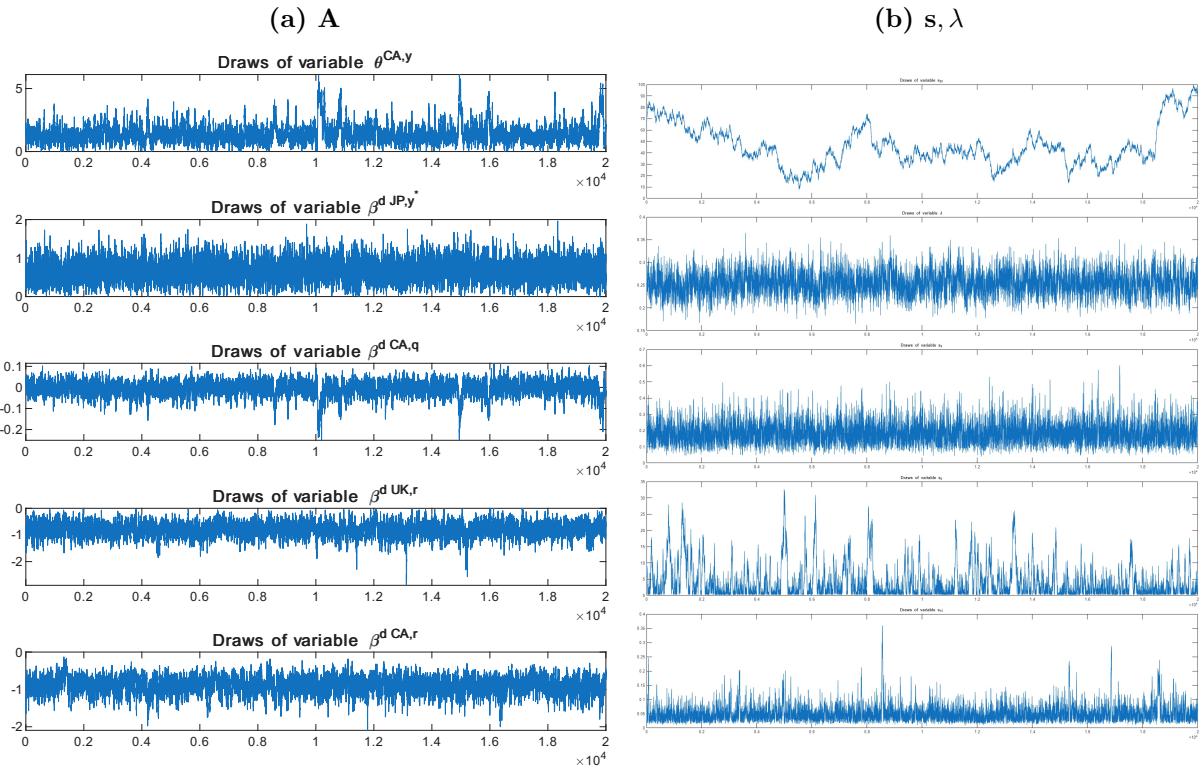
We see that the autocorrelation and trace plots for structural contemporaneous coefficients  $\mathbf{A}$  is well behaved. Some of the prior variances  $\mathbf{s}$ , however, are be correlated across retained draws. We set the same hyperparameters for countries in all prior distributions. However, since half of the parameters  $(\alpha^{sJP,q}, \beta^{dJP,\pi}, \mathbf{s}_{13}, \mathbf{s}_{14}, \mathbf{s}_{16})$  are related to Japanese variables, this might indicate that setting country-specific hyperparameters in the prior distributions of  $\mathbf{A}$  and  $\mathbf{s}$  could improve convergence.

**Figure C.1:** Autocorrelations of draws



NOTES: The plots show the autocorrelation across draws (after burn-in) of the structural parameters in  $\mathbf{A}$  (left subplot) and hyperparameters  $(\mathbf{s}, \lambda)$  (right subplot) with the weakest convergence statistics.

**Figure C.2:** Trace plot of draws



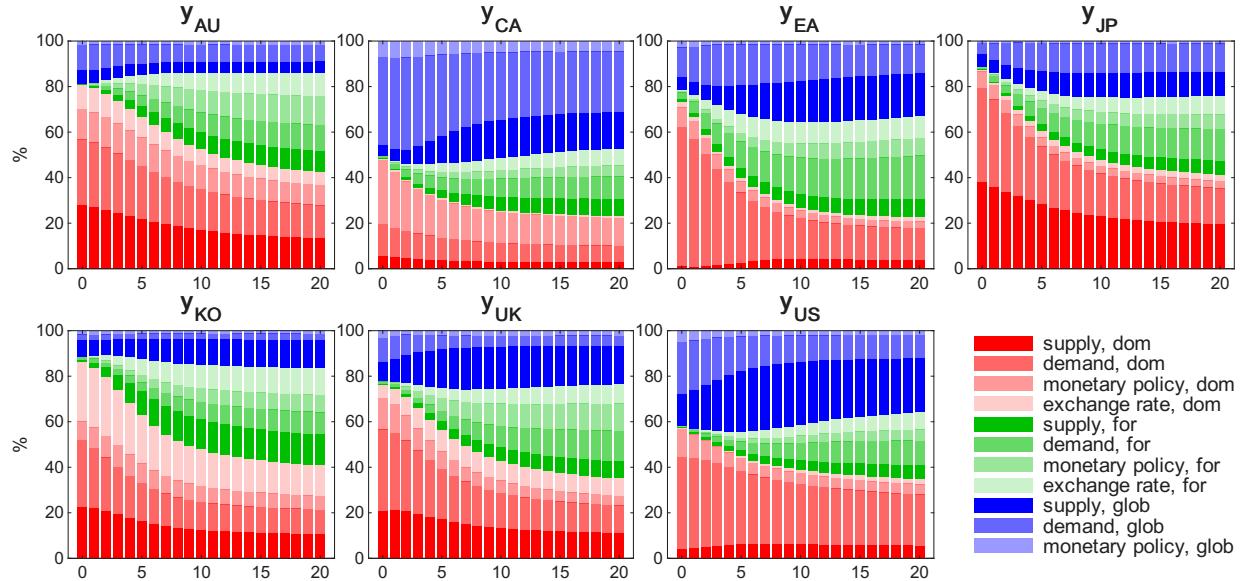
NOTES: Trace plots of the structural parameters in **A** (left subplot) and hyperparameters  $(\mathbf{s}, \lambda)$  (right subplot) with the weakest convergence statistics.

## D Further results

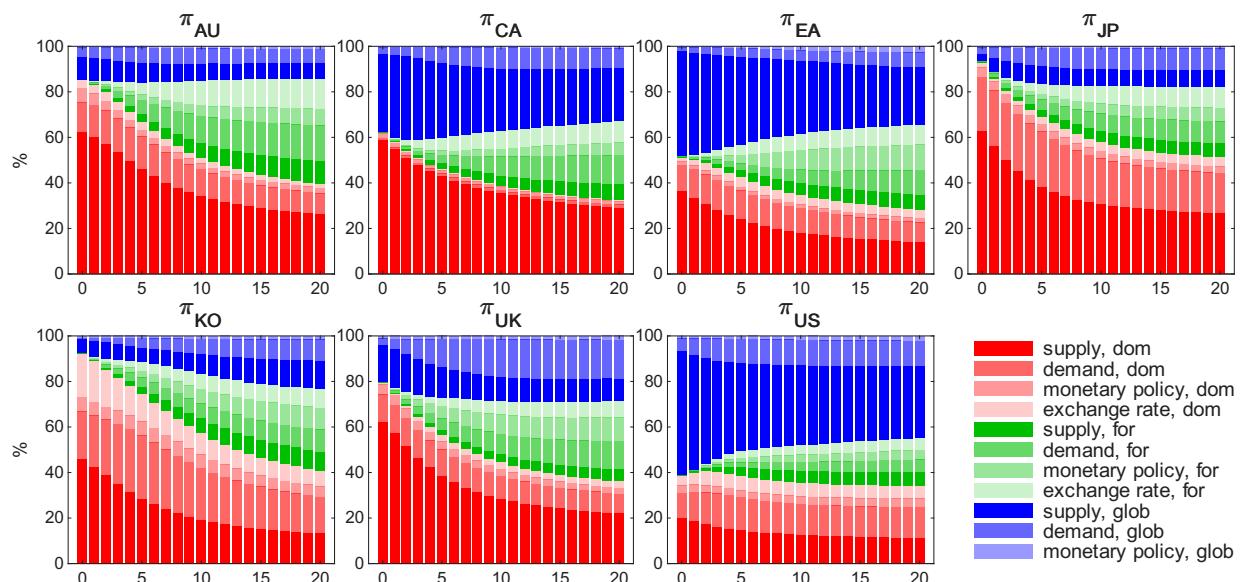
### D.1 Forecast error variance and correlation decompositions in the baseline model

The following figures show the forecast error variance decomposition of country-specific variables (in subplots) to domestic (dom) and foreign (for) supply, demand, monetary policy and exchange rate shocks and global (glob) supply, demand and monetary policy shocks over 20 quarters.

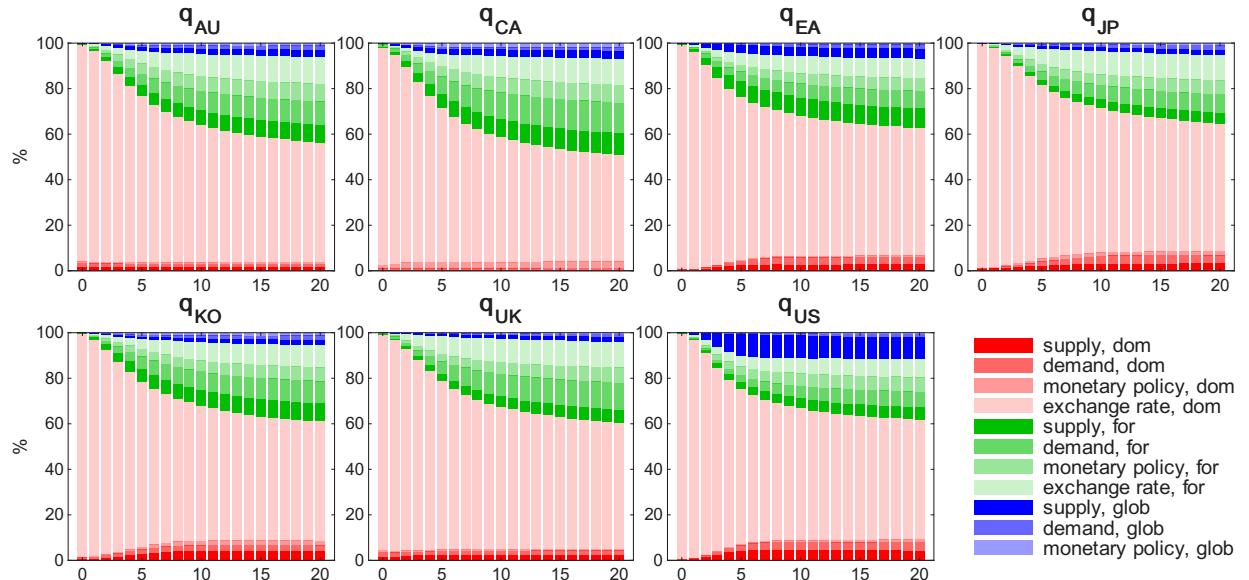
**Figure D.1:** Forecast error variance decomposition of output gaps



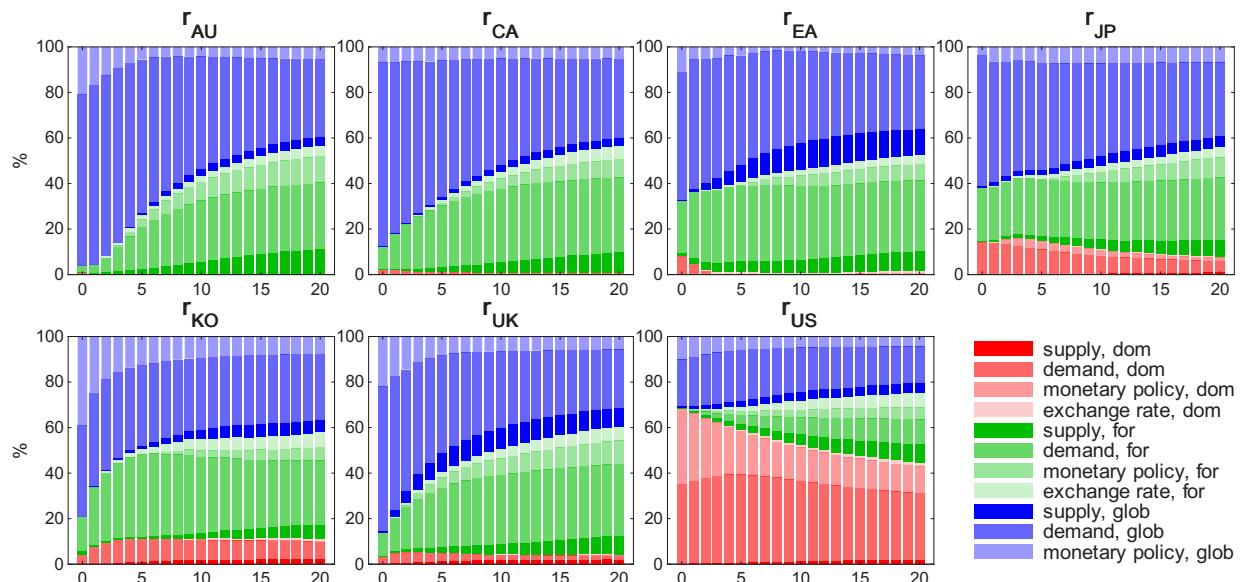
**Figure D.2:** Forecast error variance decomposition of inflation



**Figure D.3:** Forecast error variance decomposition of exchange rate growth



**Figure D.4:** Forecast error correlation decomposition between US and country-specific interest rates



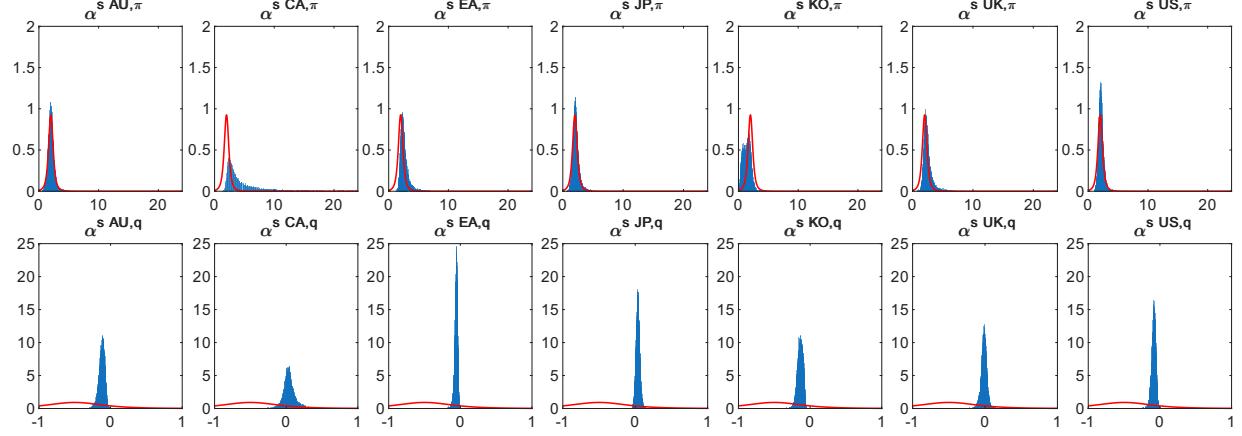
**Table D.1:** Decomposition of correlations of interest rates,  $H = 20$

	AU	CA	EA	JP	KO	UK	US
domestic							
group agg	-0.02 [-0.29,0.10]	0.01 [-0.03,0.09]	-0.01 [-0.30,0.19]	0.10 [-0.03,0.32]	0.12 [-0.09,0.39]	<b>0.06</b> [0.00,0.19]	<b>0.44</b> [0.28,0.61]
supply, dom	0.00 [-0.03,0.03]	0.00 [-0.00,0.01]	-0.02 [-0.16,0.04]	0.01 [-0.03,0.11]	0.02 [-0.03,0.12]	0.02 [-0.00,0.10]	<b>0.02</b> [0.00,0.08]
demand, dom	-0.01 [-0.16,0.07]	0.01 [-0.01,0.06]	-0.01 [-0.12,0.09]	0.05 [-0.01,0.19]	0.08 [-0.05,0.27]	0.02 [-0.01,0.11]	<b>0.29</b> [0.10,0.46]
mon. pol., dom	-0.01 [-0.12,0.04]	-0.00 [-0.03,0.04]	0.01 [-0.08,0.14]	0.01 [-0.05,0.16]	0.00 [-0.04,0.06]	0.00 [-0.01,0.04]	<b>0.12</b> [0.02,0.32]
er, dom	0.00 [-0.02,0.03]	0.00 [-0.00,0.04]	0.01 [-0.11,0.13]	0.01 [-0.04,0.10]	0.01 [-0.04,0.10]	0.01 [-0.01,0.07]	<b>0.02</b> [0.00,0.11]
foreign							
group agg	<b>0.57</b> [0.05,0.85]	<b>0.56</b> [0.28,0.79]	<b>0.51</b> [0.15,0.88]	<b>0.47</b> [0.14,0.75]	0.45 [-0.06,0.82]	<b>0.55</b> [0.33,0.77]	<b>0.30</b> [0.15,0.50]
supply, for	0.11 [-0.03,0.32]	<b>0.09</b> [0.01,0.21]	0.09 [-0.02,0.24]	0.07 [-0.02,0.21]	0.06 [-0.14,0.24]	<b>0.08</b> [0.01,0.20]	<b>0.08</b> [0.02,0.17]
demand, for	<b>0.29</b> [0.00,0.63]	<b>0.33</b> [0.12,0.54]	<b>0.31</b> [0.08,0.65]	<b>0.27</b> [0.04,0.51]	<b>0.28</b> [0.04,0.62]	<b>0.32</b> [0.11,0.51]	<b>0.11</b> [0.03,0.22]
mon. pol., for	0.12 [-0.08,0.36]	0.08 [-0.01,0.26]	0.07 [-0.10,0.31]	0.09 [-0.06,0.31]	0.06 [-0.21,0.27]	<b>0.10</b> [0.01,0.27]	<b>0.05</b> [0.01,0.13]
er, for	0.05 [-0.32,0.28]	0.06 [-0.03,0.21]	0.04 [-0.23,0.21]	0.04 [-0.16,0.23]	0.06 [-0.17,0.30]	0.06 [-0.01,0.22]	<b>0.06</b> [0.02,0.17]
global							
group agg	<b>0.45</b> [0.20,1.12]	<b>0.43</b> [0.20,0.69]	<b>0.49</b> [0.15,1.00]	<b>0.43</b> [0.15,0.80]	<b>0.43</b> [0.12,0.88]	<b>0.39</b> [0.16,0.61]	<b>0.25</b> [0.10,0.45]
supply, glob	0.04 [-0.11,0.22]	0.03 [-0.01,0.18]	0.11 [-0.16,0.36]	0.04 [-0.04,0.21]	0.05 [-0.07,0.28]	0.08 [-0.02,0.24]	<b>0.04</b> [0.00,0.17]
demand, glob	<b>0.34</b> [0.05,0.99]	<b>0.35</b> [0.08,0.60]	<b>0.32</b> [0.03,0.77]	<b>0.33</b> [0.04,0.64]	<b>0.29</b> [0.02,0.68]	<b>0.26</b> [0.04,0.47]	<b>0.16</b> [0.02,0.35]
mon. pol., glob	0.08 [-0.01,0.38]	<b>0.05</b> [0.00,0.23]	0.07 [-0.00,0.38]	0.07 [-0.00,0.30]	0.08 [-0.01,0.37]	<b>0.06</b> [0.00,0.24]	<b>0.04</b> [0.00,0.20]

*Note:* Contributions relate to correlation between the interest rate of country  $c$  and the global interest rate at horizon  $H = 20$ . We first report aggregates for domestic, foreign and global shocks before breaking them down into different types of shocks. We report the mode of the decomposition (scaled such that they sum up to 1) together with 95% credibility sets. Correlations where the 95% credibility sets do not contain zero are marked in bold.

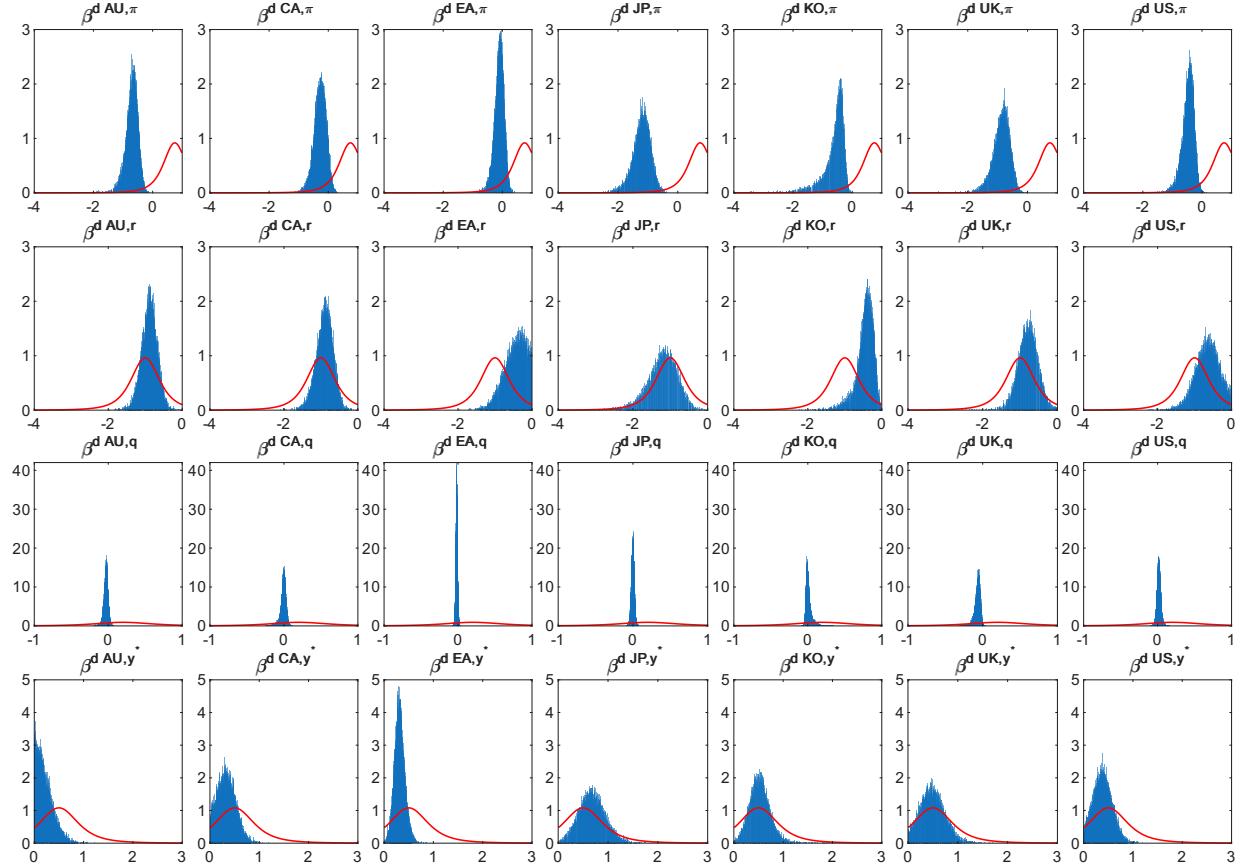
## D.2 Structural contemporaneous coefficients

**Figure D.5:** Posterior distributions of structural contemporaneous coefficients in the supply equation



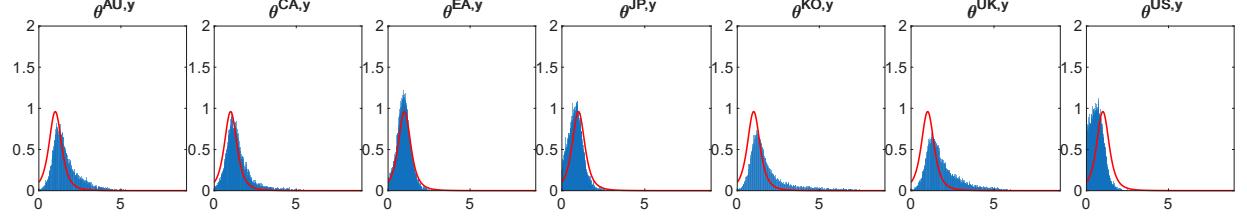
NOTES: The histograms show the posterior distribution of structural contemporaneous coefficients in the supply equation together with the prior distribution (red line).

**Figure D.6:** Posterior distributions of structural contemporaneous coefficients in the demand equation



NOTES: The histograms show the posterior distribution of structural contemporaneous coefficients in the demand equation together with the prior distribution (red line).

**Figure D.7:** Posterior distributions of structural contemporaneous coefficients in the exchange rate equation



NOTES: The histograms show the posterior distribution of structural contemporaneous coefficients in the exchange rate equation together with the prior distribution (red line).

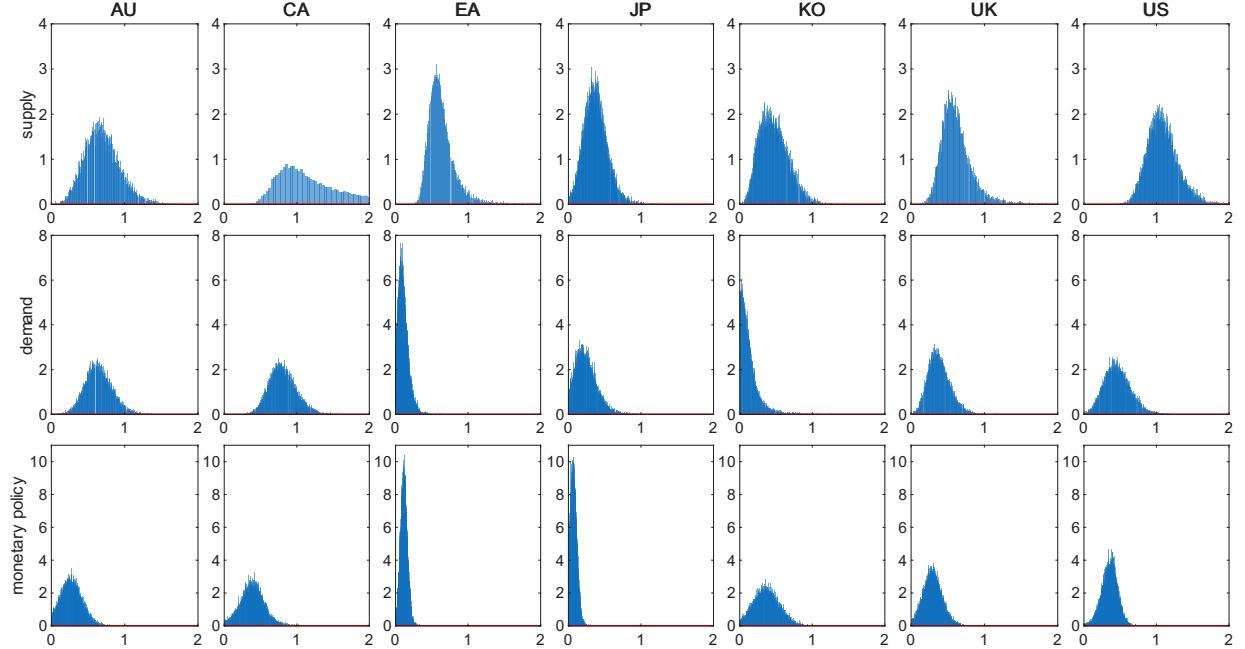
**Table D.2:** Prior and posterior mean and credibility set of structural contemporaneous coefficients

prior				posterior				prior				posterior					
	mean	95% cs	mean	95% cs		mean	95% cs		mean	95% cs		mean	95% cs		mean		
$\alpha^{sAU,\pi}$	2.02	[0.85,3.29]	2.04	[1.16,3.14]	$\alpha^{sCA,\pi}$	2.02	[0.85,3.29]	5.77	[1.95,25.31]	$\alpha^{sEA,\pi}$	2.02	[0.85,3.29]	2.17	[1.33,3.38]	$\alpha^{sKO,\pi}$	2.02	[0.85,3.29]
$\alpha^{sAU,q}$	-0.50	[-1.79,0.79]	-0.12	[-0.22,-0.05]	$\alpha^{sCA,q}$	-0.50	[-1.79,0.79]	0.05	[-0.13,0.33]	$\alpha^{sJP,\pi}$	-0.50	[-1.79,0.79]	0.04	[-0.01,0.09]	$\alpha^{sUK,\pi}$	2.02	[0.85,3.29]
$\beta^{dAU,\pi}$	0.75	[-0.53,2.03]	-0.70	[-1.16,-0.35]	$\beta^{dCA,\pi}$	0.75	[-0.53,2.03]	-0.27	[-0.71,0.08]	$\beta^{dEA,\pi}$	0.75	[-0.53,2.03]	-1.21	[-1.92,-0.69]	$\beta^{dKO,\pi}$	0.75	[-0.53,2.03]
$\beta^{dAU,r}$	-1.07	[-2.31,-0.17]	-0.89	[-1.32,-0.49]	$\beta^{dCA,r}$	-1.07	[-2.31,-0.17]	-0.90	[-1.38,-0.49]	$\beta^{dJP,\pi}$	-1.07	[-2.31,-0.17]	-0.00	[-1.29,1.29]	$\beta^{dUK,\pi}$	0.75	[-0.53,2.03]
$\beta^{dAU,q}$	0.20	[-1.09,1.49]	-0.03	[-0.09,0.02]	$\beta^{dCA,q}$	0.20	[-1.09,1.49]	-0.01	[-0.09,0.05]	$\beta^{dJP,q}$	0.20	[-1.09,1.49]	-0.00	[-0.04,0.04]	$\beta^{dUS,\pi}$	0.75	[-0.53,2.03]
$\beta^{dAU,y^*}$	0.67	[0.05,1.99]	0.22	[0.01,0.62]	$\beta^{dCA,y^*}$	0.67	[0.05,1.99]	0.33	[0.03,0.71]	$\beta^{dJP,y^*}$	0.67	[0.05,1.99]	0.68	[0.18,1.23]	$\beta^{dUS,y^*}$	0.75	[-0.53,2.03]
$\psi^{AU,y}$	0.67	[0.05,1.99]	1.46	[0.81,2.42]	$\psi^{CA,y}$	0.67	[0.05,1.99]	3.43	[1.53,7.62]	$\psi^{JP,y}$	0.67	[0.05,1.99]	0.91	[0.44,1.57]	$\psi^{UK,y}$	0.67	[0.05,1.99]
$\psi^{AU,\pi}$	1.54	[0.47,2.79]	1.49	[0.93,2.24]	$\psi^{CA,\pi}$	1.54	[0.47,2.79]	1.18	[0.31,2.05]	$\psi^{JP,\pi}$	1.54	[0.47,2.79]	1.43	[0.77,2.20]	$\psi^{US,\pi}$	0.67	[0.05,1.99]
$\psi^{AU,q}$	-0.00	[-1.29,1.29]	0.06	[-0.01,0.15]	$\psi^{CA,q}$	-0.00	[-1.29,1.29]	0.12	[-0.03,0.34]	$\psi^{JP,q}$	-0.00	[-1.29,1.29]	0.04	[-0.02,0.11]	$\psi^{US,q}$	0.67	[0.05,1.99]
$\theta^{AU,y}$	1.07	[0.19,2.33]	1.64	[0.51,3.97]	$\theta^{CA,y}$	1.07	[0.19,2.33]	1.41	[0.35,3.48]	$\theta^{JP,y}$	1.07	[0.19,2.33]	0.82	[0.08,1.75]	$\theta^{UK,y}$	0.67	[0.05,1.99]
$\rho^{AU}$	0.50	[0.13,0.87]	0.49	[0.24,0.69]	$\rho^{CA}$	0.50	[0.13,0.87]	0.55	[0.23,0.79]	$\rho^{JP}$	0.50	[0.13,0.87]	0.78	[0.63,0.89]	$\rho^{US}$	0.67	[0.05,1.99]
$\alpha^{sEA,\pi}$	2.02	[0.85,3.29]	2.60	[1.73,4.47]	$\alpha^{sJP,\pi}$	2.02	[0.85,3.29]	2.17	[1.33,3.38]	$\alpha^{sCA,q}$	-0.50	[-1.79,0.79]	0.04	[-0.01,0.09]	$\alpha^{sKO,q}$	-0.50	[-1.79,0.79]
$\alpha^{sEA,q}$	-0.50	[-1.79,0.79]	-0.06	[-0.11,-0.02]	$\alpha^{sJP,q}$	-0.50	[-1.79,0.79]	0.05	[-0.13,0.33]	$\beta^{dEA,\pi}$	0.75	[-0.53,2.03]	-1.21	[-1.92,-0.69]	$\beta^{dJP,\pi}$	0.75	[-0.53,2.03]
$\beta^{dEA,\pi}$	0.75	[-0.53,2.03]	-0.11	[-0.46,0.17]	$\beta^{dJP,r}$	-1.07	[-2.31,-0.17]	-1.21	[-2.13,-0.51]	$\beta^{dEA,r}$	-1.07	[-2.31,-0.17]	-1.21	[-2.13,-0.51]	$\beta^{dKO,r}$	-1.07	[-2.31,-0.17]
$\beta^{dEA,q}$	0.20	[-1.09,1.49]	-0.02	[-0.04,0.01]	$\beta^{dJP,q}$	0.20	[-1.09,1.49]	-0.00	[-0.04,0.04]	$\beta^{dEA,y^*}$	0.67	[0.05,1.99]	0.33	[0.03,0.71]	$\beta^{dKO,y^*}$	0.67	[0.05,1.99]
$\beta^{dEA,y^*}$	0.67	[0.05,1.99]	0.31	[0.12,0.53]	$\beta^{dJP,y^*}$	0.67	[0.05,1.99]	0.68	[0.18,1.23]	$\psi^{EA,y}$	0.67	[0.05,1.99]	3.43	[1.53,7.62]	$\psi^{KO,y}$	0.67	[0.05,1.99]
$\psi^{EA,y}$	0.67	[0.05,1.99]	3.10	[1.02,7.06]	$\psi^{JP,y}$	0.67	[0.05,1.99]	0.91	[0.44,1.57]	$\psi^{EA,\pi}$	1.54	[0.47,2.79]	1.43	[0.77,2.20]	$\psi^{KO,\pi}$	1.54	[0.47,2.79]
$\psi^{EA,\pi}$	1.54	[0.47,2.79]	1.23	[0.48,2.00]	$\psi^{JP,\pi}$	1.54	[0.47,2.79]	1.43	[0.77,2.20]	$\psi^{EA,q}$	-0.00	[-1.29,1.29]	0.04	[-0.02,0.11]	$\psi^{JP,q}$	-0.00	[-1.29,1.29]
$\psi^{EA,q}$	-0.00	[-1.29,1.29]	0.02	[-0.07,0.14]	$\theta^{JP,y}$	1.07	[0.19,2.33]	0.82	[0.08,1.75]	$\theta^{EA,y}$	1.07	[0.19,2.33]	0.82	[0.08,1.75]	$\theta^{KO,y}$	1.07	[0.19,2.33]
$\theta^{EA,y}$	1.07	[0.19,2.33]	0.95	[0.17,1.82]	$\rho^{JP}$	0.50	[0.13,0.87]	0.78	[0.63,0.89]	$\rho^{EA}$	0.50	[0.13,0.87]	0.78	[0.63,0.89]	$\rho^{KO}$	0.50	[0.13,0.87]
$\alpha^{sKO,\pi}$	2.02	[0.85,3.29]	1.41	[0.36,2.55]	$\alpha^{sUK,\pi}$	2.02	[0.85,3.29]	2.50	[1.58,4.60]	$\alpha^{sCA,q}$	-0.50	[-1.79,0.79]	-0.01	[-0.10,0.06]	$\alpha^{sKO,q}$	-0.50	[-1.79,0.79]
$\alpha^{sKO,q}$	-0.50	[-1.79,0.79]	-0.14	[-0.22,-0.07]	$\beta^{dUK,\pi}$	0.75	[-0.53,2.03]	-0.88	[-1.56,-0.39]	$\beta^{dCA,q}$	0.75	[-0.53,2.03]	-0.79	[-1.33,-0.28]	$\beta^{dKO,r}$	-1.07	[-2.31,-0.17]
$\beta^{dKO,\pi}$	0.75	[-0.53,2.03]	-0.64	[-1.84,-0.20]	$\beta^{dUK,q}$	0.20	[-1.09,1.49]	-0.07	[-0.16,-0.01]	$\beta^{dCA,y^*}$	0.67	[0.05,1.99]	0.50	[0.06,1.01]	$\beta^{dKO,y^*}$	0.67	[0.05,1.99]
$\beta^{dKO,r}$	-1.07	[-2.31,-0.17]	-0.45	[-1.09,-0.12]	$\psi^{UK,y}$	0.67	[0.05,1.99]	2.01	[1.08,3.53]	$\psi^{CA,y}$	0.67	[0.05,1.99]	1.47	[0.83,2.25]	$\psi^{KO,y}$	0.67	[0.05,1.99]
$\beta^{dKO,q}$	0.20	[-1.09,1.49]	0.01	[-0.04,0.12]	$\psi^{UK,\pi}$	1.54	[0.47,2.79]	1.47	[0.83,2.25]	$\psi^{CA,\pi}$	1.54	[0.47,2.79]	1.47	[0.83,2.25]	$\psi^{KO,\pi}$	1.54	[0.47,2.79]
$\beta^{dKO,y^*}$	0.67	[0.05,1.99]	0.53	[0.15,1.02]	$\rho^{UK}$	0.50	[0.13,0.87]	0.78	[0.63,0.89]	$\rho^{CA}$	0.50	[0.13,0.87]	0.78	[0.63,0.89]	$\rho^{KO}$	0.50	[0.13,0.87]
$\psi^{KO,y}$	0.67	[0.05,1.99]	1.16	[0.35,2.47]	$\rho^{CA}$	0.50	[0.13,0.87]	0.78	[0.63,0.89]	$\rho^{KO}$	0.50	[0.13,0.87]	0.78	[0.63,0.89]	$\rho^{UK}$	0.50	[0.13,0.87]
$\psi^{KO,\pi}$	1.54	[0.47,2.79]	1.67	[1.01,2.60]	$\rho^{KO}$	0.50	[0.13,0.87]	0.78	[0.63,0.89]	$\rho^{UK}$	0.50	[0.13,0.87]	0.78	[0.63,0.89]	$\rho^{CA}$	0.50	[0.13,0.87]

**Table D.2:** Prior and posterior mean and credibility set of structural contemporaneous coefficients

prior				posterior				prior				posterior							
	mean	95% cs	mean	95% cs		mean	95% cs		mean	95% cs		mean	95% cs		mean				
$\psi^{KO,q}$	-0.00	[-1.29,1.29]	0.12	[0.03,0.25]	$\psi^{UK,q}$	-0.00	[-1.29,1.29]	0.07	[-0.02,0.18]	$\theta^{KO,y}$	1.07	[0.19,2.33]	1.87	[0.56,4.79]	$\rho^{KO}$	0.50	[0.13,0.87]	0.52	[0.27,0.74]
$\alpha^{sUS,\pi}$	2.02	[0.85,3.29]	2.13	[1.46,3.02]															
$\alpha^{sUS,q}$	-0.50	[-1.79,0.79]	-0.08	[-0.15,-0.03]															
$\beta^{dUS,\pi}$	0.75	[-0.53,2.03]	-0.47	[-0.94,-0.15]															
$\beta^{dUS,r}$	-1.07	[-2.31,-0.17]	-0.65	[-1.33,-0.08]															
$\beta^{dUS,q}$	0.20	[-1.09,1.49]	0.02	[-0.03,0.07]															
$\beta^{dUS,y^*}$	0.67	[0.05,1.99]	0.39	[0.05,0.77]															
$\psi^{US,y}$	0.67	[0.05,1.99]	2.57	[0.99,5.25]															
$\psi^{US,\pi}$	1.54	[0.47,2.79]	1.18	[0.50,1.94]															
$\psi^{US,q}$	-0.00	[-1.29,1.29]	-0.02	[-0.14,0.09]															
$\theta^{US,y}$	1.07	[0.19,2.33]	0.65	[0.04,1.45]															
$\rho^{US}$	0.50	[0.13,0.87]	0.64	[0.38,0.82]															

**Figure D.8:** Posterior distributions of loadings



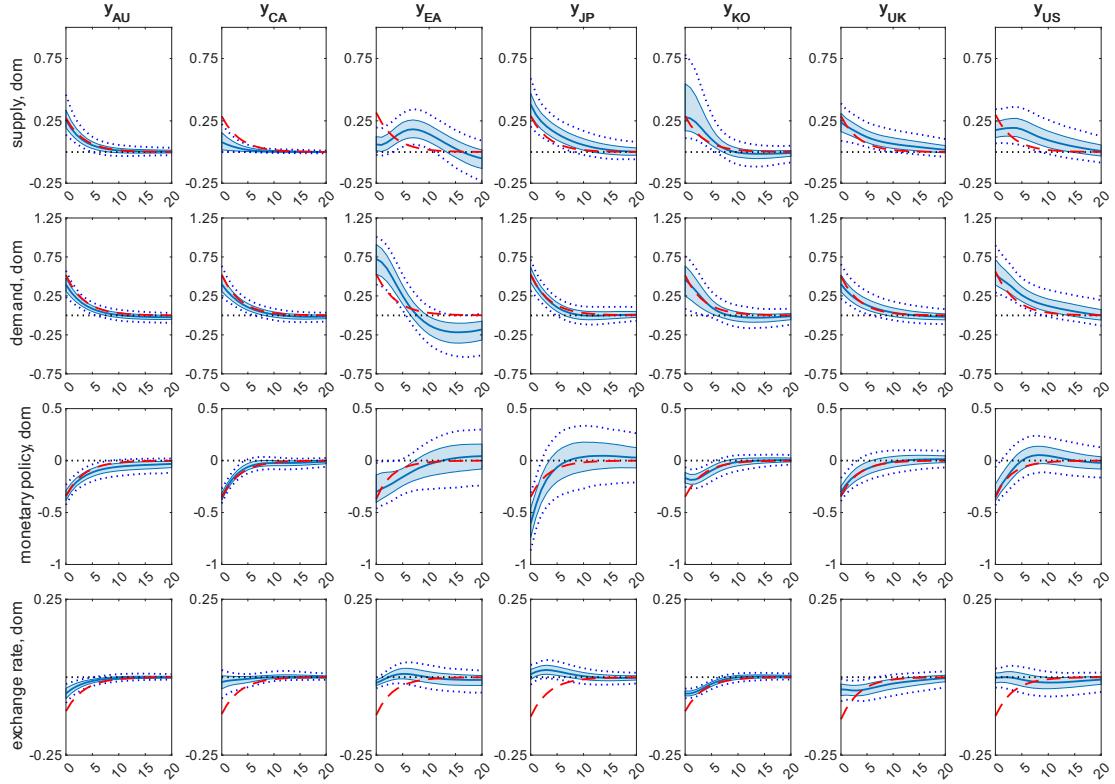
NOTES: The histograms show the posterior distribution of global shock loadings together with the uninformative prior distribution (red line).

### D.3 Impulse-response functions in the baseline model

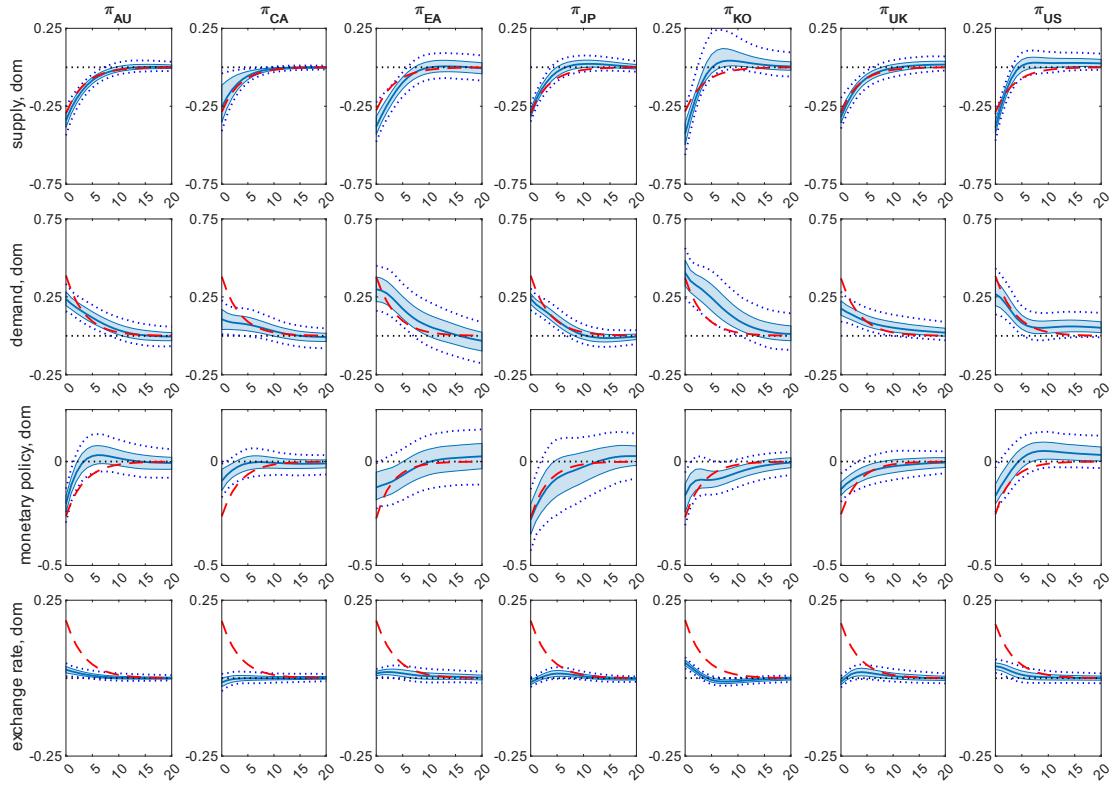
The solid lines in all the following figures show median impulse responses of country-specific variables (in columns, variable name in title) to country-specific demand, supply, monetary

policy and exchange rate shocks (in rows) over 20 quarters. The shaded areas (dotted lines) show the 68% (95%) posterior credibility sets. Red dashed lines show median prior impulse response functions. The shocks have size of one unit. Figures D.9 to D.12 show the impulse responses to domestic shocks; Figures D.13 to D.16 those to global shocks; Figures D.17 to D.19 foreign responses to Euro Area and US demand and MP shocks; Figures D.20 and D.21 the foreign interest rate responses to demand and MP shocks from other countries.

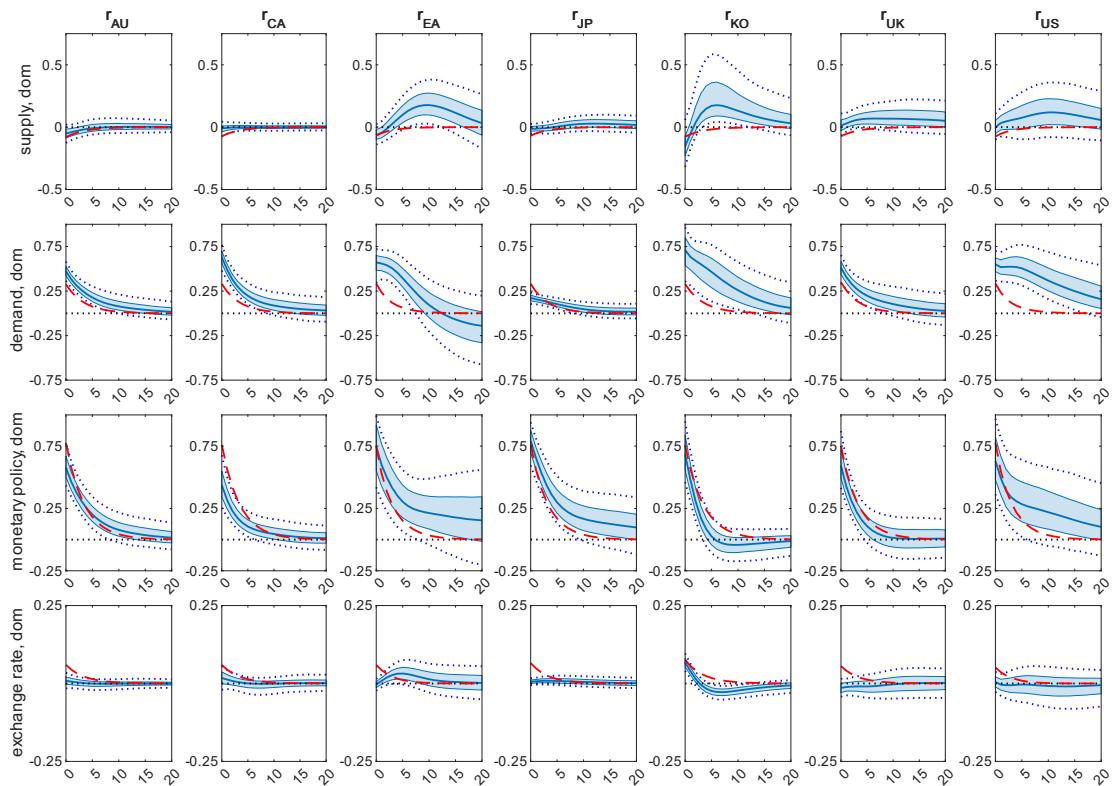
**Figure D.9:** Impulse responses of output gaps to domestic shocks



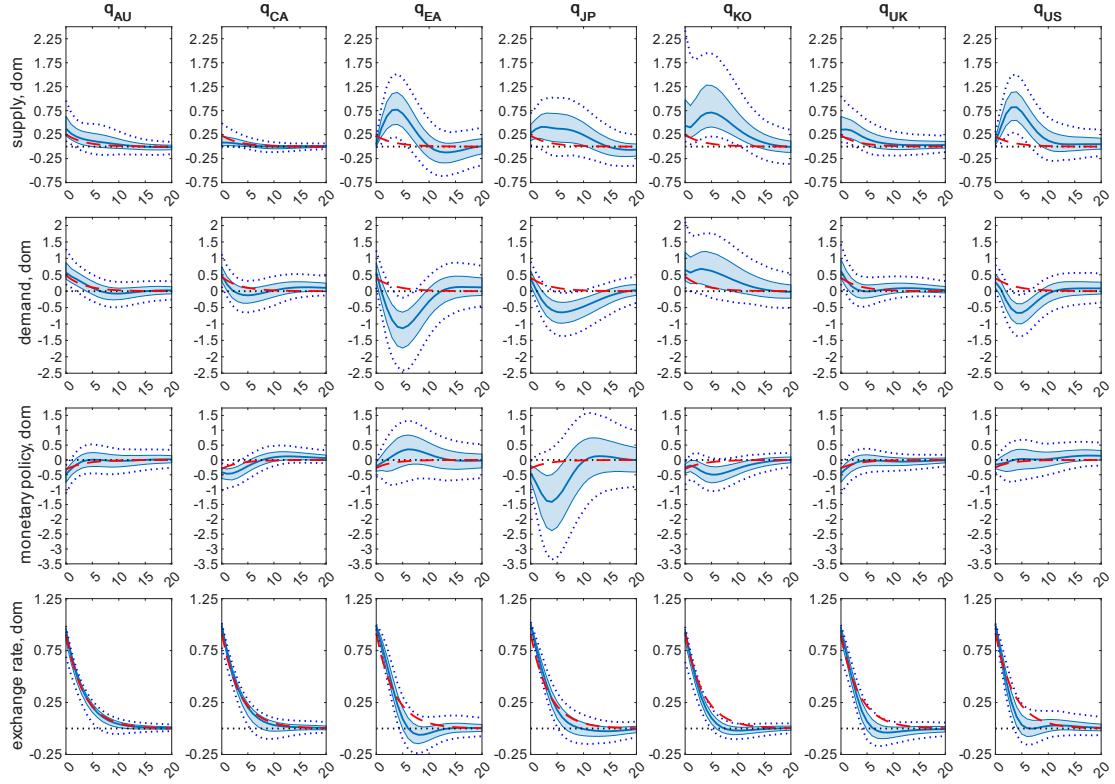
**Figure D.10:** Impulse responses of inflation to domestic shocks



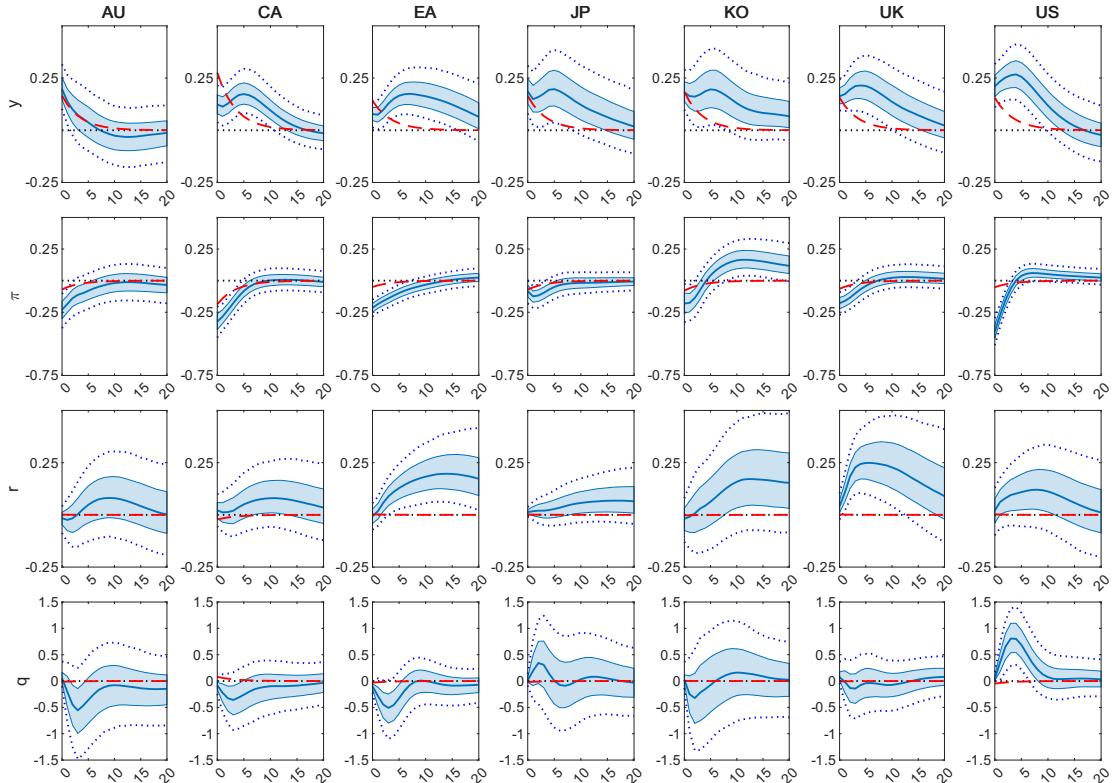
**Figure D.11:** Impulse responses of interest rates to domestic shocks



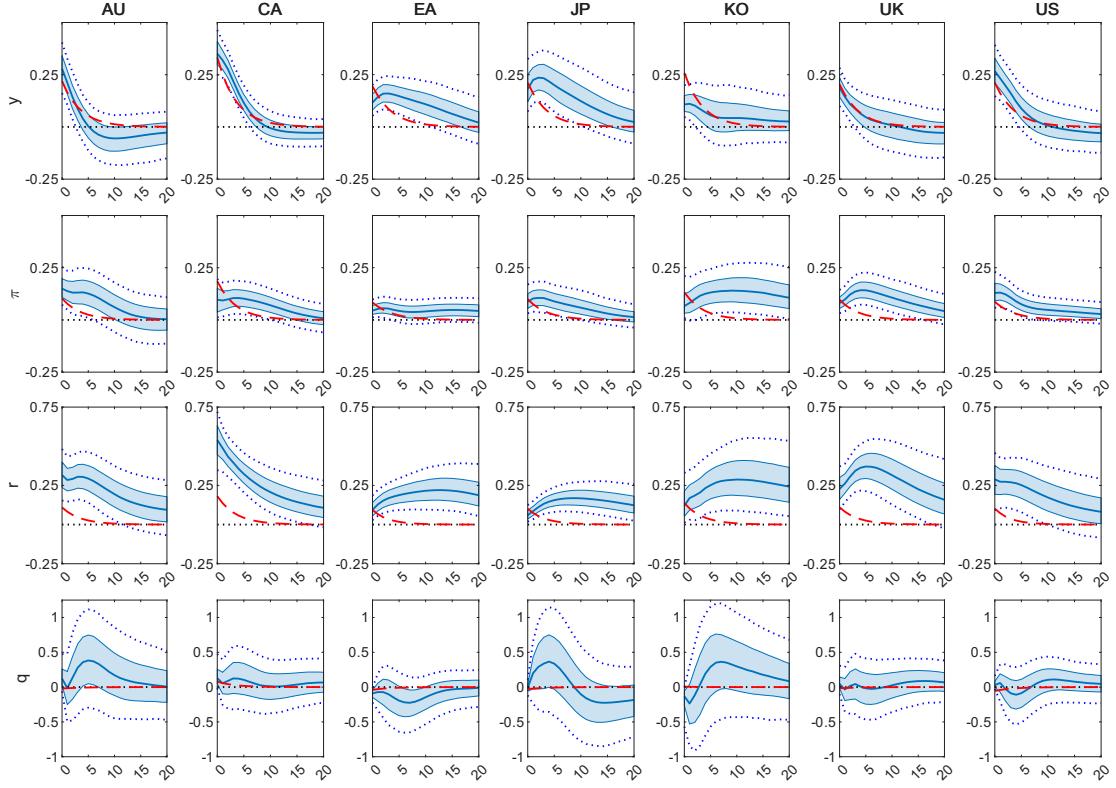
**Figure D.12:** Impulse responses of exchange rate growth to domestic shocks



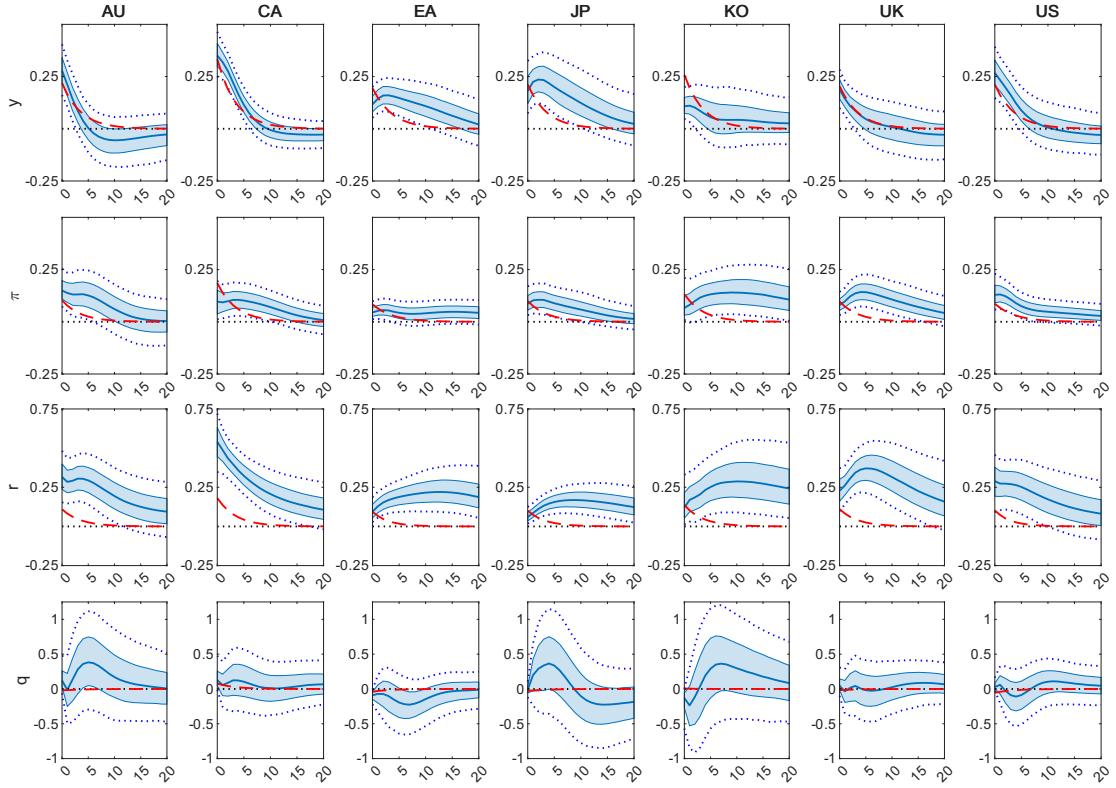
**Figure D.13:** Impulse responses to global supply shocks, all variables



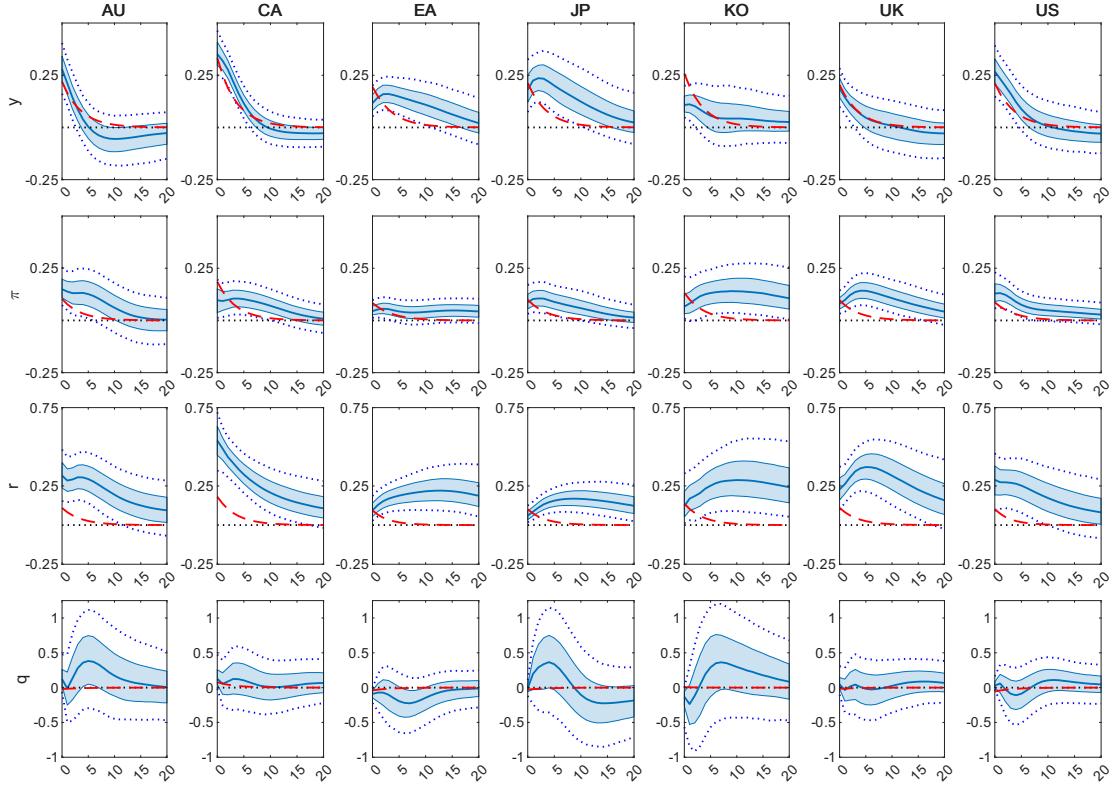
**Figure D.14:** Impulse responses to global demand shocks, all variables



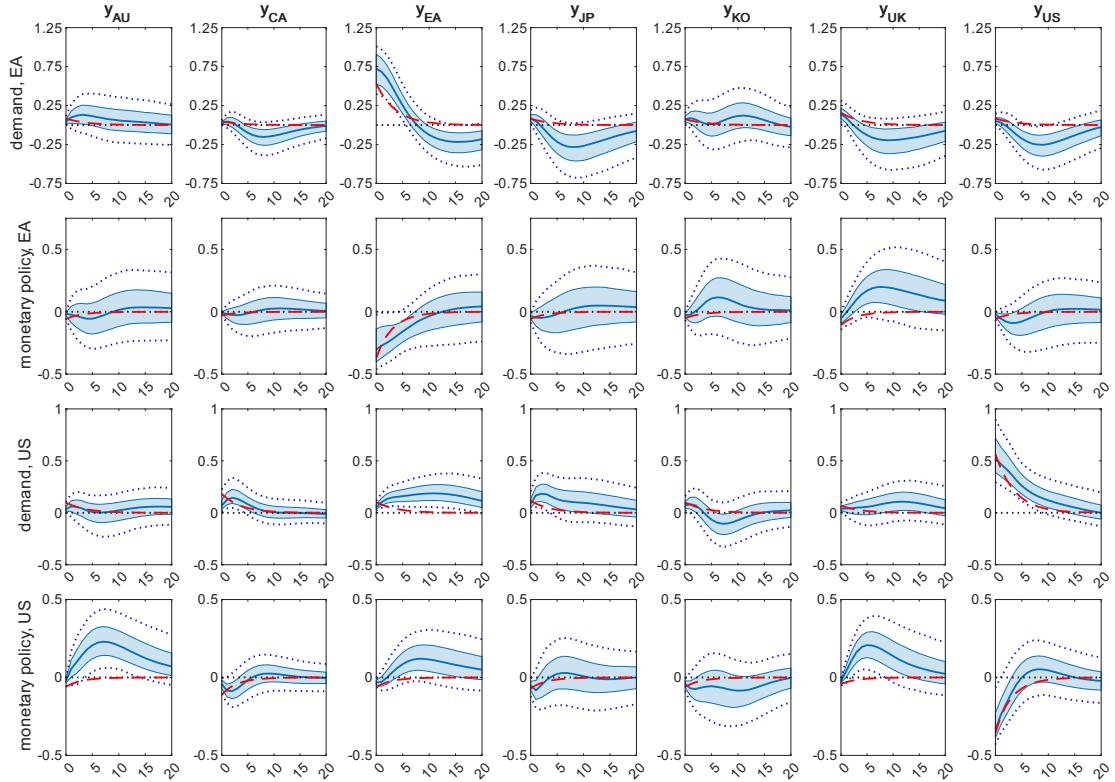
**Figure D.15:** Impulse responses to global monetary policy shocks, all variables



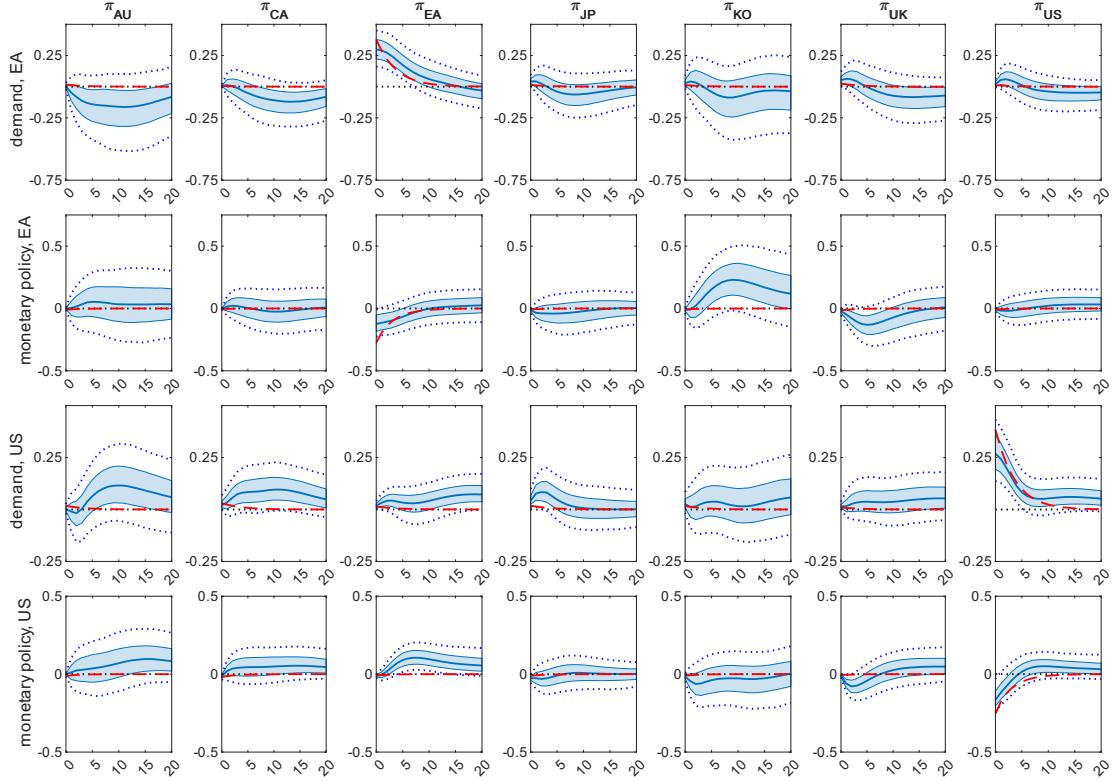
**Figure D.16:** Impulse responses to global exchange rate shocks, all variables



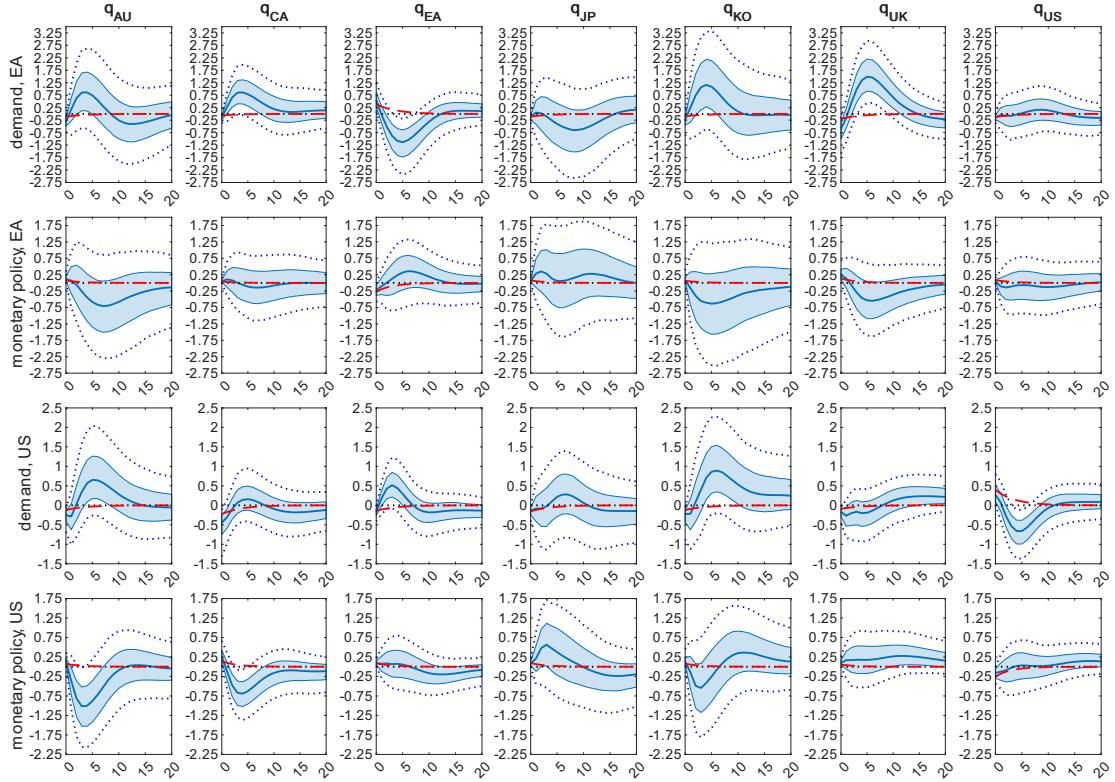
**Figure D.17:** Impulse responses of output gaps to EA and US demand and MP shocks



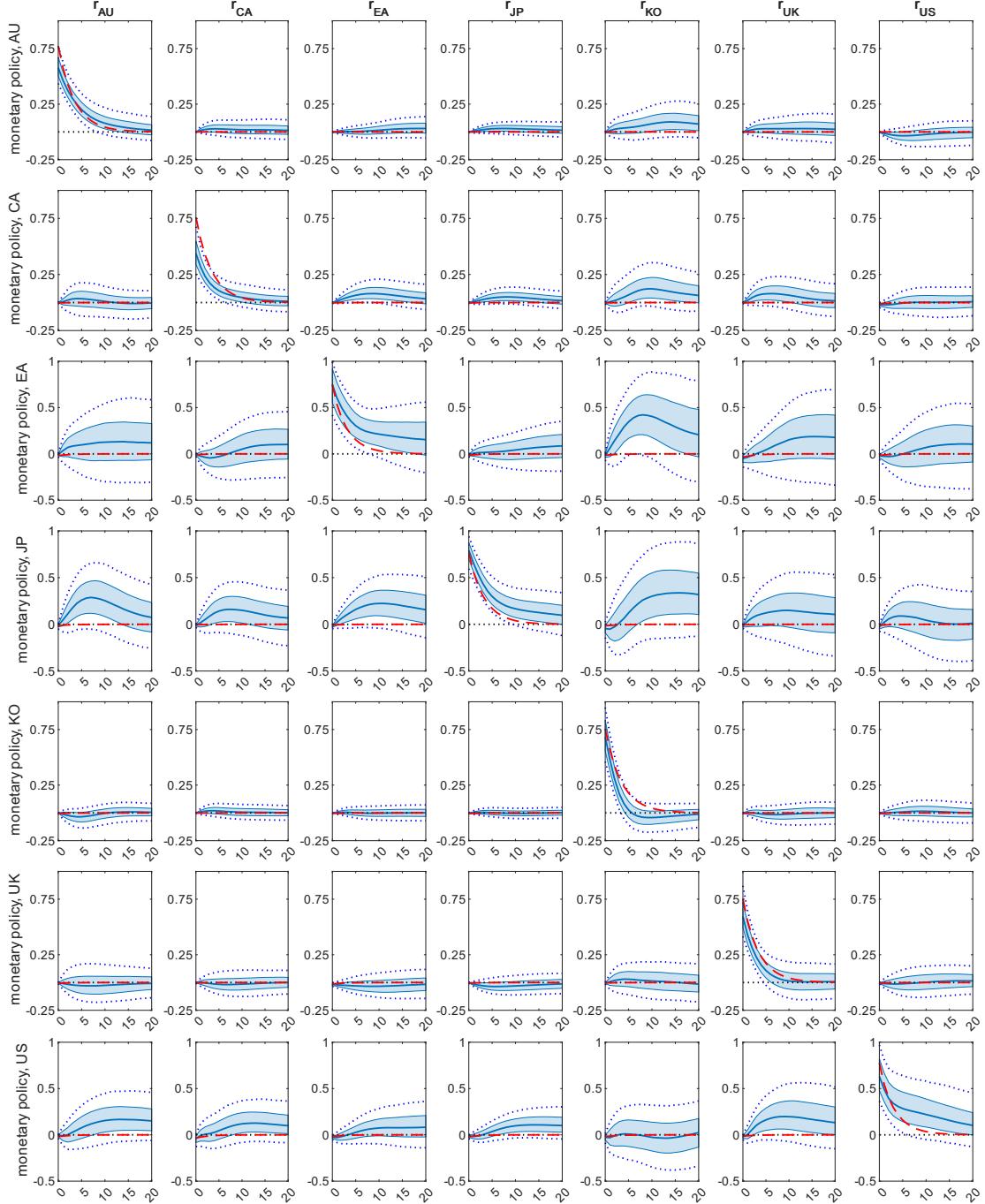
**Figure D.18:** Impulse responses of inflation to EA and US demand and MP shocks



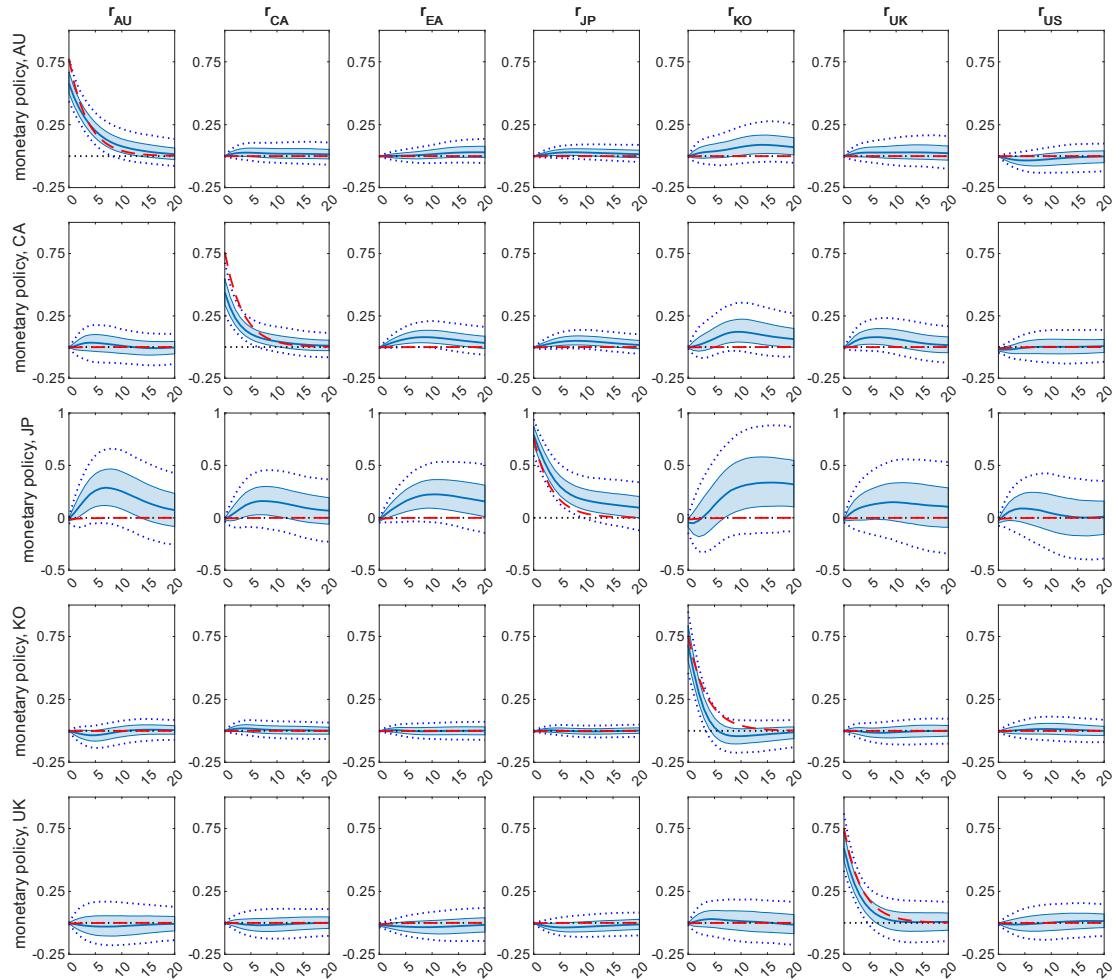
**Figure D.19:** Impulse responses of exchange rate growth to EA and US demand and MP shocks



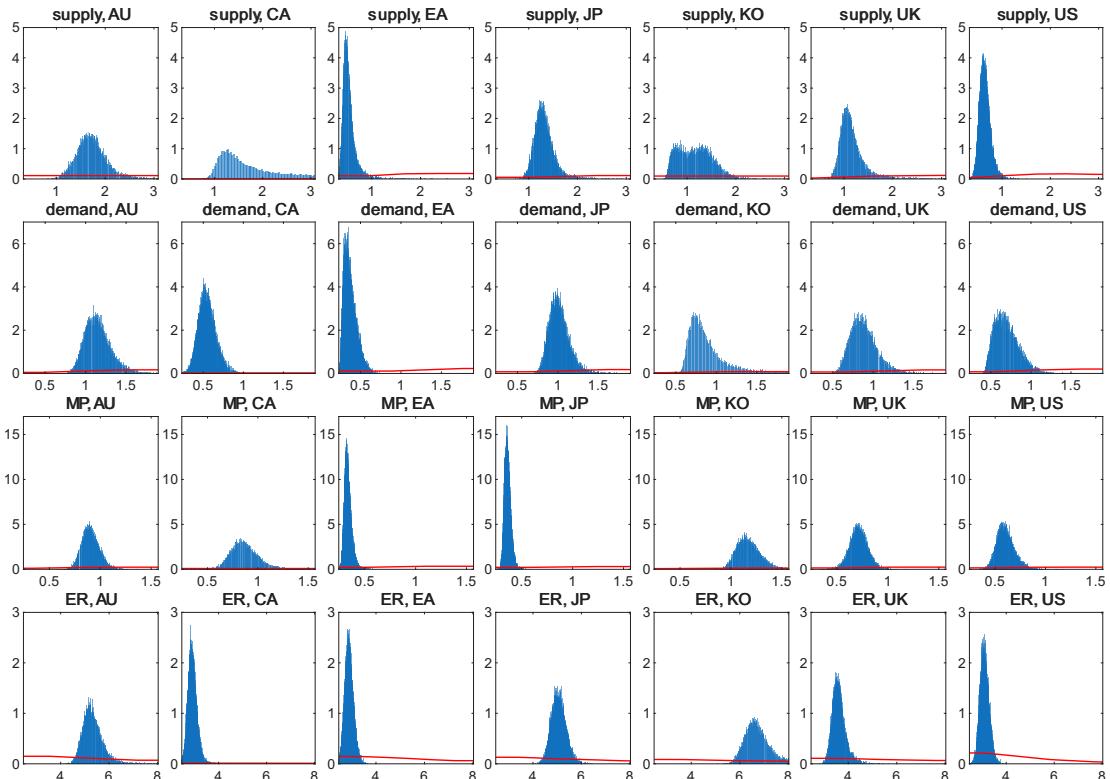
**Figure D.20:** Impulse responses of interest rates to demand shocks (AU, CA, JP, KO, UK)



**Figure D.21:** Impulse responses of interest rates to MP shocks (AU, CA, JP, KO, UK)



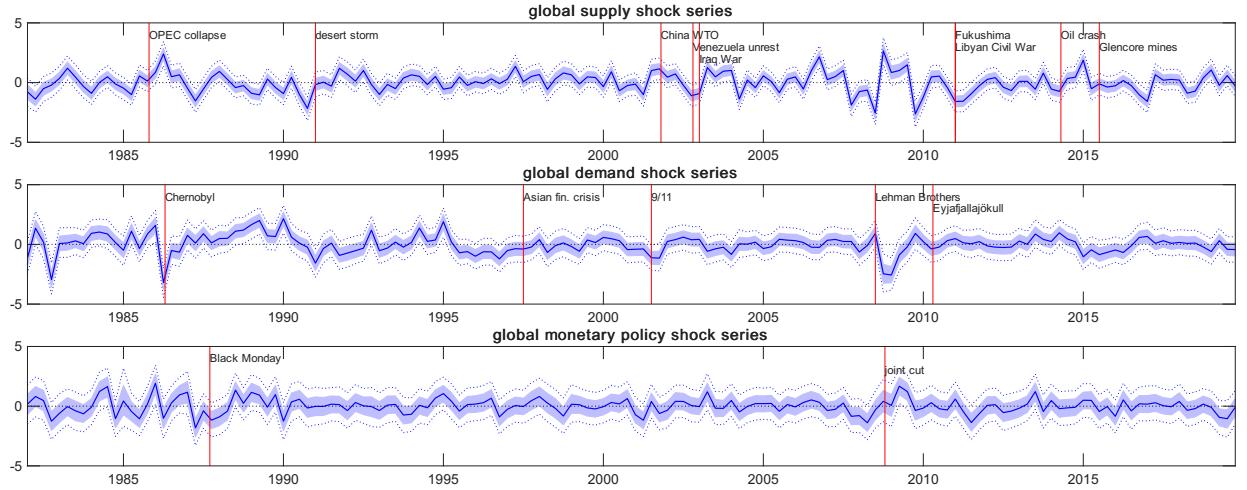
**Figure D.22:** Standard deviation of structural shocks



NOTES: The histograms show the posterior distribution of structural shock standard deviations, together with the uninformative prior distribution (red line). Global shocks have unit variance.

## D.4 Global shocks

**Figure D.23:** Estimated time series of global shocks



NOTES: The solid lines in the figure show median global shock series. The shaded areas (dotted lines) show the respective 68% (95%) posterior credibility sets. Oil supply events are drawn from [Antolín-Díaz and Rubio-Ramírez \(2018\)](#); [Käning \(2021\)](#) and reference therein.

## E Further robustness analysis

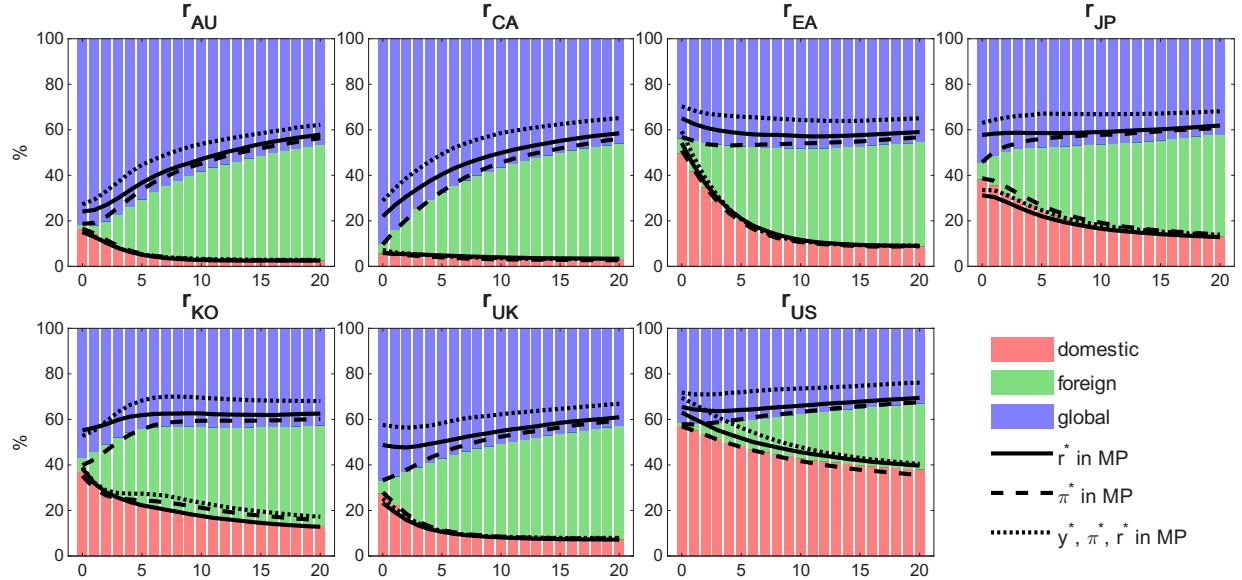
This section shows results for several robustness checks changing the model set-up and adjusting the structural contemporaneous relations. We show the forecast error correlation decomposition between global and country-specific interest rates for the alternative specifications in comparison to our main results (baseline). Further results are available on request.

### E.1 Alternative specifications of structural equations

Relaxing the restrictions that monetary policy endogenously reacts only to contemporaneous changes in foreign interest rates, output and inflation does not significantly change our results, see Figure E.1. We extend the monetary policy rules to contain coefficients on foreign interest rates (labeled  $r^*$  in  $MP$ ), foreign inflation (labeled  $\pi^*$  in  $MP$ ) and foreign output gaps, inflation and interest rates (labeled  $y^*, \pi^*, r^*$  in  $MP$ ). The main difference to the baseline results is an increase in the importance of foreign shocks to up to 20% (JP, UK) at short horizons in the first (solid lines) and third (dotted lines) variant, at the expense of domestic shocks. This is because the coefficients on foreign interest rates in monetary policy rule are both economically and statistically significantly positive. All other additional coefficients in the monetary policy rules are identified to be zero.

Four specifications adjust the structural contemporaneous relations of supply and exchange rate equations in the baseline model, shown in Figure E.2: The first adds foreign

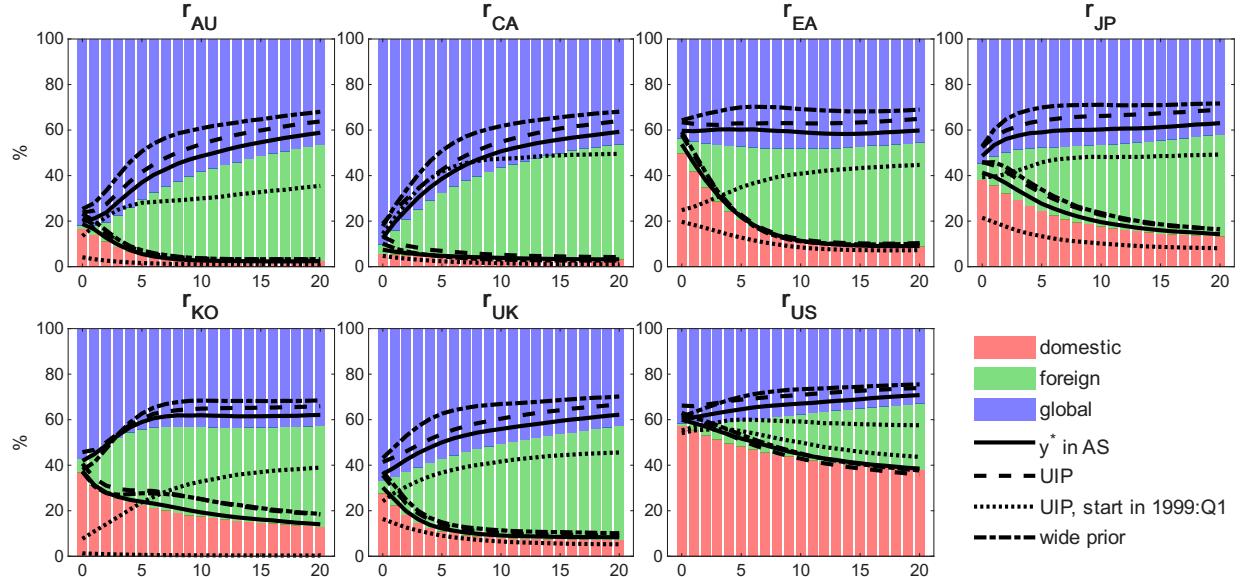
**Figure E.1:** Forecast error correlation decomposition between global and country-specific interest rates for alternative monetary policy rule specifications



NOTES: Figure shows the forecast error correlation decomposition between global and country-specific interest rates for the baseline model (bars) together with three alternative monetary policy rule specifications (lines).

output gaps to the supply equation, restricting the coefficient to be positive (labeled “ $y^*$  in AS”). The second adjusts the exchange rate equation such that interest rate differentials enter (labeled “UIP”). Our third specification (“UIP, start in 1999Q1”) also adds interest rate differentials, but restricts the sample to 1999:Q1 to 2019:Q4. Our fourth specification uses priors with a variance of 1 (instead of 0.4) for the coefficients  $\alpha^{c,\pi}, \theta^{c,y}$  (labeled “wide prior”).

**Figure E.2:** Forecast error correlation decomposition between global and country-specific interest rates for alternative AS and ER equation specifications



## E.2 Alternative global shock specifications

Four specifications change the set-up of the global shocks, shown in Figure E.3: a model without global shocks, a model with two global shocks (demand and supply shocks), a model with four global shocks (additionally a global exchange rate shock), and a model where for Australia and Canada global supply and demand shocks enter the exchange rate equation.

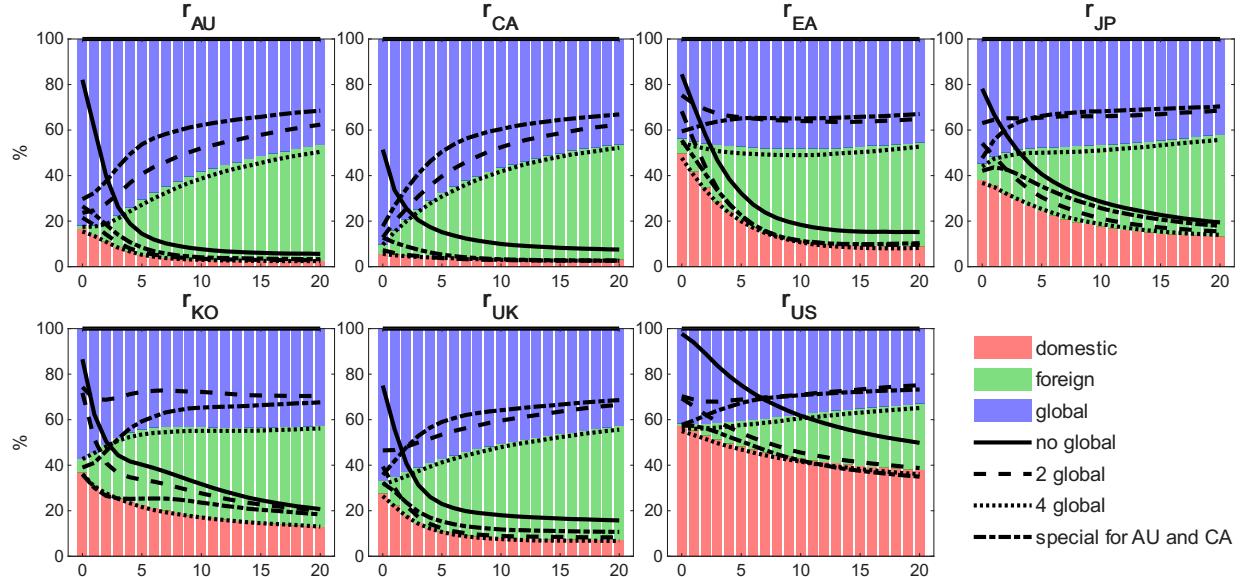
## E.3 Alternative model set-ups and samples

Four specifications change the model-set up, shown in Figure E.4: a model with a deterministic trend, a model with 8 lags, a model with no size-dependent shrinkage (no GDP weight included in the Minnesota prior), and a model with log differences of real GDP instead of output gap. Three additional specifications use shorter samples, shown in Figure E.5: a model with data starting in 1999:Q1, a model with data ending in 2007:Q2, and a model with data ending in 2007:Q2 that additionally excludes Japan.

## E.4 Accounting for financial transmission channels

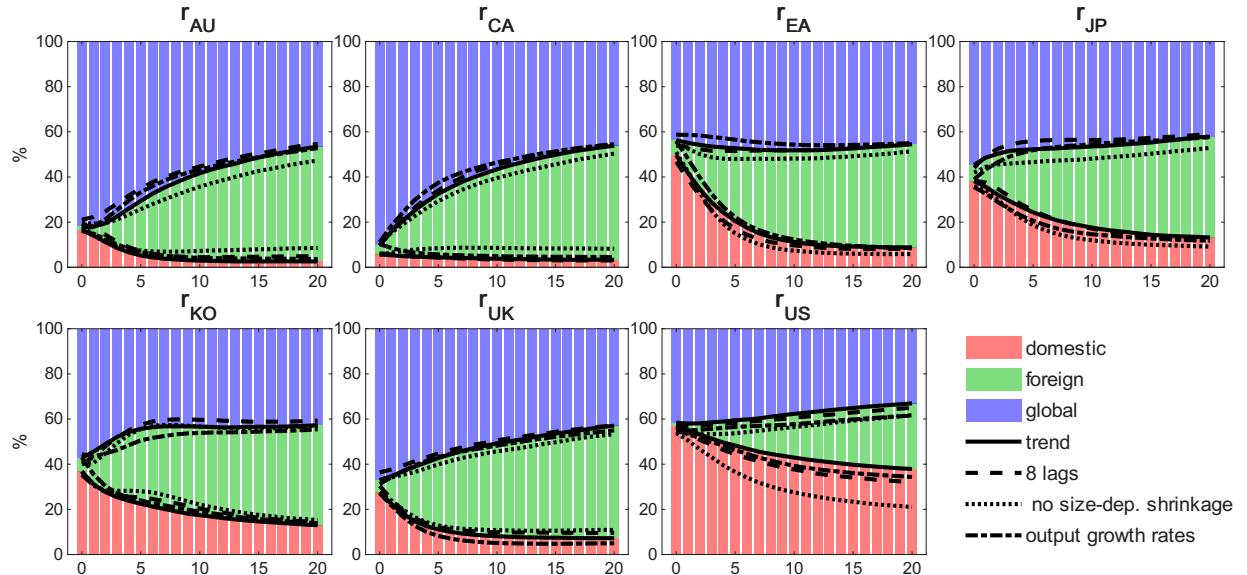
Monetary policy shocks might be transmitted internationally via financial channels, such as the wealth and credit channel (for a description of different financial channels see, for

**Figure E.3:** Forecast error correlation decomposition between global and country-specific interest rates for alternative global shock specifications



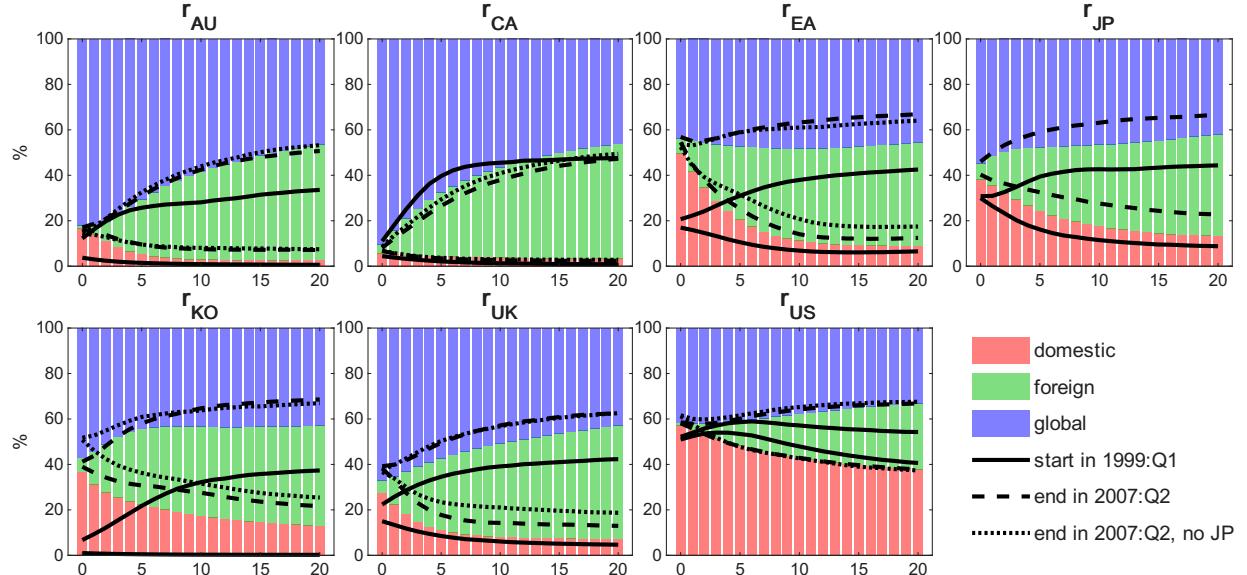
NOTES: Figure shows the forecast error correlation decomposition between global and country-specific interest rates for the baseline model (bars) together with a model without global shocks (solid lines), a model with two global shocks (dashed lines), a model with four global shocks (dotted lines), and a model where for Australia and Canada global supply and demand shocks enter the exchange rate equation (dash-dotted lines).

**Figure E.4:** Forecast error correlation decomposition between global and country-specific interest rates for alternative model set-ups



NOTES: Figure shows the forecast error correlation decomposition between global and country-specific interest rates for the baseline model (bars) together with a model with a deterministic trend (solid lines), with 8 lags (dashed lines), no size-dependent shrinkage (dotted lines), and with output growth rates (dash-dotted lines).

**Figure E.5:** Forecast error correlation decomposition between global and country-specific interest rates with alternative samples



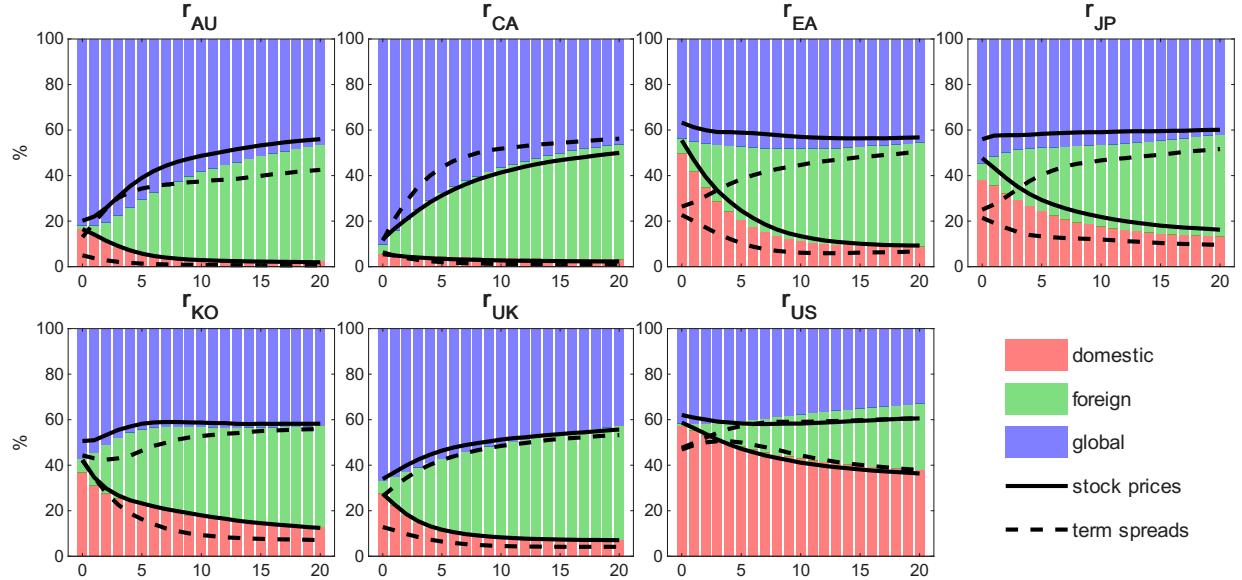
NOTES: Figure shows the forecast error correlation decomposition between global and country-specific interest rates for the baseline model (bars) together with a model with data starting in 1999:Q1 (solid lines), with data ending in 2007:Q2 (dashed lines), and additionally excluding Japan (dotted lines).

example, [Bauer and Neely, 2014](#); [Neely, 2015](#); [Fratzscher et al., 2018](#)). The central banks' actions can alter asset prices by stimulating or dampening the demand for assets. Changes in asset prices impact the wealth of households and companies leading to adjusted spending (wealth channel). The monetary authority actions can affect the availability of credit in the market which in turn alters spending and investments (credit channel).

We augment our model by growth in stock prices (wealth channel) or term spreads (credit channel), measured as 5-year yields minus shadow interest rates. We include the additional channel variable (domestic and foreign) contemporaneously in all baseline equations and allow all variables to contribute contemporaneously to the development of the channel variable, with the exception of foreign exchange rates and foreign channel variables. We set Student  $t$  priors with mode zero and scale one on the additional contemporaneous parameters. We add prior beliefs that contractionary monetary policy increases domestic interest rates, lowers domestic output gaps and inflation, and decreases competitiveness, by setting asymmetric  $t$  distributions with  $\mu = 0$ ,  $\sigma = 1$ ,  $v = 3$ , and  $\lambda = 20$  on the impact effects of monetary policy shocks. We restrict the impact response of the stock prices or term spreads to a domestic monetary policy shock to be negative.

Adding stock prices does not alter the main results substantially, while including term spreads strengthens the importance of global shocks for all countries except Canada, see Figure E.6.

**Figure E.6:** Forecast error correlation decomposition between global and country-specific interest rates with additional variables

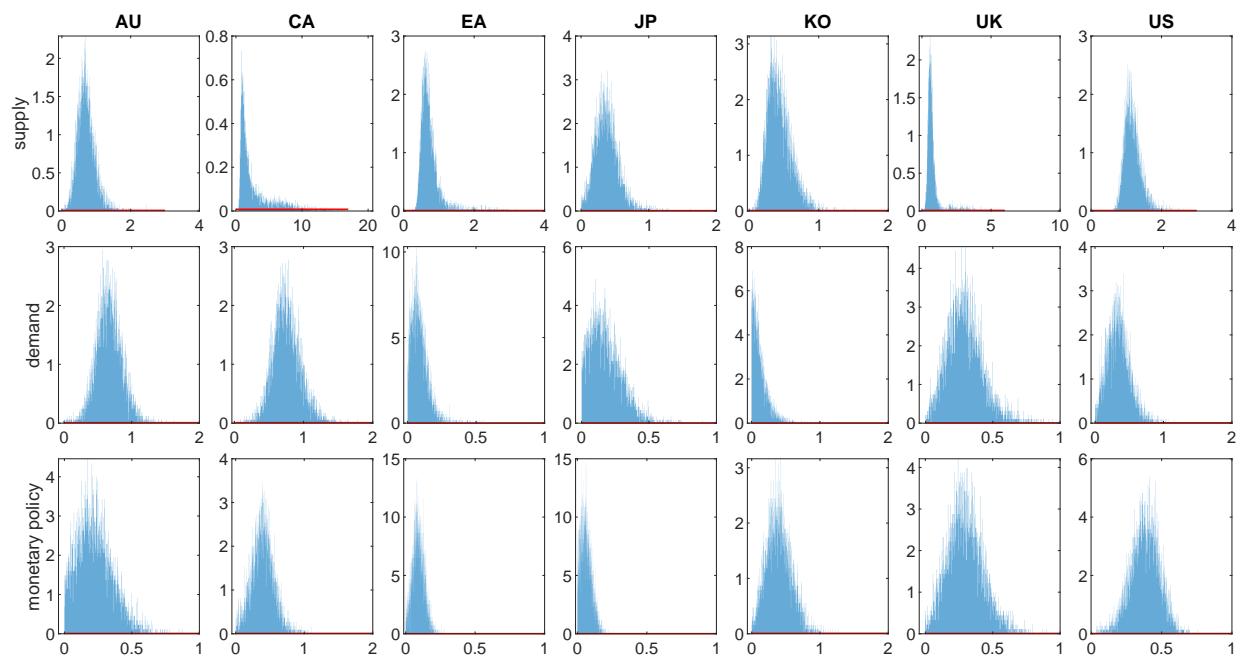


NOTES: Figure shows the forecast error correlation decomposition between global and country-specific interest rates for the baseline model (bars) together with a model including stock prices (solid lines) and a model including term spreads (dotted lines).

## E.5 Including the global financial cycle

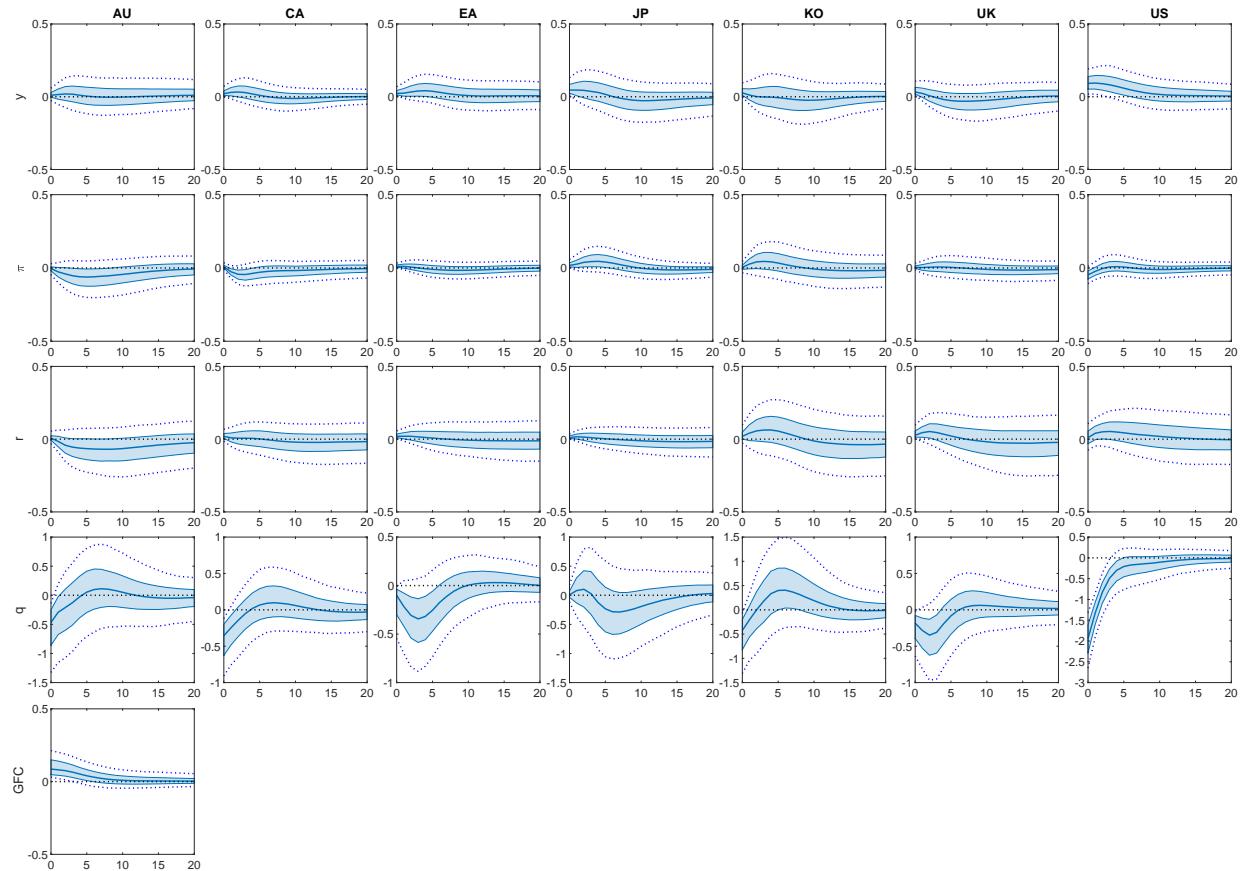
For the specification including the global financial cycle (GFC), we provide additional evidence on the loadings of global shocks in Figure E.7 and on impulse responses to the residual shock to the GFC.

**Figure E.7:** Posterior distributions of loadings, model including GFC



NOTES: The histograms show the posterior distribution of global shock loadings from the model including GFC, together with the prior distribution (red line).

**Figure E.8:** Impulse responses of all variables to the residual shock to the GFC



NOTES: The solid lines in the figure show median impulse responses of all variables (in rows) from all countries (in columns) to a residual shock to the global financial cycle over 20 quarters. The shaded areas (dotted lines) show the 68% (95%) posterior credibility sets. The shocks have size of one unit (i.e., one percentage point).