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Discussion Papers
No. 26
December 2023

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ISSN 2194-2188

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Abstract

This paper studies the interaction between fiscal policy and bondholders against the backdrop of high sovereign debt levels. For our analysis, we investigate the case of Italy, a country that has dealt with high public debt levels for a long time, using a Bayesian structural VAR model. We extend a canonical three variable macro mode to include a bond market, consisting of a fiscal rule and a bond demand schedule for long-term government bonds. To identify the model in the presence of political uncertainty and forward-looking investors, we derive an external instrument for bond demand shocks from a novel news ticker data set. Our main results are threefold. First, the interaction between fiscal policy and bondholders' expectations is critical for the evolution of prices. Fiscal policy reinforces contractionary monetary policy through sustained increases in primary surpluses and investors provide incentives for "passive" fiscal policy. Second, investors' expectations matter for inflation, and we document a Fisherian response of inflation across all maturities in response to a bond demand shock. Third, domestic politics is critical in the determination of bondholders' expectations and an increase in the perceived riskiness of sovereign debt increases inflation and thus complicates the task of controlling price growth.

Keywords: bond markets, fiscal policy, instrument, monetary policy, structural vector autoregression

JEL classification: C11, E31, E43, E52, E6

1 Introduction

The rise in inflation in advanced economies has prompted central banks to repeatedly increase interest rates in 2022. At the same time, average sovereign debt hovers at 117% of GDP, close to its peak of 2020, and is expected to recede only gradually (*IMF Fiscal Monitor*; 2022). Low interest rates and extensive quantitative easing programs, which have characterized the last decade, facilitated servicing these historically large government debt burdens and bolstered secondary bond markets. As yield curves shift upwards, interest rate expenses weigh more heavily on governments' budgets and fiscal plans could become subject to increased scrutiny. While unexpected inflation dilutes the (nominal) value of government debt and therefore provides a windfall profit to governments at the expense of existing bondholders, this relief should prove to be short-lived. Bondholders demand inflation compensation and will adjust lending rates according to their assessment of the future evolution of prices, monetary and fiscal policy. The interaction between fiscal policy and bond investors will shape the evolution and dynamics of economic and financial aggregates, as economies depart from a regime of low interest rates.

This paper looks at evidence from Italy to investigate how the interaction between fiscal policy and bondholders impacts macroeconomic outcomes and to assess the importance of the political process for bondholders' expectations against the backdrop of high public debt levels. Italy is an instructive example for two main reasons. First, Italy has long been grappling with a high level of sovereign debt relative to GDP, similar to the levels now observed in many advanced economies. Second, since the mid-1990s, Italy has seen frequent shifts in governing coalitions and political direction yielding sufficient variation for the proposed analysis.[1]

Our core results are threefold. First, fiscal policy and bondholders' expectations take on a central role for determining the evolution of prices. While fiscal and monetary policy stabilize inflation and smooth the business cycle *jointly*, fiscal policy reacts with increased primary surpluses over a protracted period of time in response to both monetary policy shocks and innovations in bond demand. Therefore, fiscal policy reinforces contractionary monetary policy through sustained increases in primary surpluses and investors provide incentives for "passive" fiscal policy, i.e. a policy design in which the sovereign adjusts future primary surpluses to stabilize debt in light of an interest rate shock.[2] Second, investors' perceptions matter for prices. When investors suddenly view long-term debt as being riskier, i.e. when they revise their expectations with respect to the present value of future primary

[1] See the introduction of Bosco and Verney (2022) for an overview of existing studies characterizing Italian politics.

[2] As opposed to an "active" sovereign that chooses primary surpluses in an unconstrained fashion, see Leeper (1991).

surpluses, inflation rises for a protracted period. The Fisherian effect of investors' sovereign risk perceptions corroborate the theoretical concerns in e.g. Leeper and Walker (2012) or Cochrane (2023). These authors argue that sovereign risk lowers the present value of future primary surpluses. In equilibrium, discounted future primary surpluses equal the real value of government debt and prices rise in order to restore this equilibrium. Therefore, a perceived increase in sovereign risk pushes up prices and thus makes it harder for fiscal and monetary authorities to control inflation—regardless of their commitment to price stability. Third, the political process is a critical driver of shifts in investors' expectations and instrumenting the bond demand shock with the derived shock series from political news data substantially improves the model. Our paper therefore establishes a credible link from day-to-day domestic politics to bond market's perceptions. This finding emphasizes the importance of political credibility for stable prices, in line with the work of Cochrane (2021) or Miller (2021).

We derive our results within a structural BVAR by extending a canonical three variable macro model,[3] consisting of aggregate supply, aggregate demand and monetary policy, to include a bond market. The bond market encompasses a fiscal policy rule, which is derived from the fiscal theory of the price level (FTPL),[4] and a bond demand schedule for long-term government bonds. These are priced by investors as a weighted average of short-term rates expected to prevail over the life of the bond. Specifically, investors believe that future short-term interest rates evolve together with expected inflation and output gaps according to a smoothed Taylor rule, consistent with the monetary policy rule. Prior values for the fiscal rule are deduced from the contractual framework of the euro area, others are drawn from the literature. Since the risk component of bond demand is not properly captured by the expectations hypothesis, we further control for primary surpluses and instrument bond market shocks with a novel sovereign risk shock series derived from intraday news feed data. The instrument enables us to trace out the impact of the political process on bondholders' expectations.

Our model is identified using Bayesian estimation techniques (Baumeister and Hamilton; 2015, 2018). The approach circumvents restrictions on the reduced form and estimation is carried out directly for the structural model. Prior values and distributions are therefore derived for the structural rather than reduced form parameters. However, VAR models do not explicitly represent expectations. To still be able to integrate the forward-looking nature of bond demand in our model, we construct an external instrument for bond market

[3]For comparison, see for example Rotemberg and Woodford (1997) and Lubik and Schorfheide (2004).

[4]The FTPL interprets the government budget constrain as an equilibrium condition, reached through endogenous movements in the price level. This theory originated with Sargent et al. (1981), Leeper (1991) and Sims (1994). The most comprehensive summary of the theory to date may be found in Cochrane (2023).

shocks based on the dependence of the bond market on the political process (Hatchondo and Martinez; 2010; Eichengreen and Esteves; 2022). Specifically, we exploit the fact that sovereign default largely depends on a country's willingness to incur the political pain of fiscal tightening (Leeper; 2013). We derive domestic policy events that potentially alter investors' expectations about Italy's future fiscal discipline, using a novel intraday news ticker data set from Thomson Reuters. The events consist of domestic policy surprises, such as comments regarding possible resignations, confidence votes and political comments. Recording bond price movements in narrow time windows around the event time enables us to calculate associated bond market reactions. The series is aggregated to quarterly frequency and used as an external instrument. The instrument is critical in the identification of the bond demand schedule. Moreover, it permits us to establish a credible link between the drivers of fluctuations in bond demand and the political process. We interpret underlying events as news on the perceived future fiscal discipline of a sovereign, along the lines of the theoretical work of Miller (2021). We include the external instrument in the framework of the Bayesian structural VAR as in Nguyen (2019) and von Schweinitz (2023). As an extension of this literature, we note that the proposed structure allows easy inclusion of additional external variables alongside the instrument. We exploit this fact to model the Italian economy conditional on euro area developments, by including output gaps and inflation from the rest of the euro area as external variables. As a consequence, monetary policy reacts endogenously to euro area developments.
The paper is structured as follows. The next section covers related literature. In section 3, we lay out the model and explain how the external instrument is constructed in more detail. In section 5, we conduct sensitivity analysis to demonstrate the robustness of our findings. Section 6 concludes the paper.

2 Literature

There exists a large body of theoretical literature on the interaction between fiscal policy and bond markets. As early as 1981, Sargent et al. challenged the monetarist tenet that inflation is exclusively a monetary phenomenon. The authors argue that if a government does not stabilize public debt, there will be a point at which bondholders refuse to lend to the government and the monetary authority must jump in and monetize the sovereign's unmet financing needs. Inflation is therefore not solely controlled by central banks. This idea has been followed up by numerous papers studying the interdependency of monetary and fiscal authorities in their interaction with investors. While outright monetization of public debt is an unlikely scenario for advanced economies, nominal denomination of government debt enables other channels through which fiscal policy and investors' beliefs may influence the way a central bank can control inflation. Advocates of the fiscal theory of the price level (FTPL)[5] have pointed out that a sovereign is not forced to adjust future primary surpluses to changes in interest rates, such that the real value of public debt equals the present value of future primary surpluses, effectively arguing that the intertemporal budget constraint is really an equilibrium condition. Prices are endogenous and adjust such that the relation holds in equilibrium. Recent contributions to this strand of the literature are for example Miller (2021), Bianchi and Melosi (2022) and Cochrane (2022). Miller devises a representative agent model with costs of information. Bondholders start to investigate the fiscal backing only if there is sufficient doubt regarding repayment. At a certain point, fiscal plans are then subjected to investors' scrutiny and inflation can increase rapidly. Bianchi and Melosi (2022) build a Markov-Switching DSGE model in which monetary and fiscal policy regimes can change. If investors do not trust the fiscal authority to stabilize public debt given a monetary tightening, this erodes the price level further and undermines the central bank's effort to control inflation. Cochrane (2022) constructs a sticky price model with long-term debt in which fiscal policy selectively adjusts primary surpluses and can partially inflate away debt.

Leeper and Walker (2012) and Cochrane (2023) explain how sovereign default risk can reduce control over inflation even when monetary and fiscal policy are both committed to price stability. If investors start to doubt a sovereign's solvency, they discount the future stream of surpluses at a higher rate. Prices adjust such that the real value of the public debt portfolio equals the present value of primary surpluses which increases inflationary pressure. Eusepi and Preston (2018) show that even if the government adjusts future primary surpluses in line with changes in the discount rates, fiscally-driven inflation can ensue from imperfect knowledge of bondholders. As investors learn from the evolution of realized aggregates and adjust their forecasts in the light of surprises, they feel more or less wealthy depending on the views of the present value of taxation relative to the perceived market value of public debt. This affects aggregate demand and compromises the transmission of monetary policy through intertemporal substitution.

More recently, the empirical literature has brought the theoretical ideas closer to the data. Bianchi and Ilut (2017) calibrate a DSGE model for the US economy with varying monetary and fiscal policy. They find that inflation was brought down in the 80s when fiscal policy and associated agents' beliefs changed. Leeper et al. (2017) document that fiscal multipliers depend on the fiscal and monetary regimes in place. Hall and Sargent (2011) investigate different debt stabilization mechanisms and find that historically the United States have not stabilized sovereign debt through adjustments in fiscal policy, but rather through economic growth, revaluation effects and low interest rates. Eichengreen and Esteves (2022) compile

[5] See for example: Leeper (1991), Sims (1994), Woodford (1995) and Cochrane (1998).

a comprehensive country panel to study sovereign debt consolidation mechanisms. The authors find that inflation has been critical in stabilizing debt. Interestingly, they find consolidation through inflation to be most effective in periods of low and stable inflation. In periods of high inflation, interest rates tend to be more reactive, reducing the governments windfall profit.

The contribution of this paper is the derivation of a structural VAR that pays particular attention to investors expectations through the inclusion of an external instrument for bond market shocks. The instrument is derived from domestic policy shocks that potentially alter investors' beliefs about Italy's fiscal discipline. This enables us to establish a link to the political process, explicitly accounting for the influence of the "vagaries of the political process" (Davig and Leeper; 2011, p.236) on investors' perceptions. We use Bayesian estimation techniques in the tradition of Baumeister and Hamilton (2015) and Baumeister and Hamilton (2018) to identify the model. The instrument is included along the lines of Nguyen (2019) and von Schweinitz (2023).

3 Empirical Model

To trace the interaction between Italian fiscal policy and investors, we use a Bayesian structural VAR. Our empirical model combines an aggregate supply and an aggregate demand curve with a monetary policy rule, a fiscal policy rule and investor bond demand. Bayesian structural VARs such as ours (Baumeister and Hamilton; 2015, 2018) draw direct inference on the structural model by using prior knowledge on the contemporaneous elasticities and semi-elasticities in the structural equations. To integrate the bond market and sharpen inference for the Italian case, we extend the core model in two directions.

First, we include an instrument for exogenous shifts in the bond demand curve. The instrument is based on high-frequency changes of bond prices around news events that are relevant for the expectation formation of bond investors, see a detailed description in subsection 3.2. The instrument is necessary to pin down bond demand. It enables us to capture the sensitivity to news and the forward-looking nature of financial markets better than through the limited number of endogenous variables employed in our model. However, we view this instrument not only as an identification device. By linking important political events distinct from monetary and fiscal policy to the bond market, it additionally provides an appealing narrative for the identified structural shocks to the bond demand equation.

Second, we model the Italian economy conditional on euro area developments. To do this, we include output gaps and inflation from the rest of the euro area as external variables. This in particular allows us to model that monetary policy as reacting endogenously to euro area developments.

The five structural economic equations are modeled using quarterly data from 1999Q1 to 2019Q4 on output gaps y_t, year-on-year inflation π_t, shadow rates i_t from Krippner (2013), primary balances s_t and 3-year Italian sovereign bond rates b_t. The primary surplus captures the fiscal policy stance and is scaled with potential GDP to avoid undesired dynamics stemming from fluctuations in GDP (cf. Cochrane (2021)). The 3-year bond rate pins down investors' appetite for long-term government bonds. We show below that our main results are not sensitive to the maturity choice. We add output gaps and inflation in the rest of the euro area (denoted as y_t^{rea}, π_t^{rea}) as exogenous variables. These are calculated such that full Euro-Area aggregates are the GDP-weighted sum of Italian variables and the rest of the euro area. Appendix B contains additional information on the construction of the data. We collect the endogenous variables in the vector $\mathbf{y}_t = (y_t, \pi_t, i_t, s_t, b_t)$. The vector $\mathbf{z}_t = (y_t^{rea}, \pi_t^{rea}, z_t^b)$ contains the exogenous variables and the bond demand instrument, while $\mathbf{x}_{t-1}$ combines $l = 2$ lags of both the endogenous variables $\mathbf{y}_t$ and the exogenous terms, a constant and a time trend. We remove any autocorrelation from the instrument, and therefore do not include it in the vector of lag terms. We can write the structural VAR model in matrix notation as

$$\mathbf{A}\mathbf{y}_t + \mathbf{C}\mathbf{z}_t = \mathbf{B}\mathbf{x}_{t-1} + \mathbf{u}_t$$
$$\mathbf{u}_t \overset{\text{i.i.d.}}{\sim} \mathcal{N}(0, \mathbf{D}),$$

Structural shocks $\mathbf{u}_t$ are mutually independent normally distributed random variables with mean zero and diagonal variance-covariance matrix $\mathbf{D}$.[6] Note that we differentiate between contemporaneous structural coefficients between endogenous variables, $\mathbf{A}$, contemporaneous structural coefficients between endogenous and exogenous variables (including instrument), $\mathbf{C}$, and structural lag coefficients $\mathbf{B}$. Thus, our inclusion of exogenous variables and an external instrument within the framework of the Bayesian structural VAR follows the extensions proposed by Nguyen (2019) and von Schweinitz (2023), such that the joint prior distribution equals

$$p(\mathbf{A}, \mathbf{C}, \mathbf{B}, \mathbf{D}) = p(\mathbf{A}, \mathbf{C})p(\mathbf{D}|\mathbf{A}, \mathbf{C})p(\mathbf{B}|\mathbf{A}, \mathbf{C}, \mathbf{D}). \tag{1}$$

Expressing the prior distribution of lag coefficients and shock variances conditional on $\mathbf{A}$ and $\mathbf{C}$ is attractive because we can use a standard normal-inverse gamma model for $p(\mathbf{D}|\mathbf{A}, \mathbf{C})$ and $p(\mathbf{B}|\mathbf{A}, \mathbf{C}, \mathbf{D})$. Much more thought, and economic argument, has to be put into the prior distribution of contemporaneous structural coefficients $p(\mathbf{A}, \mathbf{C})$. The reason for this is

[6] Strictly speaking, $\mathbf{u}_t$ does not contain the true bond demand shock u_t^B, but the measurement error v_t^B from an instrument regression $u_t^B = \chi^B z_t^B + v_t^B$, see von Schweinitz (2023). For identification of the model, this distinction is irrelevant. However, it does play a role for impulse-response functions and historical decompositions, where we properly take this distinction into account.

that the importance of identifying assumptions (the role of the prior) cannot be completely mitigated through the use of additional observations. This means that, for example, we need to impose a zero restriction on the semi-elasticity of aggregate supply to interest rates, or positive signs on Taylor rule coefficients, because the data might not be able to rule out the contrary. Thus, we want our prior choices to be informative for the model and consistent with economic theory.

3.1 Deriving Structural Model from Prior Theoretical Knowledge

To pin down the structure of the model, we can draw on an extensive literature. Specifically, the structural equations, namely an aggregate supply (S in the following) and an aggregate demand curve (D) with a monetary policy rule (M), a fiscal policy rule (F) and investor bond demand (B), are as follows:[7]

$$y_t = \Theta_\pi^S \pi_t + \text{lag terms} + u_t^S \tag{S}$$

$$y_t = \Theta_\pi^D \pi_t + \Theta_i^D i_t + \Theta_s^D s_t + \Theta_b^D b_t + \Gamma_y^D y_t^{rea} + \text{lag terms} + u_t^D \tag{D}$$

$$i_t = (1-\rho)\left[\Theta_y^M \left(\omega y_t + (1-\omega) y_t^{rea}\right) + \Theta_\pi^M \left(\omega \pi_t + (1-\omega)\pi_t^{rea}\right) + \Theta_s^M s_t + \Theta_b^M b_t\right] + \text{lag terms} + u_t^M \tag{M}$$

$$s_t = \Theta_y^F y_t + \Theta_\pi^F \pi_t + \Theta_i^F i_t + \Theta_b^F b_t + \text{lag terms} + u_t^F \tag{F}$$

$$b_t = \Theta_y^B \left(\omega y_t + (1-\omega) y_t^{rea}\right) + \Theta_\pi^B \left(\omega \pi_t + (1-\omega)\pi_t^{rea}\right) + \Theta_i^B i_t + \Theta_s^B s_t + \text{lag terms} + u_t^B \tag{B}$$

The literature allows us to construct informative yet nonrestrictive priors for the individual coefficients $\Theta_{variable}^{equation}$. Economically, most of these coefficients can be interpreted as (semi-)elasticities of the corresponding structural relationship with respect to each variable. In the following subsections, we document our prior assumptions and how we draw inference on the posterior model distributions. However, beyond the distributions of individual coefficients, the general form of the structural equations implies two types of strong restrictions, which we wish to discuss directly. First, we add zero restrictions. We assume that aggregate supply (S) contemporaneously only depends on inflation (Baumeister and Hamilton; 2018). This implies, for example, that fiscal and monetary policy can influence business cycle development mainly through demand channels. Additional zero restrictions relate to the role of developments in the rest of the Euro-Area. For aggregate demand (D), we follow the literature on small open economies and allow only for a role of foreign output gaps (Lubik and Schorfheide; 2007). We further assume that Italian fiscal policy shifts endogenously only with domestic developments. Thus, we implicitly impose the restriction that European programs do not lead to contemporaneous shifts of Italian fiscal policy. We argue that this is reasonable as EU budgets have long negotiation times and are decided for six-year periods. Second, we add equality restrictions in the monetary policy rule and the investor bond demand equation. Monetary policy conducted by the ECB is based on average developments

[7]The implied matrices of structural contemporaneous coefficients **A** and **C** are given in the appendix.

in the euro area. We reflect this by applying the structural coefficients Θ_y^M (Θ_π^M) to the GDP-weighted average of output gaps (inflation) in Italy and the rest of the euro area. In our paper, we assume time-invariant weights ω (for Italy) and $1-\omega$ (for rest of the euro area), where ω is calculated as the average GDP share of Italy within the euro area over the sample period (cf. figure A5). The same logic is applied to investor bond demand, which we relate to an expectation hypothesis. According to this hypothesis, medium- to long-term interest rates should reflect expectations about future developments of short-term interest rates. As monetary policy rates change endogenously with inflation and output gaps, we apply the same logic as for the monetary policy rule (albeit with different prior distributions for Θ_y^B and Θ_π^B). The structural shocks ($u_t^S, u_t^D, u_t^M, u_t^F$ and u_t^B) denote unexpected shifts of structural equations. In particular, we differentiate shocks to the fiscal policy rule, u_t^F, and shocks to investor bond demand, u_t^B. The former arise, for example, from unforeseen changes in government spending or taxation, while the latter describes changes in the (perceived) riskiness of government debt.

3.1.1 Prior Information about Contemporaneous Coefficients

Let us now discuss the prior distributions on individual coefficients Θ and Γ in detail, which we summarize in table 1. Following Baumeister and Hamilton (2015), we use t-distributions with different modes, a scale of 0.4 and 3 degrees of freedom for all free parameters except from ρ, the degree of interest rate smoothing.

Supply, Demand and Monetary Policy Leaving aside the influence of the bond market, equations (S) through (M) are standard. We adopt the prior specifications for these parameters, ($\Theta_\pi^S, \Theta_\pi^D, \Theta_i^D, \Theta_y^M, \Theta_\pi^M$), from the three-equation monetary model of Baumeister and Hamilton (2018). As in their paper, we assume a positively sloped Phillips-curve and allow for the fact that inflation might influence aggregate demand above and beyond its impact via real interest rates. For the monetary policy equation, we assume a Taylor-type rule based on euro area developments. As euro area output gap and inflation (y_t^{ea}, π_t^{ea}) are GDP-weighted sums of Italian variables (y_t, π_t) and those from the rest of the euro area (y_t^{rea}, π_t^{rea}), the common Taylor rule can be decomposed into an Italian and non-Italian part (Drygalla et al.; 2020):

$$\begin{aligned} i_t &= (1-\rho)\left[\Theta_y^M y_t^{ea} + \Theta_\pi^M \pi_t^{ea}\right] + \text{other terms} \\ &= (1-\rho)\left[\Theta_y^M(\omega y_t + (1-\omega)y_t^{rea}) + \Theta_\pi^M(\omega \pi_t + (1-\omega)\pi_t^{rea})\right] + \text{other terms} \\ &= \underbrace{(1-\rho)\omega\left[\Theta_y^M y_t + \Theta_\pi^M \pi_t\right]}_{\text{(I)}} + \underbrace{(1-\rho)(1-\omega)\left[\Theta_y^M y_t^{rea} + \Theta_\pi^M \pi_t^{rea}\right]}_{\text{(II)}} + \text{other terms,} \end{aligned}$$

Table 1: Priors for structural contemporaneous coefficients

Parameter	Meaning	Prior Mode	Prior Scale	Sign Restriction
	Student t distribution with three degrees of freedom			
Θ_π^S	Effect of π on supply	2.0	0.4	≥ 0
Θ_i^S	Effect of i on supply			
Θ_s^S	Effect of s on supply			
Θ_b^S	Effect of b on supply			
Θ_π^D	Effect of π on demand	0.75	0.4	
Θ_i^D	Effect of i on demand	-1.0	0.4	≤ 0
Θ_s^D	Effect of s on demand	-0.5	0.4	
Θ_b^D	Effect of b on demand	0.0	0.4	
$\Gamma_{y^{rea}}^D$	Effect of y^{rea} on demand	0.0	1.0	
Θ_y^M	ECB response to $y^{\text{euro area}}$	0.5	0.4	≥ 0
Θ_π^M	ECB response to $\pi^{\text{euro area}}$	1.5	0.4	≥ 0
Θ_s^M	ECB response to s	0.0	0.4	
Θ_b^M	ECB response to b	0.0	0.4	
Θ_y^F	Fiscal response to y	0.08	0.4	
Θ_π^F	Fiscal response to π	0.39	0.4	
Θ_i^F	Fiscal response to i	-0.19	0.4	
Θ_b^F	Fiscal response to b	-0.19	0.4	
Θ_y^B	Effect of y on bond demand	0.06	0.4	
Θ_π^B	Effect of π on bond demand	0.18	0.4	
Θ_i^B	Effect of i on bond demand	0.24	0.4	
Θ_s^B	Effect of s on bond demand	0.0	0.4	
χ^B	Effect of z_t on bond demand	0.0	1.0	
	Beta distribution with $\alpha = 2.6$ and $\beta = 2.6$			
ρ	Interest rate smoothing	0.5	0.5	$0.2 \leq \rho \leq 1$

Notes: While the structural equations (S) through (M) are largely standard and values either agnostic or taken from the literature, the fiscal policy rule (F) and (B) are non-standard and therefore derived in detail in the appendix. Note that the ECB responds to euro area output gap and inflation computed as GDP-weighted averages of Italian and rest of the euro area variables, $\omega\nu + (1-\omega)\nu^{rea}|_{\nu \in \{y,\pi\}}$.

where (I) contains terms of $\mathbf{Ay}_t$, and (II) relates to $\mathbf{Cz}_t$. As in Baumeister and Hamilton (2018), we take possible interest rate smoothing into account through an additional parameter ρ, for which we assume a Beta prior with mean 0.5 and scale 0.2. This set-up can reflect central banks' preference for imposing changes only gradually rather than abruptly. In addition to the above parameters, we allow for shifts in aggregate demand and endogenous monetary policy responses in reaction to primary surpluses and bond yields. However, by keeping prior modes at zero, we do not impose any additional prior assumptions.

Fiscal Policy The fiscal policy equation (F) represents the sovereign's decision rule, which is derived from an FTPL model, developed in Cochrane (2022), integrated within a New-Keynesian sticky price framework. The model features fiscal and monetary policy rules and long-term government debt. Critically, the model allows for partial repayment of government debt and, complementarily, partial inflating away of government debt through deficits. This is in contrast to typical FTPL models in the literature, which assume fiscal policy to either react to all changes in inflation (passive fiscal policy) or to none at all, implying that deficits are financed entirely by diluting the value of outstanding government debt. Prior modes of our coefficients are derived from the medium term budgetary objectives associated with the Stability and Growth Pact (SGP).[8]

In Cochrane (2022), the government decides on a future primary surplus path depending on its preferences regarding inflation, economic activity and borrowing costs. Expectations are approximated using an autoregressive process. The prior modes for the parameters $\Theta_j^F | j = \{\pi, y, b\}$ depend most critically on α, a parameter which controls the intensity with which an increase in debt levels encourages higher primary surpluses given expectations about future economic activity, inflation and interest rates. Using the debt path rule from the SGP, we deduce a value for α of 0.07 as being consistent with the implied debt reduction. This value is on the same order of magnitude as empirical estimates of around 0.05 (cf. Cochrane (2022)). It is however considerably larger in relative terms, which reflects the strictness of budgetary rules compared to actually observed behavior.

The prior distribution for the effect of inflation on the primary surplus is chosen as $\Theta_\pi^F \sim t_3(0.39, .4)$. A positive coefficient is qualitatively in line with "Ricardian" behavior, as for example described in Sargent (1986) and required in standard models, such as Woodford (1999). From a purely empirical point of view, the coefficient also seems sensible. Most tax systems are not perfectly indexed, implying windfall revenue for the government whenever prices increase. Empirical estimates are close to our prior, Price et al. (2015) e.g. find a mode of 0.5, which gives us confidence regarding this prior choice. The prior modes of Θ_i^F and Θ_b^F, which refer to the effect of short-term and long-term interest rates on the primary

[8]Details are provided in the appendix.

surplus respectively, are set equal to -0.19. The value is derived from the coefficient of the *ex-post* nominal bond returns of the entire government bond portfolio. We approximate the portfolio return with the short and long-term bond rates of our model and use the expectations hypothesis, according to which bonds of all maturities pay the same interest in equilibrium, to arrive at the prior values. Note that the model from Cochrane (2022) implies a negative prior for the contemporaneous coefficient of the nominal rate of return on surpluses (cf. A.1.2). A negative sign is sensible considering the fact that government expenditures are largely fixed in the short run and an increase in interest rate expenditures will therefore likely be met with higher deficits rather than immediate spending cuts or tax increases (Lorenzoni and Werning; 2019). However, in the medium and long run an increase in interest rates is expected to lead to long and protracted periods of increased primary surpluses (Cochrane; 2022).

Investors' Bond Demand Investors demand government long-term bonds and require interest payments in compensation. The government debt demand equation is derived against the backdrop of the expectation hypothesis, using yields of bonds with 3-year maturity as the interest rate of choice. The expectation hypothesis states that the interest rate demanded for holding long-term government bonds equals the average of the short-term interest rates that people expect to occur over the life of the long-term bond. Specifically, agents expect the ECB to endogenously react to euro area inflation and business cycle dynamics. As in Baumeister and Hamilton (2018), we assume that 3-year ahead expectations of deviations from steady state can be approximated by an $AR(1)$ decay of current deviations. Using this assumption together with the prior modes of the monetary policy rule coefficients allows us to derive priors for the influence of output gap, inflation and interest rates on investor bond demand.[9] We set the prior mode of Θ_{π}^{B} to 0.18. Naturally, the prior implies that higher rates of inflation feed into higher nominal long-term bond yields. Conversely, increased economic activity results in a higher real rate driving up nominal rates. The derived prior mode for $\Theta_{y}^{B} = 0.06$ seems a sensible starting point from this perspective. By construction through the expectations hypothesis, the prior mode for Θ_{i}^{B} is large and positive with a value of 0.24. The expectation hypothesis is known to be an over-simplification, abstracting for example from liquidity risk and predicting a flat yield curve, a feature clearly at odds with the data. We address this shortcoming in three ways. First, we strengthen the identification of shocks through the use of our news-based instrument. Second, we include surpluses in the bond demand equation, which should aid in pinning down the risk component. We remain agnostic with respect to the sign and set $\Theta_{s}^{B} \sim t_3(0.0, 0.4)$. This choice acknowledges the ambiguity: while higher surpluses reduce

[9]Details of the derivation are provided in the Appendix.

default risks, they may also lead to potential political unrest. Third, structural shocks to investor bond demand, u_t^B are by construction orthogonal to monetary policy shocks u_t^M, and could therefore (together with lagged coefficients) also allow for persistent deviations from the expectation hypothesis.

3.1.2 Prior Information about Impact Effects of Structural Shocks

Baumeister and Hamilton (2018) have shown that the algorithm of Baumeister and Hamilton (2015) can be extended to accommodate sign restrictions on contemporaneous impact effects, $\mathbf{H} = \mathbf{A}^{-1}$. Through the impact effects we add further sources of information, see table 2 for an overview. The asymmetric t distribution has been developed in Baumeister and Hamilton (2018) and combines the densities of a Student t distribution with 3 degrees of freedom, prior mode and scale, with a normal cumulative distribution function with scaling factor λ_h. The degree of asymmetry is controlled by λ_h: smaller values maintain the notion that signs on impact responses are not known with certainty a priori, while large values ($\lambda_h \rightarrow \pm 5000$) numerically imply strict sign restrictions (Baumeister and Hamilton; 2018). We choose three types of priors: two informative priors on the relative reaction of variables to monetary policy shocks, three priors on the sign of impact effects of structural shocks, and a regularity prior on $\det(\mathbf{A})$.

The first type of prior, h_1 and h_2, targets the impact reaction of output gap and long-term bond yields to a monetary policy shock, relative to the impact reaction of the shadow rate. The first prior on the relative reaction of output gaps, h_1, is taken directly from Baumeister and Hamilton (2018), who argue that the output gap reaction should be smaller in absolute terms than the interest rate response, and most likely negative. As for long-term bond yields, the literature documents an incomplete pass-through of monetary policy shocks (Hristov et al.; 2014). Thus, we think it unlikely that long-term bond yields react more strongly than short-term rates, or even negatively, to a monetary policy shock. We incorporate this belief with a prior centered around 0.5 that leaves a 10% probability to be outside the $[0, 1]$ interval.

The second type of priors enforces signs on impact reactions. We apply this prior to the output response to an aggregate supply shock and the output and inflation response to a monetary policy shock. These impact restrictions help sharpen the model further and are theoretically uncontroversial. A positive supply shock should increase the output gap and a monetary tightening reduce the output gap and inflation on impact.

Table 2: Priors on impact effects of structural shocks

Prior variable	Prior Description	μ_h	σ_h	λ_h	Sign
Asymmetric t priors with 3 degrees of freedom					
$h_1 = \frac{\mathbf{H}(1,3)}{\mathbf{H}(3,3)}$	Reaction of output gap to a 100bp increase in interest rates	-0.3	0.5	-2	
$h_2 = \frac{\mathbf{H}(5,3)}{\mathbf{H}(3,3)}$	Reaction of long-term bond yield to a 100bp increase in interest rates	0.5	0.2	0	
$h_3 = \mathbf{H}(1,1)$	Output gap to S shock	0	1	5000	≥ 0
$h_4 = \mathbf{H}(1,3)$	Output gap to M shock	0	1	-5000	≤ 0
$h_5 = \mathbf{H}(2,3)$	Inflation to M shock	0	1	-5000	≤ 0
$h_6 = \det(\mathbf{A})$	Regularity condition	6	5	4	

Notes: Restrictions on h_1 and h_6 are taken from Baumeister and Hamilton (2018).

3.2 An Instrumental Variable for Bond Demand Shocks

Our prior is that bond demand depends on expectations about the future stance of fiscal policy. However, there is considerable uncertainty with respect to future fiscal policy, even in good times (Davig and Leeper; 2011). Therefore, we expect that a large share of yield changes would be unpredictable in the basic model. To overcome this issue, we make use of the fact that bondholders often rely on information gathered from the day-to-day political process to form beliefs about the future fiscal policy stance. To embed this forward-looking aspect in the model, we derive an instrument for bond demand shocks from domestic policy events that potentially shift investors' beliefs with respect to Italy's future fiscal discipline, covering the time period from 2000 to 2019.

To identify the timing of relevant events, we use the Thomson Reuters Real-Time Political, General and Economic News (Thomson Reuters; 2018). These data have not been used for economic analysis before to the best of our knowledge. Relevant political events are reported on within at most five minutes. The feed is consumed by $300'000$ users globally via different channels, such as real-time subscriptions, alerts, machine-digestible information, etc. The historical data used in this paper span the years from 2000 - 2019 and consist of roughly 20 million feeds. The textual data contain two features that allow us to filter out a small number of 221 relevant events. First, "top news" summary feeds contain a list of the stories that have been deemed relevant at the time (Romer and Romer; 2019). Second, associated stories can be tracked since summary news provide story references such as "nR1E7LJ00Y", leading to the actual story further upstream within the news corpus.

They are both visualized in the top half of Figure 1 for the event of Silvio Berlusconi, Italy's prime minister in the year 2011, addressing rumors of his resignation.

Our instrument is constructed in three steps, illustrated in Figure 1. First, stories from a suitable summary news category are collected and reduced to those concerning Italy. Second, textual filters are applied to clean the events from noise or potential other structural shocks. Third, we calculate the surprise size as changes in high-frequency bond spreads during a short time window around the event (Gertler and Karadi; 2015).

#1 Selecting potentially relevant stories from summary news We use the summary news to filter relevant events. Specifically, we only consider stories featured in the category "*TOP NEWS* World Politics and General". It is the natural choice for this paper, since it covers high impact political news and since it has the largest coverage.[10] From this top news feed, we include headlines that contain a permutation of the word "Italy" and "Italian" and / or the presence of the name of a large Italian city.

The top news contain story identifiers ("nR1E7LJ00Y" in the example above) that link to the corresponding collection of feeds in the news stream. The alert (the part in all caps) is sent out and subsequently fleshed out with additional information, as shown underneath the NEWSBREAK bar. To correctly time the event, we fetch the timestamp of the alert feed.[11] To ensure that fluctuations in bond prices are informative, we disregard events that materialize outside of usual trading hours (7:15-17:45) and those with less than five quotes within the constructed time windows. This leaves a set of 540 events for further analysis.

#2 Textual filters The set of stories selected above contains a lot of noise, and may also be related to other structural shocks. Therefore, we apply textual filters on the text bodies of the associated full stories, using both keywords provided by Thomson Reuters (e.g. EUROZONE) and regular expressions. Overall six filters were applied, leaving 221 (of 822) stories in the final set, see Table 3.[12]

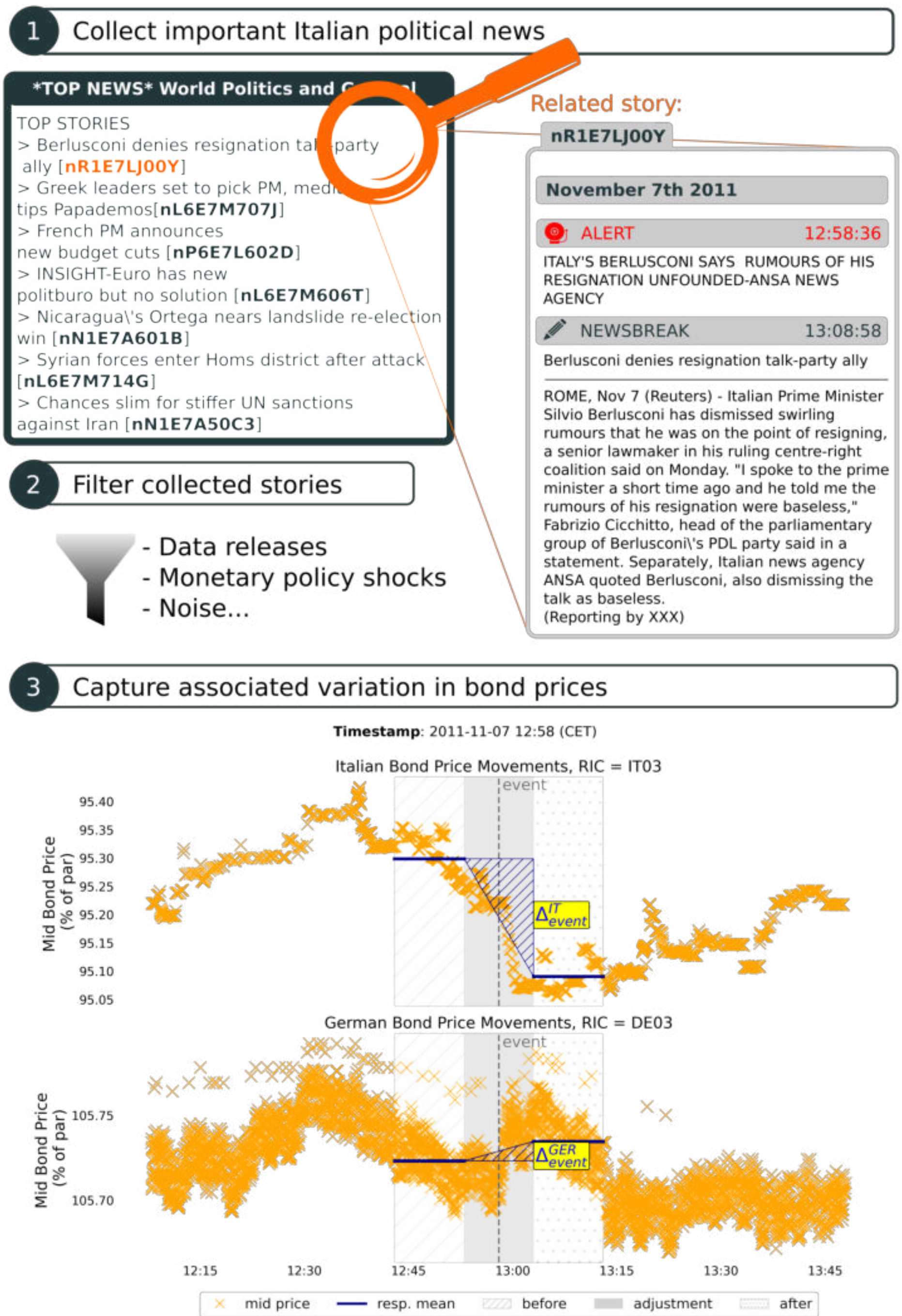
First, we remove data releases. However, such feeds are not given a clear-cut identifier in our textual data. To overcome this challenge, we exploit the presence of relatively more numbers within data releases' text corpora. Taking a conservative approach, we exclude all events if their headlines and text bodies both contain a higher fraction of numbers than the

[10] There are various other top news categories present in the feed, with overlapping content. However, alternative choices start later or are not sufficiently focused.

[11] Note that not all stories sport an alert because they do not contain original information (e.g. an analysis of a political conflict written *ex-post*). We only include referenced stories that feature an alert.

[12] Note that the selection could have been done manually. However, a manual selection process is less transparent, does not scale as well and is not easily replicated.

Figure 1: Sovereign Risk Shock Construction



Notes: Illustration of how shocks to the perceived riskiness of sovereign debt are derived. In the given example, seven references would be collected ("nR1E7LJ00Y" through "nN1E7A50C3"). The right-hand side shows how a related story is structured for (story) reference: "nR1E7LJ00Y".

Table 3: Text Filter Summary

Filter	Number Excluded: absolute n	recursive n
Data Releases	164	164
Supranational Institutions	125	89
Corporate News	42	16
Recurring News	41	22
Monetary Policy	39	24
Rating Agencies	16	4
	Number of events before:	540
	Final Number of events:	221

Notes: Applied filters to ensure exogeneity and reduce noise of the resulting instrument series. Absolute n refers to the number of stories marked by that filter. Recursive n refers to the remaining number when recursively filtering out the respective stories. The recursive numbers are smaller than the absolute numbers since sets are non-exclusive.

median story from the full textual data set.[13] The second text filter aims at news about supranational institutions such as the IMF, the European Commission, or the European Union. On the one hand, such events are not directly informative on Italy's fiscal discipline. On the other hand, these stories often cover data releases by the respective institutions. The third text filter reduces noise by removing corporate news via the presence of firm markers in the text bodies. Fourth, Thomson Reuters tags the release of recurring reports on specific topics, such as exchange rates or stock markets. In essence these are summary news which do not yield timeable events and are thus excluded as well. These can be detected with relative ease since they always sport the same headlines. Fifth and sixth, central bank news are excluded as monetary policy events and rating agencies news are removed as a precautionary measure. Both filters rely on regular expressions and keyword tags.

#3 Calculation of a quarterly instrument Third, exact timestamps of the filtered events are used to capture associated variation in bond prices in very narrow time windows, as displayed in the lowest panel in figure 1. To derive a risk measure we compute the shift in sovereign risk as the change in Italian bond prices relative to the safe asset, namely German bonds of the same maturity.[14] More specifically, it is assumed that markets take 10 minutes

[13] Using an external calendar from Bloomberg to exclude timestamps that overlap with data releases, as in Bahaj (2019), does not change our results.

[14] Alternatively, sovereign risk could be measured using credit default swaps instead of bond prices. However, from a fiscal perspective bond prices (or yields) are more relevant to the sovereign as they proxy

to digest the information (the adjustment period in figure 1) and use the change in the ten-minute window after this adjustment time to before as the relevant final measure, computing the shift in perceived sovereign risk as $\sigma_{\tau}^{IT} = \Delta_{event}^{IT} - \Delta_{event}^{GER}$. We can see that the exemplary event of Berlusconi denying his resignation, led to a drop in Italian and a slight increase in German bond prices. Possibly, markets assessed the possibility of Berlusconi resigning as a positive risk and thus perceived sovereign risk after the event as having increased. Note that bond prices move inversely to yields and a drop in bond prices leads to an increase in yields. Table 4 displays the five largest shocks in absolute terms.

TABLE 4: 5 LARGEST ABSOLUTE SHOCKS (AFTER FILTERING)

Timestamp (CET)	Story-ID	First Headline	$\Delta\sigma_{\tau}^{IT}$
2012-06-26 16:27	nR1E8GA02C	(a) ITALY PM MONTI SAYS JOINT EUROPEAN SOLUTIONS NEEDED TO PREVENT SOME COUNTRIES FALLING INTO RECESSION SPIRAL	-0.231
2011-11-07 12:58	nR1E7LJ00Y	(b) ITALY'S BERLUSCONI SAYS RUMOURS OF HIS RESIGNATION UNFOUNDED-ANSA NEWS AGENCY	-0.218
2018-10-08 10:49	nR1N1VZ00V	(c) ITALY DEPUTY PRIME MINISTER SALVINI SAYS MOSCOVICI AND JUNCKER ARE REAL ENEMIES OF EUROPE	-0.188
2011-11-25 10:59	nL5E7MP0XX	(d) ITALY TRYING TO PERSUADE ITS FIRMS TO DIVERSIFY FROM USING IRANIAN OIL -FOREIGN MINISTRY	-0.179
2011-07-14 11:38	nR1E7HU012	(e) ITALIAN GOVT CALLS CONFIDENCE VOTE IN SENATE OVER AUSTERITY PACKAGE	-0.151

Notes: Computation of $\Delta\sigma_{\tau}^{IT}$ is based on Italian and German bond prices with a remaining maturity of three years. To see the 30 largest shocks please go to Table A1. The 5 largest shocks in absolute terms are also marked in the results section in figure 4.

To incorporate the resulting intra-day fluctuations in our BVAR model, we aggregate the shocks following Kuttner (2001). Each event impact is stretched out to last 90 days, and we then take quarterly sums. By construction, this procedure leads to autocorrelation. If a mid-quarter event has a large bond market impact, it affects the following quarter as well. We clean the quarterly aggregation of any autocorrelation, and refer to the aggregated series as our instrument z_t^B. Equation

$$u_t^B = \chi^B z_t^B + v_t^B, \qquad v_t^B \overset{i.i.d.}{\sim} \mathcal{N}(0, d^B), \tag{B\_IV}$$

replaces structural investor bond demand shocks in equation (B) by the instrument z_t^B and a measurement error v_t^B as in Nguyen (2019); von Schweinitz (2023).
A natural question arising from the construction of the instrument, is its relation to the structural shock in the fiscal policy equation (F). It is possible that information on, say,

sovereign financing costs.

a prime minister's resignation also influences actual surpluses. While we cannot rule out that some events affect fiscal policy, we do not believe this to be a problem in our set-up. While the bond price encapsulates the expected stream of future primary surpluses and therefore exhibits an explicit forward-looking element, surpluses only enter our model contemporaneously. Contemporaneous fiscal policy is unlikely to be susceptible to such short-term fluctuations because most government expenses and revenues are fixed in the short term (cf. Lorenzoni and Werning (2019)).

4 Results

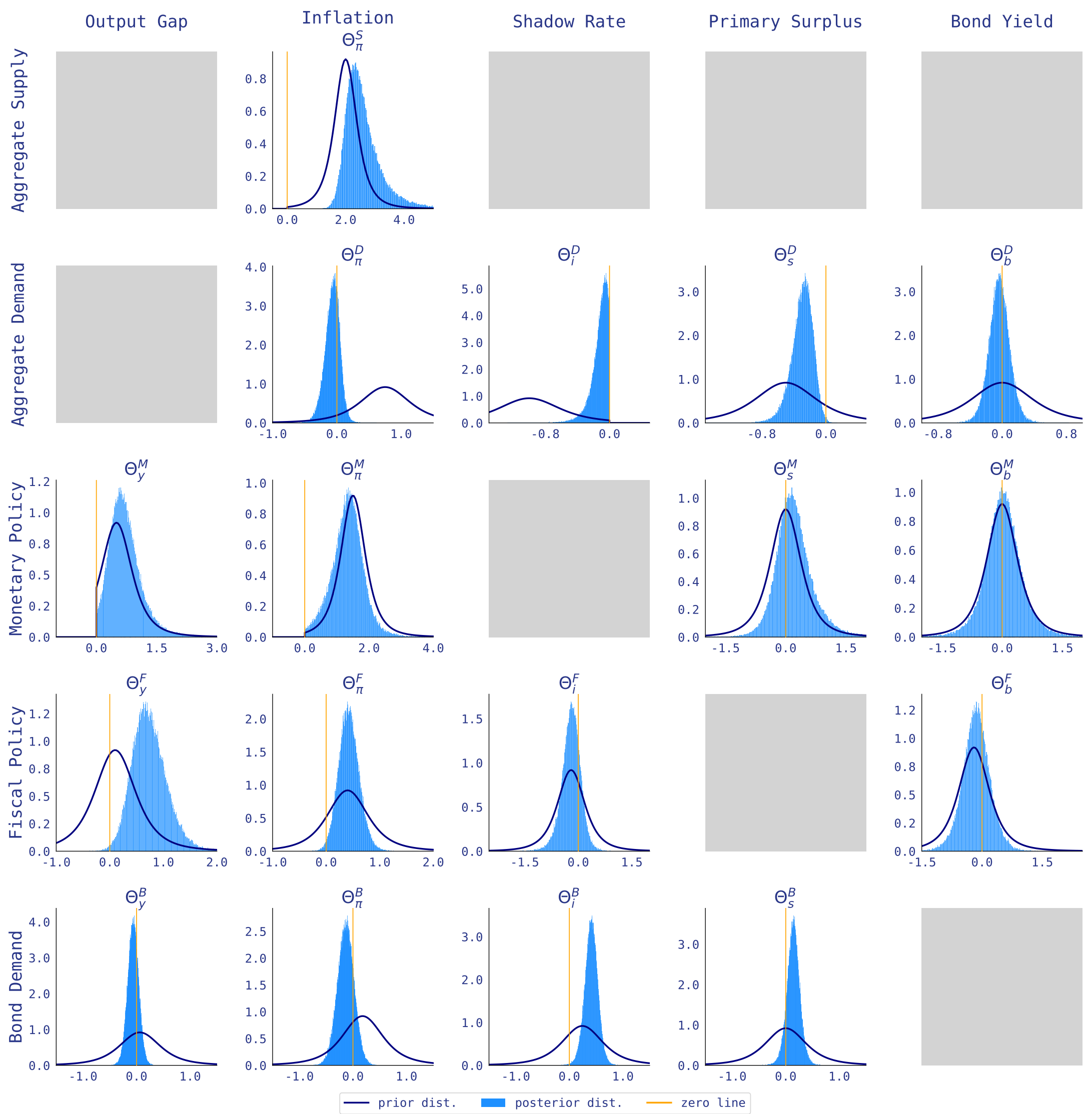
We investigate the interaction between Italian fiscal policy and investors by combining insights from impulse response functions to structural shocks and posterior distributions of structural contemporaneous coefficients, i.e. the shape of structural equations. The structural coefficients directly related to contemporaneous endogenous variables are displayed in Figure 2.[15] Our results feature three recurring themes. First, the long-term sustainability of government debt necessitates that lower primary surpluses at one point in time need to be followed by either higher surpluses (relative to GDP), higher output gaps or higher inflation in the future. Second, investors' reactions factor in how likely current deficits are paid back in the future. Thus, good fiscal policy has the potential to yield beneficial market responses, while bond markets at the same time discipline fiscal policy. Third, we observe a cooperative behavior of monetary and fiscal policy, as both react in a similar contractionary manner to inflation. Fiscal policy, however, reacts more strongly and more persistently.

4.1 Investor Bond Demand and its Macroeconomic Effects

The last row of Figure 2 displays coefficients of the bond demand equation. The posterior distributions provide evidence that investor bond demand is contemporaneously only elastic with respect to the monetary policy rate. Investors react slightly more sensitively to changes in monetary policy than anticipated in our prior distribution. We do not observe shifts of bond demand as a result of changes in output and inflation, as Θ_y^B and Θ_π^B are nearly centered around zero. Moreover, the data seem to be very informative for the coefficients, as posterior distributions are concentrated with large density values at the posterior mode. There are two possible reasons for this. First and more likely, bond rates may be more sensitive to news than to ex-post observable developments. From the perspective of our

[15]The difference between the prior and posterior distributions indicates that the data are highly informative for the overwhelming majority of coefficients. For readability reasons, the locations of subplots correspond to the matrix of structural coefficients $\mathbf{A}$. Therefore, we plot the foreign output elasticity of aggregate demand $\Gamma^D_{y^{rea}}$, the degree of interest rate smoothing ρ and the instrument coefficient χ^B separately.

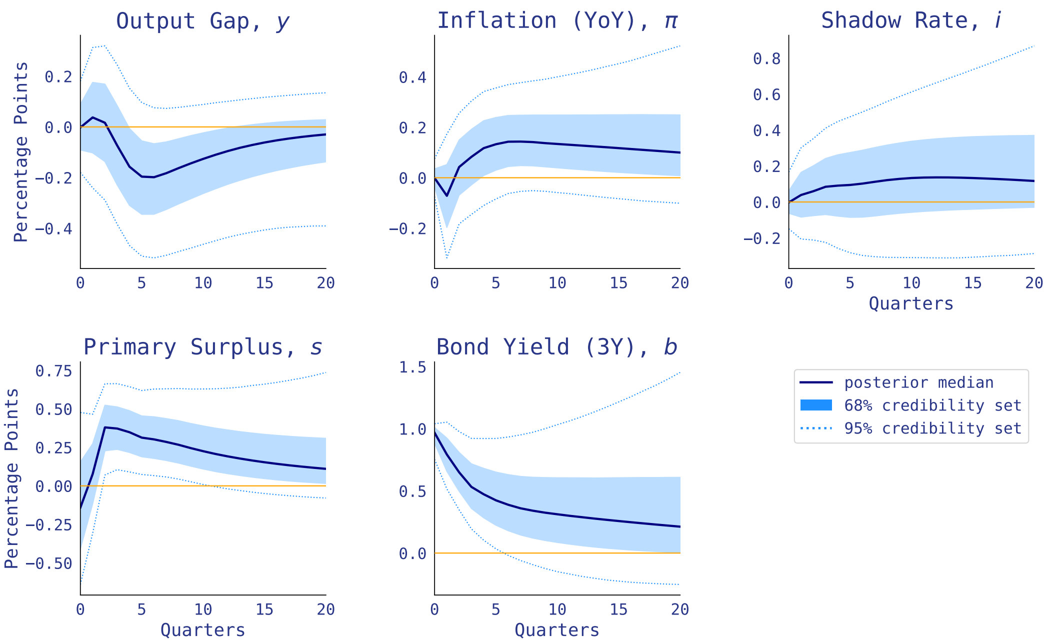
Figure 2: Posterior Distributions of Contemporaneous Coefficients of **A**



Notes: Contemporaneous structural coefficients from the five model equations (one equation per row in the figure). Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients. Additional model coefficients (degree of interest rate smoothing ρ, demand elasticity with respect to foreign output gaps Γ_y^D and instrument coefficient χ^B) are displayed in figures A7 and A6.

model, this would imply that contemporaneous changes in bond rates should mostly be driven by variables that are observable without delay (i.e. interest rates) and by shocks which incorporate news elements. This argument is supported by the fact that current primary surpluses have little influence on current bond demand. The finding is in line with the theoretical literature, which stresses that forward-looking bond markets care about the future stream of primary surpluses and react to sound and credible fiscal plans for the future rather than to the current situation (Miller; 2021; Davig and Leeper; 2011; Cochrane; 2023). An alternative possibility for the insensitivity of bond demand to output gaps and inflation comes from our modeling choice. We argued that capital mobility would induce investors to treat Italian macroeconomic fluctuations similarly to those in the rest of the euro area. Enforcing this assumption (if incorrect) could result in posterior distributions biased towards zero. Results from a robustness check in Section 5 are quite comparable, indicating that the concern is unjustified.

Figure 3: Impulse Response Functions Bond Demand (B)



Notes: Bond demand shock, u^B: Structural IRF's for 5-variable VAR($p^{AICC} = 2$).

Figure 3 shows the median impulse response function to a bond demand shock of one percentage point, together with their 68% and 95% credibility sets. The responses of endogenous variables reveal interesting dynamics. Bond yields increase strongly on impact (underlining the importance of news for bond demand development), and fall slowly back towards steady state. However, zero is still not included in 68% credibility sets after 20 quarters. Moreover, 68% credibility sets show a recessionary response of output gaps, and a protracted Fisherian response of inflation after a time lag of approximately one year. Median output gaps fall by up to -0.2%, while median inflation increases by up to 0.15%. While the inflation response is around one half smaller than after a monetary policy shock, the output response is significantly stronger.[16] We observe an inactive endogenous monetary policy response, and an increase in primary surpluses. With inflation increasing after a year, primary surpluses rise further, and then recede slowly with long-term bond rates and inflation rates. As will be seen in section 5, this result is robust across multiple sensitivity tests and model perturbations. This observation underpins the notion that investors' expectations matter for inflation and that fiscal policy is a critical tool in managing investors' beliefs over time. As coupon rates remain unchanged, an increase in bond yields implies a lower market value of outstanding Italian government bonds. In the short-term government expenditures and revenues are inflexible, the dynamic view however illustrates that fiscal policy is reactive and that surpluses are raised over a protracted period of time, potentially in an effort to regain investor confidence. The positive inflation response to a bond demand shock illustrates that primary surpluses do not increase sufficiently to fully quell price pressures. A possible reason is the economic cost which is associated with mustering higher primary surpluses. The costs to the sovereign become apparent when looking at figure 2, specifically parameter Θ_s^D. Reductions in government spending (or tax increases) cause a clear leftward shift of aggregate demand, which is the main reason for the recessionary response after around 3 quarters. Given the different signs of output and inflation responses about a year after the shock, and due to the fact that Italian fluctuations only make up a fraction of aggregate European developments, monetary policy does not react strongly to a bond demand shock.[17] Moreover, the positive elasticity of fiscal policy to inflation (Θ_π^F), as well as the persistent pressure from higher bond yields, may explain why we do not observe the usual countercyclical fiscal policy response ($\Theta_y^F > 0$) to the short recession, but instead a further increase of primary surpluses to dampen the Fisherian response.

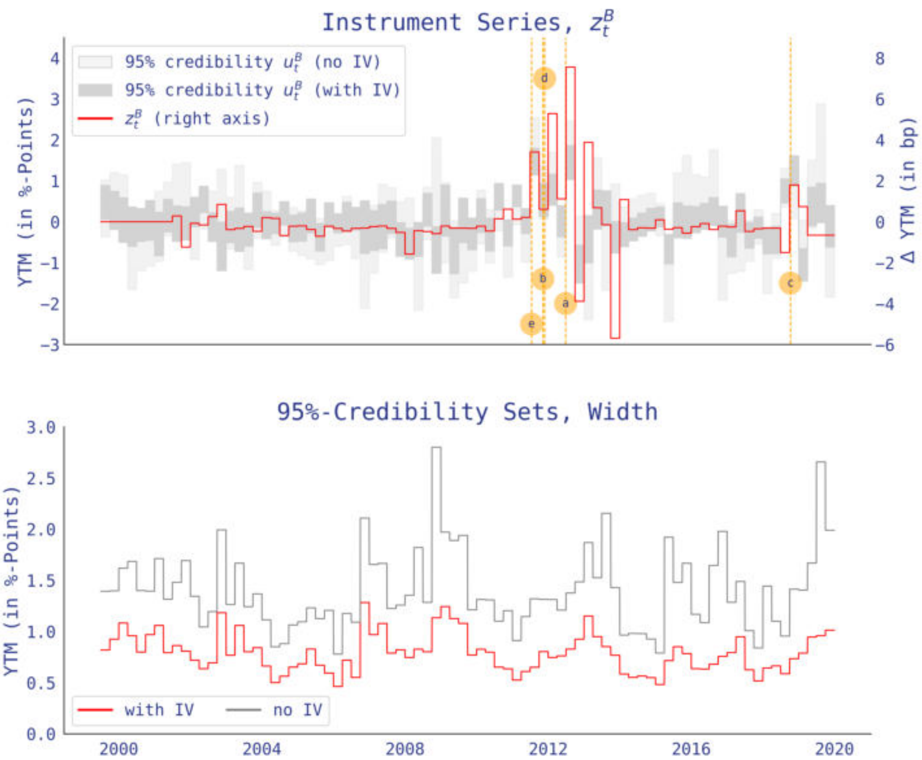
Our model set-up allows us to delve deeper and further qualify the nature of shifts in investors' beliefs. Following the arguments of e.g. Davig and Leeper (2011), Hall and Sargent (2011) and Miller (2021), we suspect that investors' expectations' are at least partially driven by political news. We exploit this knowledge to identify bond demand and accommodate the forward-looking nature of financial markets by using our external instrument. The probability mass of the posterior distribution for the coefficient in the instrument equa-

[16]We can directly compare the impulse response functions to a monetary policy and a bond demand shock, since both shocks have very similar standard deviations.

[17]Note that the monetary policy equation is not particularly well identified, as posterior distributions are close to our (informative) priors. However, this is not particularly surprising given our focus on the Italian economy.

tion $\left(u_t^B = \chi^B z_t^B + v_t^B\right)$ lies almost entirely below zero (see Figure A6 in the Appendix), indicating a strong and informative instrument.[18] The improvement of the model inlcuding the instrument over a model without the instrument becomes tangible, when calculating the Bayes factor, i.e. the ratio of marginal data densities (Kass and Raftery; 1995). If twice the logarithm of the Bayes' factor exceeds a threshold of ten, the instrument is very strong. With a value of around 100, the model with instrument comfortably surpasses this threshold when compared to the model without instrument. The data thus establish a credible link between Italian day-to-day politics and bond market movements, supporting the hypotheses of the above-mentioned authors.

FIGURE 4: INSTRUMENT AND STRUCTURAL BOND MARKET SHOCK



Notes: Upper panel: Time series plot for 95% credibility sets of structural bond market shocks for model with and without instrument and instrument time series in yield spread equivalents. Lower Panel: Difference between upper and lower border of the 95% credibility sets. The letters "a" through "e" correspond to the letters denoting the five largest shocks in table 4.

The upper panel of figure 4 displays time series of the 95% credibility sets over time for the model with and without the instrument and the instrument (converted into approximate

[18]Note that the instrument is constructed based on bond prices and defined such that an increase in z_t^B corresponds to a decrease in sovereign risk. So we expect that an increase in the instrument series, causes investors to demand lower yields.

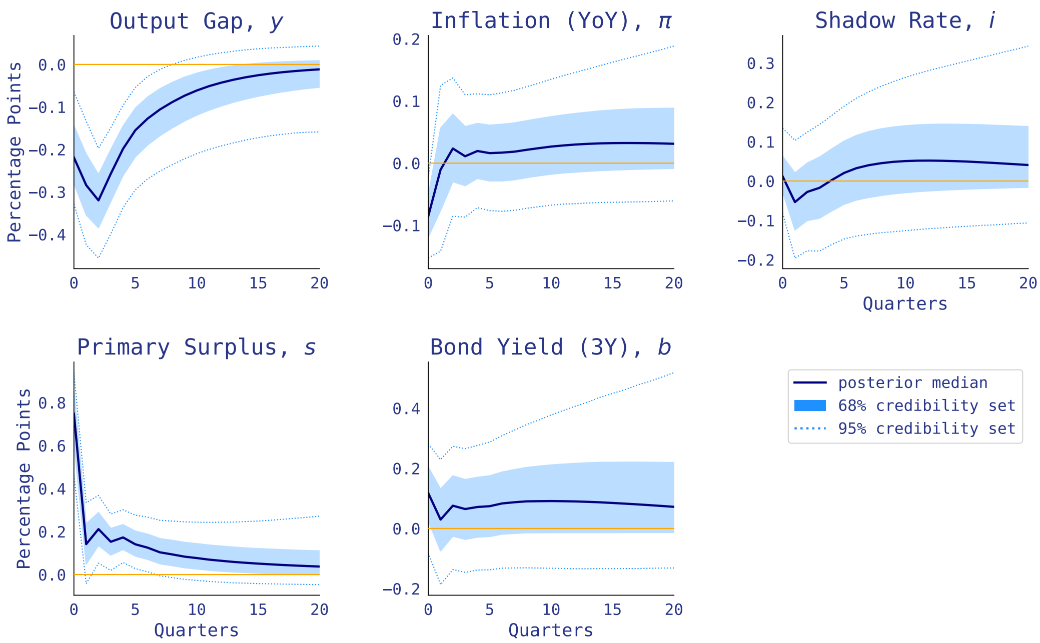
yield spread equivalents). The lower panel compares the width of the credibility sets over time. Two observations stand out. First, structural bond demand shocks with and without instrument increase sharply during the Euro Crisis. Second, the instrument aids in the identification by stabilizing and reducing the credibility sets of the structural bond demand shock. Compared to the model without instrument, the 95% credibility sets are reduced by more than half.

Inspection of the instrument series z_t^B reveals that much of the variation occurs during the Euro Crisis as well. Variations prior to 2010 in the instrument are relatively small. Chronologically, the events may be divided into five different phases. The first period runs from the beginning of the sample up to 2006. Effectively, this period starts with the election of Silvio Berlusconi as prime minister in May 2001 and ends five years later with his resignation. During that period, variations in the instrument center around tensions in Berlusconi's ruling coalition. Other notable fluctuations in sovereign risk were caused by critical discussions about the Stability and Growth Pact affecting the last two quarters of 2001. Further political quarrels arose from pejorative comments made about Germans by an Italian government official. The second phase, running from 2007 to 2009 was relatively calm when judged by the fluctuations picked up by our instrument. The confidence vote called by Romano Prodi, then prime minister, in the beginning of 2008, was a notable exception, apparently received with relief by financial markets. The confidence vote became necessary after one party left the ruling coalition in the wake of a corruption scandal involving the minister of justice. Italian bond prices increased significantly (the yield spread dropped) due to that single event. The third phase marks the peak of changes in sovereign risk registered by our instrument and spans the years 2010 to 2014. The period is characterized by debates regarding austerity and the judicial woes of Silvio Berlusconi, who served his third spell as Italy's prime minister from 2006 to 2013 and was embroiled in multiple corruption scandals. Sizeable movements occurred, for example, during summer 2011 when the Italian government called a confidence vote on a four-year austerity package (shock “e” in figure 4). Markets were also rattled when then prime minister Mario Monti voiced discontent with austerity policies (shock “a” in figure 4). The fourth phase stretches from 2014 to 2016 and covers the term of prime minister Matteo Renzi who implemented numerous reforms. In particular, discussions about his major constitutional reform attracted media attention and drove fluctuations in the instrument. The final phase runs from 2017 to the end of the sample, a period in which Italian politics was characterized by a high degree of polarization on topics such as immigration and further EU integration (Bosco and Verney; 2022). The leader of the right-wing party, Matteo Salvini, openly referred the European Commission president of the time as an “enemy of Europe” (shock “c” in figure 4).

4.2 Fiscal Policy

The contemporaneous coefficients of the fiscal policy rule in our empirical model are displayed in the fourth row of Figure 2. The data is not very informative about the effect of long-term bond rates. However, the data speaks to the coefficient of short-term interest rates and corroborates our reasoning from above. Fiscal policy does not react to interest rates contemporaneously, but the dynamics unfold over time, as posited in Cochrane (2022). Consistent with this argument, we document in Figure 6 (third column) below, that primary surpluses respond positively to a monetary policy shock after a delay of around 4 quarters. The countercyclical reaction of fiscal policy, Θ_y^F, is much stronger than we expected a priori based on the Medium Term Budgetary Objectives associated with the SGP: An increase of the output gap by one percentage point increases primary surpluses (on average) by 0.75%. While the Stability and Growth Pact allows for little leniency in debt reduction over the business cycle, actual policy turns out to be more prone to fluctuations in the output gap. This finding may not be surprising, given that automatic stabilizers burden public finances specifically when economic activity is depressed. Conversely, when the economy booms, tax revenues rise because they represent roughly a constant share of domestic product.

FIGURE 5: IMPULSE RESPONSE FUNCTIONS FISCAL POLICY (F)



Notes: Fiscal policy shock, u^F: Structural IRF's for 5-variable VAR($p^{AICC} = 2$).

Our results also support the positive median prior for the reaction of fiscal policy to inflation, Θ_π^F. There is virtually no posterior probability mass below zero and the posterior

concentrates roughly at the prior mode of 0.39. The results thus indicate that Italian fiscal policy plays a significant role in counteracting inflation. Empirically and theoretically, such fiscal restraint has shown to be particularly important in a monetary union, in which unsustainable fiscal policy of member countries can contribute to diverging inflation trends, complicating the task of the monetary authority, see for example Sims (1999) and Mody (2018). However, these results cannot be used to validate the proposition that Italian fiscal policy can be considered Ricardian.[19]
Instead, our findings lend empirical support to the claim that governments are neither fully "Ricardian" nor do they act completely unconstrained. In the short run, fiscal policy does not react sufficiently to prevent a Fisherian response of inflation, such as that observed for bond demand shocks. However, in the longer run, fiscal policy reacts to higher long-term bond rates with higher primary surpluses, and thereby serves to bolster monetary tightening. Thus, investors appear to indirectly incentivize "Ricardian" behavior. This finding aligns with the empirical evidence that inflation plays a critical role in alleviating the sovereign's debt burden, as documented for example in Eichengreen and Esteves (2022) and Hall and Sargent (2011).

Table 5: Cumulative fiscal multiplier, selected horizons

Horizon (quarter)	Cumulative Multiplier
0	0.29
	(0.17,0.46)
4	0.90
	(0.52,1.6)
8	0.93
	(0.49,1.86)
12	0.91
	(0.42,2.07)

Notes: Multipliers are calculated as the ratio of the (cumulative) impulse-response functions of the output gap and primary surplus (relative to potential GDP) after a fiscal policy shock, multiplied by -1. The resulting multipliers rely on the assumption that potential output is not systematically affected by fiscal policy shocks. 95% credibility sets in brackets.

Beyond fiscal austerity and higher inflation, GDP growth offers a potential third way to keep government debt sustainable in the long run. This is best investigated through fiscal

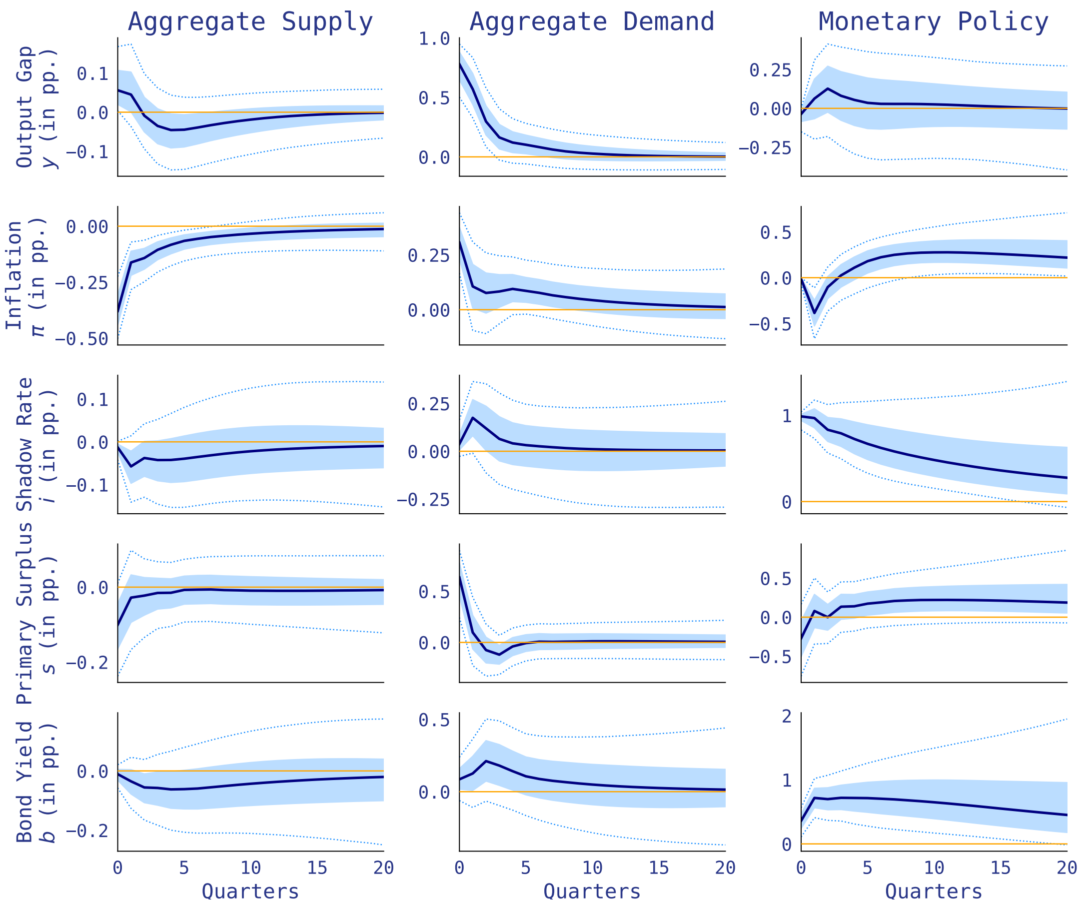
[19] See for example Woodford (1995). For a more formal treatment of the question, see for example Panjer et al. (2020).

multipliers, which can be derived from the impulse response function to fiscal policy shocks, see Figure 5. We find that a fiscal policy shock increasing primary surpluses has a strong contractionary effect on the economy. Additionally, it lowers inflation on impact and causes a small expansionary monetary policy response. We can quantify the effects further by calculating cumulative fiscal multipliers, as reported in Table 5. We find an impact multiplier of 0.3, which then rapidly increases to around 0.9 after a year. For longer horizons, median multipliers start to decline slowly, albeit with widening credibility sets. That is, these results indicate that output growth initiated by an expansionary fiscal policy shock is not sufficient to overcompensate higher debt levels.

Monetary policy, aggregate supply and demand We now turn to ECB policy. While the data are not very informative about the Taylor rule coefficients (cf. row of Figure 2[20]), they are more revealing about dynamic relationships which can be seen in the third column of Figure 6. First, we see a strong degree of interest rate smoothing (cf. Figure A7). Second, we observe an incomplete pass-through of monetary policy rates to bond rates, and an increase in primary surpluses to counter the higher short- and long-run financing costs. Third, we see a drop in inflation for the first couple of quarters. However, this response reverses, and Italian inflation increases above steady-state after around two years in a Fisherian response similar to the one observed for bond demand shocks. This speaks to the difficulties of the ECB to react to country-specific shocks in a monetary union and stresses its reliance on complementing fiscal policy. The importance of fiscal policy for inflation is further stressed when looking at aggregate demand. An uptick in demand after an aggregate demand shock drives up output and inflation rates increase, see the second column of figure 6. Both, Italian fiscal policy and the ECB, react to the demand shock in contractionary manner. In fact, fiscal policy reacts strongly on impact while short-term interest rates increase only modestly and briefly after one quarter at the 68% credibility level. Inflation swiftly abates given the joint response. This finding echoes the work of for example Sims (1999) stressing the importance of fiscal policy in a monetary union for keeping inflation at bay. A supply shock increases output and lowers inflation for a short while, see first column in figure 6. As the disinflationary response is stronger than the output expansion, fiscal and monetary policy endogenously react in an expansionary way. However, the timing of their respective responses is different, as fiscal policy reacts and reduces the strength of its response faster. This difference in timing may be linked to the high degree of interest rate smoothing, ρ, which enters not only the contemporaneous structural coefficients in the monetary policy rule, but also (as a prior) the first lag coefficient of the shadow rate. Bond rates, albeit with

[20]Note that the coefficients Θ_y^M and Θ_π^M reflect the ECB's response to euro area inflation and output given our inclusion of exogenous variables (cf. section 3 and equation (M)).

Figure 6: Impulse Response Functions Supply, Demand, and Monetary Policy



Notes: Structural IRF's for 5-variable VAR($p^{AICC} = 2$) for aggregate supply shock (u^S), aggregate demand shock (u^D) and monetary policy shock (u^M).

a low degree of confidence, mirror the shadow rate in their response.

5 Sensitivity Analysis

Our results remain consistent across varied configurations. Three main robustness checks are highlighted. First, our prior modes for the fiscal policy equation (F) depend strongly on the degree to which the sovereign cares about stabilizing debt (Cochrane; 2022). We assess the effect of variations in this policy choice and associated changes in priors on the posterior results. Second, we take the middle ground in our choice of long-term bond maturities between (a) a literature that emphasizes long-term debt stabilization objectives (Cochrane; 2021) and (b) a literature that argues for shorter maturities, which are less likely to be driven by unobserved variables (Bahaj; 2019). However, it is possible that choosing other maturities could alter results. Third, it is unclear whether investors treat output gaps within the euro area similarly as specified in equation (B). All primary findings hold across these checks. We also adjust the number of lags, and results remain consistent. For comprehensive results, refer to the appendix.

Varying the prior on fiscal discipline The model of Cochrane (2021), on which we base some of our priors, uses a structural parameter α to describe how fiscal policy reacts to the market value of sovereign debt, where a large α implies a stronger focus on debt stabilization. As this market value depends, among other things, on the expectations of future economic development, our prior choice of Italy's "fiscal discipline" influences all structural coefficients in our fiscal policy rule. For our baseline, we used $\alpha = 0.07$, in line with empirical estimates. For this set of robustness checks, we set alternative values $\alpha \in \{0.05, 0.1, 0.15\}$. Figure A8 displays the respective posterior distributions for contemporaneous coefficients of equation (F).[21] Three observations stand out from this exercise. First, it illustrates the dependence of prior modes on the choice of α. In particular the prior modes for the endogenous fiscal policy response to inflation and interest rates shift considerably to the right with stronger fiscal discipline. The prior mode on the endogenous policy reaction to business cycle fluctuations is hardly affected. Second, the posterior distributions appear stable even when opting for high prior values such as $\alpha = .15$. This holds in particular for the distribution of the endogenous fiscal policy response to an increase in inflation – a main parameter of this paper. Third, the dispersion of posterior mass increases as α increases, because priors shift away from the empirical baseline estimates. In other words, as the reaction to higher debt levels assumed *a priori* increases to more unrealistic values, uncertainty increases. This seems reasonable and is taken as evidence in support of our model design.

[21]The remaining graphs associated with this robustness check can be found in figures A10 through A18.

Varying bond maturity The term 'long-term' bonds may be understood to refer to 10-year maturity bonds rather than 3-year bonds. To assess whether our choice of long-term bond maturity affects results, we estimate the model for 5-year, 7-year and 10-year bonds. The baseline results remain virtually unchanged, as seen in figures A19 through A27 in the Appendix. There is, however, one notable exception, namely the impulse response functions to a bond demand shock, shown in Figure A9. The first point to notice is that bond market shocks seem to decay more slowly with increasing maturity. This observation is intuitively plausible, as we generally expect more inertia for long term bonds, which are driven by longer-term factors less prone to short-term volatility. Just as in the benchmark specification, we document a protracted Fisher effect, that cannot be fully compensated by fiscal policy across all maturities. Interestingly, the short-term economic cost of an increase in interest rates decreases with increasing maturity. In other words, for long term bonds there is no liquidity effect weighing on activity, but only a price effect. Sovereign debt with long maturities is a more stable form of public financing because the roll-over risk is reduced. If all debt is short-term, a temporary increase in interest rates can seriously dent public access to funding as each period requires rolling over the entire debt portfolio. The other extreme are government perpetuities, paying a fixed interest for an infinite time horizon. Such financing eliminates roll-over risk altogether. Longer term maturities are more stable forms of sovereign financing and they can enable a country to inflate away parts of its debt, while reducing short-term costs. This finding may be viewed as additional empirical evidence in line with Eichengreen and Esteves (2022) who document that governments were able to consolidate debt through inflation most effectively during periods of stable fiscal policies.

Varying bond demand We have derived bond demand based on the premise that investors treat the Italian output gap similarly to the rest of the euro area, likewise for inflation. It is however conceivable that investors differentiate between countries when investing in sovereign debt. A respective motive found in the literature is the 'home bias' of banks (Merler et al.; 2012; Asonuma et al.; 2015), which posits that banks have a relative preference for sovereign debt of their home country. Thus, a negative Italian output gap may for example attract relatively more bond demand from Italian banks, as they fear a euro area break-up and hope for preferential terms. Depending on the composition of demand, we might observe different coefficients on output gaps from Italy as opposed to the rest of the euro area. To address concerns, that the simplifying assumption of similar treatment by investors somehow drives our results, we estimate the model by modifying equation (B) to:

$$b_t = \Theta_y^B y_t + \Gamma_{y^{rea}}^B y_t^{rea} + \Theta_\pi^B \left(\omega\pi_t + (1-\omega)\pi_t^{rea}\right) + \Theta_i^B i_t + \Theta_s^B s_t + \text{lag terms} + u_t^B. \tag{B'}$$

Unfortunately, the business cycles of Italy and the rest of the euro area are quite synchronous with a (Pearson) correlation of .9, so implementing equation (B') no longer pins down the posterior distribution for the contemporaneous effect of output gap on bond demand due to multicollinearity. This is illustrated in figure A33. However, the inflationary effect of bond demand is robust, as shown in figure A38. All other posterior results are stable. So while we are unable to control for composition effects in bond demand, we can show that – even if this effect were sizeable – the implications are confined to changes in the posterior distributions concerning output gap measures only, without affecting our main conclusions. As pointed out for example by Ivanov et al. (2001), impulse response functions are generally sensitive to the choice of lags in the model.

To scrutinize our results with respect to different lag numbers, we estimate the model using 1, to 6 lags and summarize our findings in figures A39 through A48. While an increase in the number of lags renders resulting IRF's more wiggly, as there are more parameters to be estimated from fewer observations, results are broadly similar.

6 Conclusion

The proposed structural model allows us to shed light on fiscal policy in interaction with the bond market in a regime of high public debt levels using the case of Italy. The model produces robust results and our findings lend empirical support to the central bank's dependence on the fiscal authority when pursuing price stability. We find that Italian fiscal policy increases primary surpluses when inflation rises and stabilizes debt in response to interest rate increases. The response is not, however, strong enough to fully compensate the Fisher effect. Therefore, Italian fiscal policy may be regarded as neither fully passive, nor setting surpluses entirely unconstrained, which would correspond to active fiscal policy. Rather, some portions of debt are inflated away, given fluctuations in interest rates and investors' expectations. Our results also stress the importance of investors' expectations for price stability. We find that a sudden jump in the perceived riskiness of Italian bonds causes inflation to increase for a protracted period of time. Bonds with longer term maturities appear to allow inflating away debt while limiting short-run economic costs. On one hand, this finding echoes the argument expressed in Cochrane (2022) that government's policy actions are likely to fall in between the extremes of active and passive policy. On the other hand, these findings are suggestive of stable fiscal policy – if we accept that longer term public financing signals better fiscal discipline – enabling the consolidation of debt through inflation while incurring limited short-run economic pain. Additionally, we document that the Italian day-to-day political process drives fluctuations in investors' perceptions. We believe that this is important for two main reasons. First, it establishes an empirical link between the vicissitudes of the political process and resulting economic costs. Second, the susceptibility of bondholders' expectations to day-to-day politics implies the risk of sudden swings and emphasizes the need for credible institutional set-ups, so as to at least partially insulate expectations from short-term political disturbances.

We believe our results hold at least three lessons for the current state of advanced economies that are heavily indebted and struggling to bring inflation rates down. First, controlling inflation will require both monetary and fiscal policy action. Importantly, fiscal policy action includes devising credible fiscal plans and communicating them to the public. Second, investors expectations are prone to day-to-day politics inducing volatility. Third, longer-term public financing seems to aid in consolidating sovereign debt levels.

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A Bond Market – Derivation

The derivation is divided into two subsections that provide a detailed derivation of the fiscal policy equation (subsection A.1) and the bond demand equation (subsection A.2), respectively. Subsection A.1 derives the fiscal policy equation based on the Fiscal Theory of the Price Level, as specified in Cochrane (2022). Subsection A.2 derives the bond demand equation against the backdrop of the expectations hypothesis.

A.1 Fiscal Policy (F)

A.1.1 Derivation

To derive the fiscal policy equation, we draw on the model from Cochrane (2022), henceforth C22. C22 integrates the fiscal theory of the price level within a New-Keynesian sticky price framework, using long-term debt and fiscal and monetary policy rules. The model features an active fiscal policy with the key novelty that the government decides whether to choose surpluses such that accumulated deficits are repaid partially or fully—enabling the government to inflate away fractions of its debt while paying back the rest. Typical fiscal theory models in the literature have the government either react to all changes in inflation—a passive fiscal policy regime—or to none at all which implies deficits are entirely financed by diluting the value of outstanding government debt. Naturally, we base the structural fiscal policy equation on the fiscal reaction function from C22

$$s_{t+1} = \theta_{s\pi}\pi_{t+1} + \theta_{sx}x_{t+1} + \alpha v_t^* + u_{t+1}^s \tag{C22 eq.13}$$

where π_τ and x_τ denote inflation and the output gap in period τ, respectively. The variable s_τ corresponds to the real primary surplus scaled by the steady-state value of government debt. The coefficients $\theta_{s\pi}$ and θ_{sx} specify the fiscal responsiveness to changes in inflation and the output gap. The latent variable v_t^* corresponds to the value of debt and is used in conjunction with α to generate the repayment dynamics. For example, a negative value for s_{t+1} (a deficit) raises the value of outstanding debt and will subsequently, for $\tau > t+1$, increase primary surpluses. Therefore, α controls the fiscal responsiveness with respect to the value of the outstanding government debt portfolio.

For our prior derivation, we take on a steady state view and replace v_t^* with its equilibrium value v_t. We then use the recursive formulation of the value flow identity and iterate forward.

Note we take the version including log GDP growth from Cochrane (2023) (equation 3.17)

$$\begin{aligned} v_t &= \rho v_{t+1} - r_{t+1} + g_{t+1} + s_{t+1} \\ &= \rho(g_{t+2} + s_{t+2} - r_{t+2} + \rho v_{t+2}) - r_{t+1} + g_{t+1} + s_{t+1} \\ &= \ldots \\ &= \sum_{j=0}^{\infty} \rho^j (g_{t+1+j} + s_{t+1+j} - r_{t+1+j}) \\ &= \sum_{j=0}^{\infty} \rho^j (g_{t+1+j} + s_{t+1+j} - (r^n_{t+1+j} - \pi_{t+1+j})). \end{aligned}$$

This relation states that the log debt-to-GDP ratio at the end of period $t+1$, v_{t+1}, equates with its value at the end of the preceding period, v_t, augmented by the log real return on the government bond portfolio, r_{t+1}, less log GDP growth g_{t+1}, and less the scaled surplus s_{t+1}. ρ is a constant of linearization, close to one, and we set it to one in our application. Taking expectations, one can re-arrange such that

$$\begin{aligned} v_t &= E_t \sum_{j=0}^{\infty} (g_{t+1+j} + s_{t+1+j} - (r^n_{t+1+j} - \pi_{t+1+j})) \\ &= \sum_{j=0}^{\infty} E_t(g_{t+1+j}) + \sum_{j=0}^{\infty} E_t(s_{t+1+j} + \pi_{t+1+j} - r^n_{t+1+j}) \end{aligned}$$

As in Baumeister and Hamilton (2018), we assume that expectations can be approximated by an $AR(1)$-forcast with lag coefficient $\varphi^j | j = \{\pi, x, r^n, s\}$. Moreover, we use the output gap rather than GDP growth in our regression set-up. Therefore, we replace the expected deviation from the steady state growth, $E_t g_{t+1}$, with $E_t \Delta x_{t+1} = (E_t x_{t+1} - x_t) = (\varphi - 1) x_t$.[22]

[22] Note that the deviation could be written like $g_t - \overline{g}_t = (\log(G_t) - \log(G_{t-1})) - (\log(\overline{G}_t) - \log(\overline{G}_{t-1}))$; however $x_t = \log(G_t/\overline{G}_t)$, therefore $\Delta x_t = \log(G_t/\overline{G}_t) - \log(G_{t-1}/\overline{G}_{t-1}) = (\log(G_t) - \log(G_{t-1})) - (\log(\overline{G}_t) - \log(\overline{G}_{t-1})) = g_t - \overline{g}_t$.

We obtain,

$$
\begin{aligned}
v_t &= \sum_{j=0}^{\infty} E_t(g_{t+1+j}) + \sum_{j=0}^{\infty} E_t(s_{t+1+j} + \pi_{t+1+j} - r^n_{t+1+j}) \\
&= [E_t g_{t+1} + E_t g_{t+2} + E_t g_{t+3} + E_t g_{t+4} + \dots] + \sum_{j=0}^{\infty} E_t(s_{t+1+j} + \pi_{t+1+j} - r^n_{t+1+j}) \\
&= \left[(\varphi^x - 1)x_t + \varphi^x(\varphi^x - 1)x_t + (\varphi^x)^2(\varphi^x - 1)x_t + (\varphi^x)^3(\varphi^x - 1)x_t + \dots\right] \\
&+ \sum_{j=0}^{\infty} E_t(s_{t+1+j} + \pi_{t+1+j} - r^n_{t+1+j}) \\
&= (\varphi^x - 1)\sum_{j=0}^{\infty}(\varphi^x)^j x_t + \varphi^s \sum_{j=0}^{\infty}(\varphi^s)^j s_t + \varphi^\pi \sum_{j=0}^{\infty}(\varphi^\pi)^j \pi_t - \varphi^r \sum_{j=0}^{\infty}(\varphi^r)^j r^n_t \\
&= (\varphi^x - 1)\frac{1}{1-\varphi^x} x_t + \frac{\varphi^s}{1-\varphi^s} s_t + \frac{\varphi^\pi}{1-\varphi^\pi}\pi_t - \frac{\varphi^r}{1-\varphi^r} r^n_t \\
&= \frac{\varphi^s}{1-\varphi^s} s_t + \frac{\varphi^\pi}{1-\varphi^\pi}\pi_t - \frac{\varphi^r}{1-\varphi^r} r^n_t - x_t
\end{aligned}
$$

We can now plug in the derived expression for the equilibrium value of outstanding government debt into the fiscal policy equation (C22 eq.13) and obtain

$$
\begin{aligned}
\varphi^s s_t &= \theta_{s\pi}\varphi^\pi \pi_t + \theta_{sx}\varphi^x x_t + \alpha\left(\frac{\varphi^s}{1-\varphi^s} s_t + \frac{\varphi^\pi}{1-\varphi^\pi}\pi_t - \frac{\varphi^r}{1-\varphi^r} r^n_t - x_t\right) + \eta_s u_{s,t} + u^s_{t+1} \\
\Leftrightarrow \frac{\varphi^s(1-\varphi^s-\alpha)}{1-\varphi^s} s_t &= \frac{\theta_{s\pi}\varphi^\pi(1-\varphi^\pi) + \alpha\varphi^\pi}{1-\varphi^\pi} + (\theta_{sx}\varphi^x - \alpha)\, x_t - \frac{\alpha\varphi^r}{1-\varphi^r} r^n_t + u^s_{t+1}.
\end{aligned}
$$

Further, we replace the fiscal innovation u^s_{t+1} with the autoregressive process as specified in equation (C22 eq.20)

$$
\frac{\varphi^s(1-\varphi^s-\alpha)}{1-\varphi^s} s_t = \frac{\theta_{s\pi}\varphi^\pi(1-\varphi^\pi) + \alpha\varphi^\pi}{1-\varphi^\pi} + (\theta_{sx}\varphi^x - \alpha)\, x_t - \frac{\alpha\varphi^r}{1-\varphi^r} r^n_t + \rho_s u^S_t + \varepsilon^S_{t+1}.
$$

To derive a formulation akin to our regression set-up, we re-arrange and get the following expression for the fiscal policy equation,

$$
\begin{aligned}
s_t = &\left[\frac{\theta_{s\pi}\varphi^\pi(1-\varphi^\pi) + \alpha\varphi^\pi}{\varphi^s(1-\varphi^s-\alpha)} \cdot \frac{1-\varphi^s}{1-\varphi^\pi}\right]\pi_t \\
&+ \left[\frac{\theta_{sx}\varphi^x - \alpha}{\varphi^s(1-\varphi^s-\alpha)} \cdot \frac{(1-\varphi^s)}{1}\right] x_t \\
&- \left[\frac{\alpha\varphi^r}{\varphi^s(1-\varphi^s-\alpha)} \cdot \frac{(1-\varphi^s)}{(1-\varphi^r)}\right] r^n_t \\
&+ (\rho_s(\rho_s u_{s,t-1} + \varepsilon_{s,t}) + \rho_s \varepsilon_{s,t})\, \frac{1-\varphi^s}{\varphi^s(1-\varphi^s-\alpha)}
\end{aligned}
$$

further collecting terms and subsuming past innovations in $\mathbf{x}_{t-1}$, we have

$$\begin{aligned} s_t = &\left[\frac{\theta_{s\pi}\varphi^{\pi}(1-\varphi^{\pi}) + \alpha\varphi^{\pi}}{\varphi^{s}(1-\varphi^{s}-\alpha)} \cdot \frac{1-\varphi^{s}}{1-\varphi^{\pi}}\right]\pi_t \\ &+ \left[\frac{\theta_{sx}\varphi^{x} - \alpha}{\varphi^{s}(1-\varphi^{s}-\alpha)} \cdot \frac{(1-\varphi^{s})}{1}\right]x_t \\ &- \left[\frac{\alpha\varphi^{r}}{\varphi^{s}(1-\varphi^{s}-\alpha)} \cdot \frac{(1-\varphi^{s})}{(1-\varphi^{r})}\right]r_t^{n} \\ &+ [\mathbf{b}^{s}]'\,\mathbf{x}_{t-1} \\ &+ \left[\frac{(\rho_s + \varphi^{\varepsilon})}{\varphi^{s}(1-\varphi^{s}-\alpha)} \cdot \frac{(1-\varphi^{s})}{1}\right]\varepsilon_{s,t}. \end{aligned}$$

To translate this expression to our regression setting, we add a constant and represent the scaled (theoretical) structural error, as the structural error u_t^S, such that the fiscal policy rule reads

$$\begin{aligned} s_t &= k^{s} + \left[\frac{\theta_{s\pi}\varphi^{\pi}(1-\varphi^{\pi}) + \alpha\varphi^{\pi}}{\varphi^{s}(1-\varphi^{s}-\alpha)} \cdot \frac{1-\varphi^{s}}{1-\varphi^{\pi}}\right]\pi_t + \left[\frac{\theta_{sx}\varphi^{x} - \alpha}{\varphi^{s}(1-\varphi^{s}-\alpha)} \cdot \frac{(1-\varphi^{s})}{1}\right]x_t \\ &- \left[\frac{\alpha\varphi^{r}}{\varphi^{s}(1-\varphi^{s}-\alpha)} \cdot \frac{(1-\varphi^{s})}{(1-\varphi^{r})}\right]r_t^{n} + [\mathbf{b}^{s}]'\,\mathbf{x}_{t-1} + u_t^{s} \\ s_t &= k^{s} + \Theta_{\pi}^{S}\pi_t + \Theta_{y}^{S}x_t - \left[\frac{\alpha\varphi^{r}}{\varphi^{s}(1-\varphi^{s}-\alpha)} \cdot \frac{(1-\varphi^{s})}{(1-\varphi^{r})}\right]r_t^{n} + [\mathbf{b}^{s}]'\,\mathbf{x}_{t-1} + u_t^{s}. \end{aligned}$$

We are not using the ex post government bond portfolio return, r_t^n, in our set-up, but approximate the bond portfolio return with short term interest rate i_t and bond yields for longer maturity bonds, b_t. Against the backdrop of the expectations hypothesis, which states that in equilibrium all maturities pay the same, we allocate the coefficient on r_t^n in equal proportions to i_t and b_t. Furthermore, we change variable names to the conventions of the main paper (x to y),

$$\begin{aligned} s_t &= k^{s} + \Theta_{\pi}^{S}\pi_t + \Theta_{y}^{S}y_t - \frac{\left[\frac{\alpha\varphi^{r}}{\varphi^{s}(1-\varphi^{s}-\alpha)} \cdot \frac{(1-\varphi^{s})}{(1-\varphi^{r})}\right]}{2}i_t - \frac{\left[\frac{\alpha\varphi^{r}}{\varphi^{s}(1-\varphi^{s}-\alpha)} \cdot \frac{(1-\varphi^{s})}{(1-\varphi^{r})}\right]}{2}b_t + [\mathbf{b}^{s}]'\,\mathbf{x}_{t-1} + u_t^{s} \\ &= k^{s} + \Theta_{\pi}^{S}\pi_t + \Theta_{y}^{S}y_t + \Theta_{i}^{S}i_t + \Theta_{b}^{S}b_t + [\mathbf{b}^{s}]'\,\mathbf{x}_{t-1} + u_t^{s} \end{aligned}$$

A.1.2 Prior Values

Prior values for the structural fiscal policy equation are derived from the contractual framework of the euro zone. Specifically the stability and growth pact (SGP) and associated regulations are used to derive values for the composite underlying model parameters, namely: the fiscal responsiveness to inflation $\theta_{s\pi}$, the fiscal responsiveness to the output gap θ_{sx} and fiscal responsiveness to the value of outstanding government debt α. In line with Baumeister and Hamilton (2018), autoregressive parameters $\varphi^{\cdot}$ are set to .75. In the following the derivation of values for the composite parameters is laid out. Finally, numbers are put together to determine prior modes for the estimation.

Reaction of the primary surplus to inflation, $\theta_{s\pi}$ Euro area member states are not permitted to deviate from debt rules in response to inflation. Therefore, we choose a value of $\theta_{s\pi} = 0.0$.

FIGURE A1: FISCAL ADJUSTMENTS OVER BUSINESS CYCLE

ANNEX 2 - MATRIX FOR SPECIFYING THE ANNUAL FISCAL ADJUSTMENT
TOWARDS THE MEDIUM-TERM OBJECTIVE (MTO)
UNDER THE PREVENTIVE ARM OF THE PACT

		Required annual fiscal adjustment*	
	Condition	Debt below 60 % and no sustainability risk	Debt above 60 % or sustainability risk
Exceptionally bad times	Real growth <0 or output gap <-4	No adjustment needed	
Very bad times	-4 ≤ output gap <-3	0	0.25
Bad times	-3 ≤ output gap < -1.5	0 if growth below potential, 0.25 if growth above potential	0.25 if growth below potential, 0.5 if growth above potential
Normal times	-1.5 ≤ output gap < 1.5	0.5	> 0.5
Good times	output gap ≥ 1.5 %	> 0.5 if growth below potential, ≥ 0.75 if growth above potential	≥ 0.75 if growth below potential, ≥ 1 if growth above potential

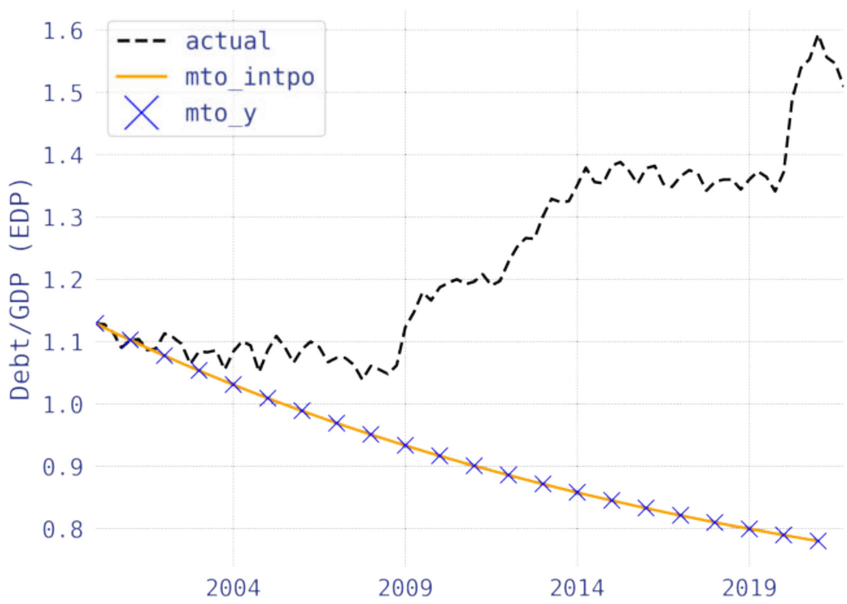
* all figures are in percentage points of GDP

Notes: Figure shows screenshot taken from the table ANNEX 2 in European Commission (2015).

Reaction of the primary surplus to output gap, θ_{sx} We base the responsiveness to the business cycle on the preventive arm of the SGP, specifying the fiscal adjustments necessary for the Medium-Term Objectives (MTO) (cf. European Commission (2015)), as specified in table ANNEX 2 (for comparison see figure A1). We first compute the fraction of quarters that have historically fallen into the different categories specified in figure A1 for the entire euro zone, measured by the eurozone output gap (Refinitiv: `EKXOGAP.R`). Weighting the recommended fiscal adjustments then yields, $\theta_{sx} = 0.15$.

Reaction of primary surplus to the value of government debt, α To derive a prior for α based on the contractual framework of the SGP, we use the excessive deficit procedure "debt path rule" described for example in Larch and Malzubris (2022). The rule posits that member countries have to reduce the distance between the 60% reference value for debt-to-GDP ratio and current debt-to-GDP by on average 1/20 per year over the previous three years. We compute a counterfactual SGP compliant path for debt to GDP starting from the outset of the sample period, as shown in figure A2. We obtain the value

FIGURE A2: SGP PRIOR DEBT/GDP PATH

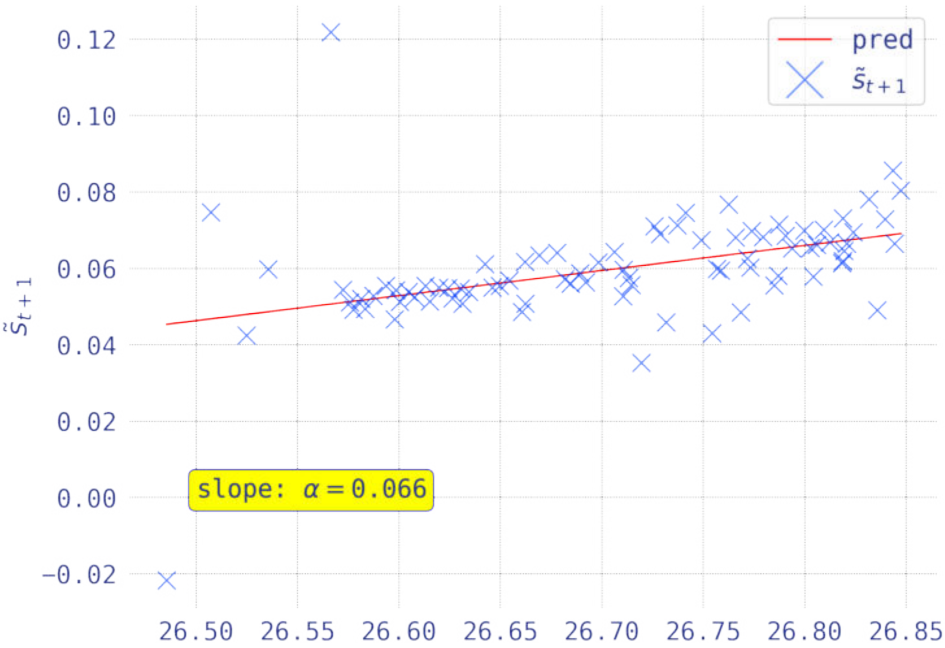


Notes: SGP compliant debt/gdp path vs. actual over sample period: (1) take beginning of sample period debt/GDP ratio and compute yearly path according to the SGP rule (blue ticks) (2) interpolate to obtain quarterly path (orange line)

of outstanding debt in levels (V_t) by multiplying the quarterly path by potential GDP. This allows to deduct the primary surpluses necessary to sustain the SGP compliant debt path, i.e. $s_{t+1} = -\Delta V_t + \iota \times V_t$ where $\iota = 3.5\%$[23] is the weighted average interest rate paid on outstanding debt. This accounts for the fact that the government needs to reduce debt levels and pay down interest on existing debt to follow the SGP path. We then back out an estimate for α by projecting the log value of outstanding real government debt v_t onto primary surpluses, s_{t+1}, scaled by the steady state real value of debt ($60\% * GDPPOT$). As displayed in figure A3, the resulting estimate is $\alpha = 0.07$.

[23]The value for ι is derived as the roundabout number based on average interest rate paid on different maturities and the average maturity of the outstanding government debt portfolio.

FIGURE A3: RECOVER α



Notes: regression: $\tilde{s}_{t+1} = k + \alpha \times v_t + \epsilon$; resulting value for $\alpha = 0.07$. Note that the $\tilde{}$ indicates the scaling of primary surpluses with the steady state real value of government debt.

Compute prior modes for $\Theta^F_\cdot$ With the derived values and setting autoregressive parameters to .75, it is no possible to solve for the structural coefficients, such that

$$\Theta^F_\pi \sim t_3\left(\left[\frac{\theta_{s\pi}\varphi^\pi(1-\varphi^\pi)+\alpha\varphi^\pi}{\varphi^s(1-\varphi^s-\alpha)}\cdot\frac{1-\varphi^s}{1-\varphi^\pi}\right],.4\right) = t_3(0.39,.4)$$
$$\Theta^F_y \sim t_3\left(\left[\frac{\theta_{sx}\varphi^x-\alpha}{\varphi^s(1-\varphi^s-\alpha)}\cdot\frac{(1-\varphi^s)}{1}\right],.4\right) = t_3(0.08,.4)$$
$$\Theta^F_i \sim t_3\left(-\left[\frac{\alpha\varphi^r}{\varphi^s(1-\varphi^s-\alpha)}\cdot\frac{(1-\varphi^s)}{(1-\varphi^r)}\right]/2,.4\right) = t_3(-0.19,.4)$$
$$\Theta^F_b \sim t_3\left(-\left[\frac{\alpha\varphi^r}{\varphi^s(1-\varphi^s-\alpha)}\cdot\frac{(1-\varphi^s)}{(1-\varphi^r)}\right]/2,.4\right) = t_3(-0.19,.4).$$

A.2 Bond Demand (B)

A.2.1 Derivation

The bond demand schedule is derived against the backdrop of the expectations hypothesis which holds that the long-term bond rate is determined by current and future expected short-term rates. Investors are assumed to form expectations about the monetary policy rule as specified in the model, which is the monetary policy rule with smoothing, similar to

Baumeister and Hamilton (2018)

$$i_t - \bar{\iota} = (1-\rho)\Theta_y^M y_t + (1-\rho)\Theta_\pi^M(\pi_t - \pi^*) + \rho(i_{t-1} - \bar{\iota}) + u_t^M,$$

where π^* is the ECB's long-run inflation target, $\bar{\iota}$ corresponds to the long-run nominal interest rate, ρ represents the ECB's preference for implementing changes in a gradual manner over time. We first re-arrange to isolate the short-term interest rate,

$$\begin{aligned} i_t &= (1-\rho)\Theta_y^M y_t + (1-\rho)\Theta_\pi^M(\pi_t - \pi^*) + \rho(i_{t-1} - \bar{\iota}) + \bar{\iota} + u_t^M \\ &= (1-\rho)\left(\Theta_y^M y_t + \Theta_\pi^M \pi_t\right) + \rho i_{t-1} - (1-\rho)\left(\Theta_\pi^M \pi^* + \bar{\iota}\right) + u_t^M. \end{aligned}$$

To obtain the 3-year bond yield according to the expectation hypothesis, we use the representation as the average of the short-term interest rates over that same time horizon. We get

$$\begin{aligned} b_t &= \frac{1}{12} E_t \sum_{j=0}^{12-1} i_{t+j} \\ &= \frac{1}{12} i_t + \frac{1}{12} E_t \sum_{j=1}^{12-1} i_{t+j} \\ &= \frac{1}{12} i_t + \frac{1}{12} E_t \sum_{j=1}^{12-1} \left((1-\rho)\left(\Theta_y^M y_{t+j} + \Theta_\pi^M \pi_{t+j}\right) + \rho i_{t-1+j} - (1-\rho)\left(\Theta_\pi^M \pi^* + \bar{\iota}\right) + u_{t+j}^m\right) \\ &= \frac{1+\rho}{12} i_t + \frac{1-\rho}{12} E_t \sum_{j=1}^{11} \left(\Theta_y^M y_{t+j} + \Theta_\pi^M \pi_{t+j}\right) + \frac{\rho}{12} E_t \sum_{j=1}^{10} i_{t+j} \\ &\quad - \underbrace{\frac{11}{12}(1-\rho)\left(\Theta_\pi^M \pi^* + \bar{\iota}\right)}_{\text{subsume in constant}} + \underbrace{\frac{1}{12} E_t \sum_{j=1}^{11} u_{t+j}^m}_{=0} \\ &= k^B + \frac{1+\rho}{12} i_t + \frac{1-\rho}{12} E_t \sum_{j=1}^{11} \left(\Theta_y^M y_{t+j} + \Theta_\pi^M \pi_{t+j}\right) + \frac{\rho}{12} E_t \sum_{j=1}^{10} i_{t+j} \end{aligned}$$

$$
\begin{aligned}
&= k^B + \frac{1+\rho}{12} i_t + \frac{1-\rho}{12}\left(\Theta_y^M y_t \sum_{j=1}^{11} (\varphi^y)^j + \Theta_\pi^M \pi_t \sum_{j=1}^{11} (\varphi^\pi)^j\right) + \frac{\rho}{12} i_t \sum_{j=1}^{10} (\varphi^i)^j \\
&= k^B + \frac{1+\rho}{12} i_t + \frac{1-\rho}{12}\left(\frac{\Theta_y^M (1-(\varphi^y)^{11})\varphi^y}{1-\varphi^y} y_t + \frac{\Theta_\pi^M (1-(\varphi^\pi)^{11})\varphi^\pi}{1-\varphi^\pi} \pi_t\right) + \frac{\rho}{12}\frac{(1-(\varphi^i)^{10})\varphi^i}{1-\varphi^i} i_t \\
&= k^B + \frac{(1-\rho)\Theta_\pi^M (1-(\varphi^\pi)^{11})\varphi^\pi}{12(1-\varphi^\pi)} \pi_t + \frac{(1-\rho)\Theta_y^M (1-(\varphi^y)^{11})\varphi^y}{12(1-\varphi^y)} y_t \\
&+ \frac{(1+\rho)(1-\varphi^i) + \rho(1-(\varphi^i)^{10})\varphi^i}{12(1-\varphi^i)} i_t \\
&= k^B + \Theta_\pi^B \pi_t + \Theta_y^B y_t + \Theta_i^B i_t + \Theta_s^B s_t + \left[\mathbf{b}^b\right]' \mathbf{x}_{t-1} + u_t^B.
\end{aligned}
$$

Within the expectations hypothesis, there is no explicit role for the surplus. It is however taken into the equation, however with an agnostic prior distribution of $\Theta_s^B \sim t_3(0.0, .4)$.

A.2.2 Prior Values

As a consequence of basing investors' beliefs on the monetary policy function, prior modes for structural parameters of Θ_π^B, $\Theta_y^B y_t$ and $\Theta_i^B i_t$ depend on the structural parameters from the monetary policy equation and the autoregressive parameters $\varphi^{\cdot}$. For these values, we use the configuration of Baumeister and Hamilton (2018), such that prior distributions are given by

$$
\begin{aligned}
&\Theta_\pi^B \sim t_3\left(\frac{(1-\rho)\Theta_\pi^M (1-(\varphi^\pi)^{11})\varphi^\pi}{12(1-\varphi^\pi)}, .4\right) = t_3(0.18, .4) \\
&\Theta_y^B \sim t_3\left(\frac{(1-\rho)\Theta_y^M (1-(\varphi^y)^{11})\varphi^y}{12(1-\varphi^y)}, .4\right) = t_3(0.06, .4) \\
&\Theta_i^B \sim t_3\left(\frac{(1+\rho)(1-\varphi^i) + \rho(1-(\varphi^i)^{10})\varphi^i}{12(1-\varphi^i)}, .4\right) = t_3(0.24, .4) \\
&\Theta_s^B \sim t_3(0.0, .4).
\end{aligned}
$$

Note that we do not sample ρ in the bond demand equation but plug in the prior mean from the Beta distribution of $\rho = 0.5$.

A.3 Contemporaneous Coefficients

The equations (S) to (B) and (B_IV) define the matrices of structural contemporaneous coefficients $\mathbf{A}$ and $\mathbf{C}$ as

$$\mathbf{A} = \begin{bmatrix} 1 & -\Theta_\pi^S & 0 & 0 & 0 \\ 1 & -\Theta_\pi^D & -\Theta_i^D & -\Theta_s^D & -\Theta_b^D \\ -(1-\rho)\Theta_y^M\omega & -(1-\rho)\Theta_\pi^M\omega & 1 & -(1-\rho)\Theta_s^M & -(1-\rho)\Theta_b^M \\ -\Theta_y^F & -\Theta_\pi^F & -\Theta_i^F & 1 & -\Theta_b^F \\ -\Theta_y^B\omega & -\Theta_\pi^B\omega & -\Theta_i^B & -\Theta_s^B & 1 \end{bmatrix}$$

and

$$\mathbf{C} = \begin{bmatrix} 0 & 0 & 0 \\ -\Gamma_{y^{rea}}^D & 0 & 0 \\ -(1-\rho)\Theta_y^M(1-\omega) & -(1-\rho)\Theta_\pi^M(1-\omega) & 0 \\ 0 & 0 & 0 \\ -\Theta_y^B(1-\omega) & -\Theta_\pi^B(1-\omega) & -\chi^B \end{bmatrix}.$$

B Data Appendix

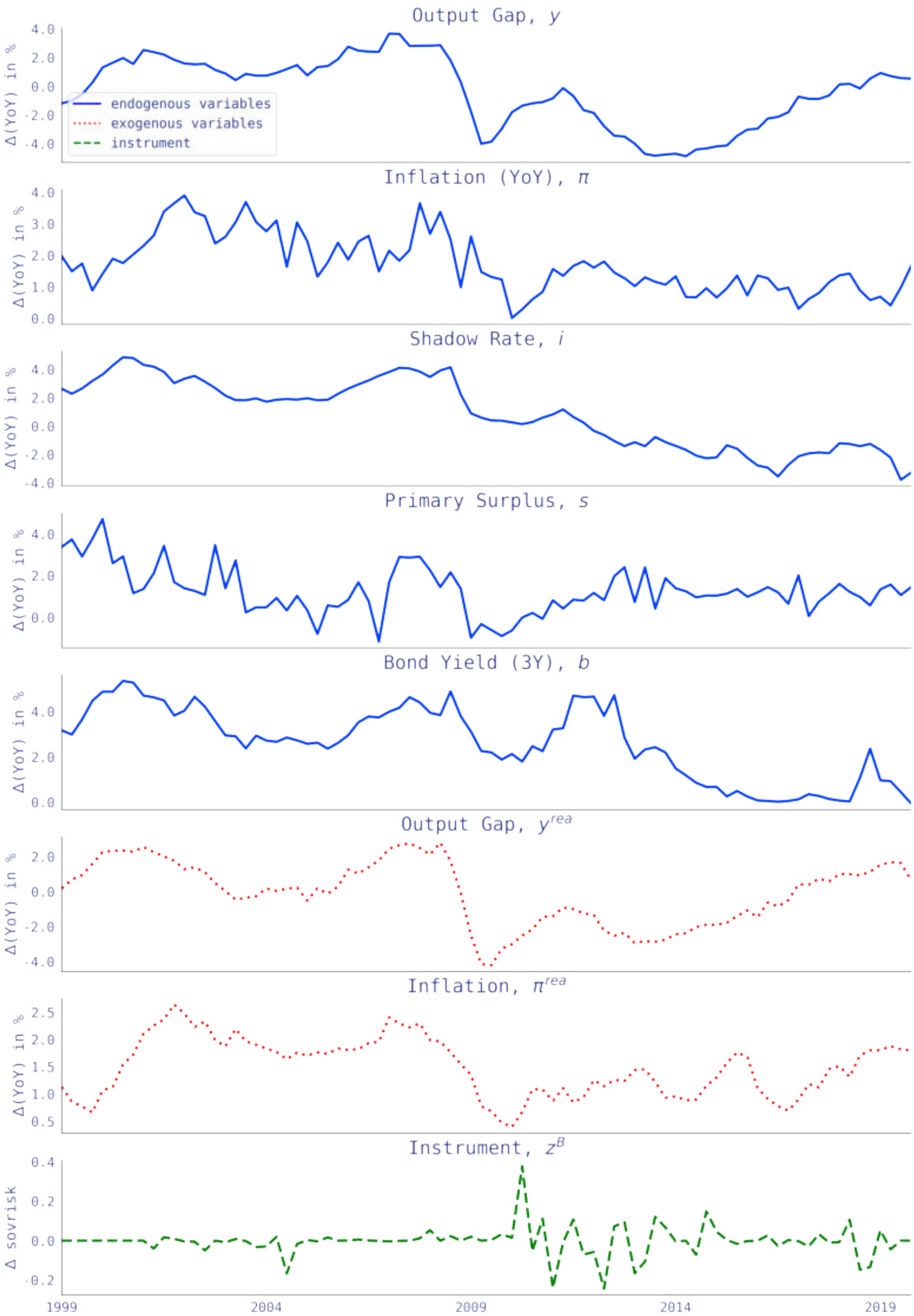
Our sample consists of eight quarterly time series from the first quarter of 1999 to the last quarter in 2019. There are five endogenous variables: output gap y_t, inflation π_t, short-term interest rates i_t, surplus scaled by potential output s_t and long-term bond rates b_t. The exogenous variables include GDP-weighted output gap and inflation of the euro area without Italy. Finally, the instrument series is taken from Staffa (2022). The time series of all variables can be seen in figure A4.

Endogenous variables Since the prior values of equation (F) are derived from the medium term budgetary objectives associated with the Stability and Growth Pact, we draw on the potential output series `OVGDP` of the European Commission to derive our output gap measure. This output gap is computed according to a production function methodology as specified in Havik et al. (2014). `OVGDP` is available only in yearly frequency. We therefore interpolate it to quarterly frequency using the Chow and Lin (1971) method, taking the quarterly potential GDP series from Oxford Economics as the indicator variable. The corresponding GDP series that is used to compute the output gap y_t is drawn from eurostat (table `namq_10_gdp`). We measure inflation by the implicit price deflator drawn from the Quarterly National Accounts database of the OECD (series name `DOBSA`). Since the implicit price deflator takes into account companies and businesses, it is better suited for this analysis when compared to purely consumer based price indices. For short-term interest rates, we resort to the shadow interest rate series constructed by Krippner (2013) which captures both conventional and unconventional monetary policy. We take the surplus series from the quarterly accounts of ISTAT, the Italian statistical agency. The series is seasonally adjusted and scaled by the interpolated potential output series from the European Commission.[24] Scaling with potential output rather than actual GDP ensures stationarity but also delivers a good measure of the fiscal stance without causing confounding dynamics through movements in GDP. The long term bond yield, b_t, is drawn from the Refinitiv database for the constant maturities of 3, 5, 7, 10 years. In the benchmark specification, the long-term bond is taken to be of 3-year maturity.

Exogenous variables Output gap for the rest of the euro area y_t^{rea} is constructed similarly interpolating the European Commission measure onto quarterly frequency using the series from Oxford Economics where available. Otherwise, we base the interpolation on productivity and GDP. We weigh the output gaps with the GDP series from eurostat, such

[24] Seasonal adjustment is conducted using the package of the U.S. Bureau of the Census X-13ARIMA-SEATS Seasonal Adjustment Program (from 'statsmodel' package python).

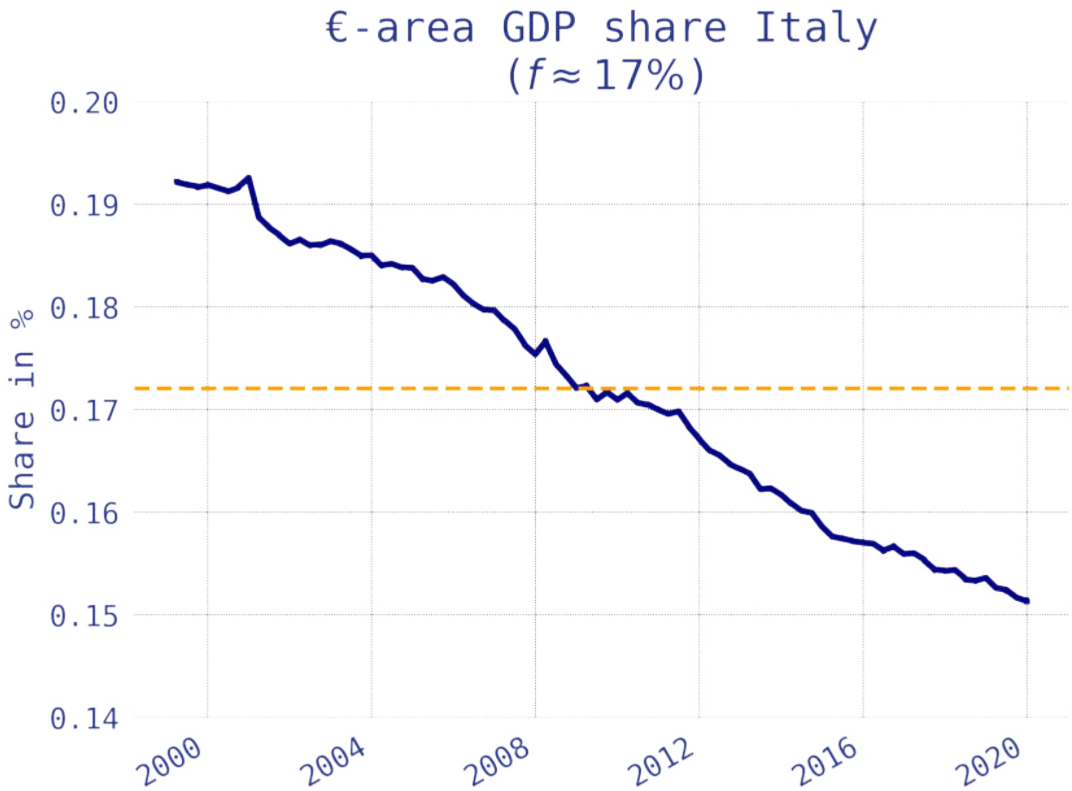
Figure A4: Time Series All Variables



Notes: Note that the instrument is derived from changes in bond prices which move in the opposite direction as yields. Therefore, a positive (negative) value is associated with a decrease (increase) in sovereign risk.

that unity equals all countries in the euro area at the respective point in time, excluding Italy. Inflation for the rest of the euro area π_t^{rea} is measured as the implicit price deflator provided by National Accounts database of the OECD (series name `DOBSA`). Unfortunately, implicit price deflators are not available for Cyprus and Malta. The associated GDP weights are however very small and therefore we undertake no further adjustments. The weighting is conducted analogously to the construction of y_t^{rea}.

FIGURE A5: ITALY'S GDP SHARE

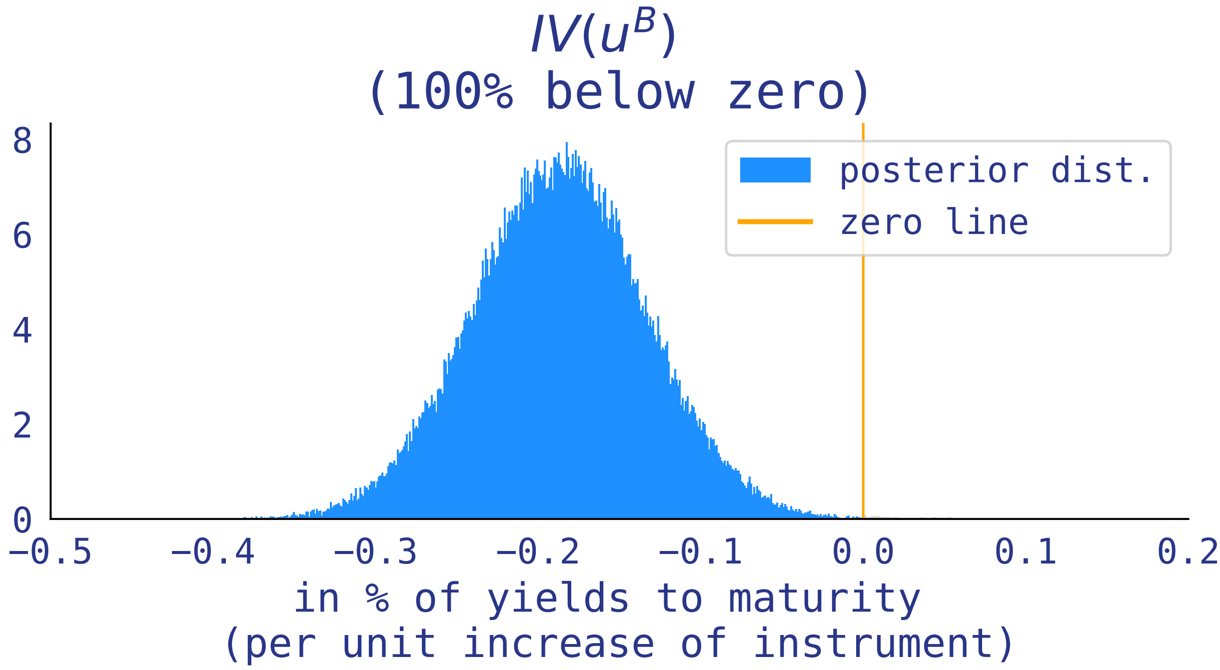


Notes: Italy's GDP Share within euro area over the sample period.

Instrument The instrument series is based on Staffa (2022) in which domestic policy surprises are derived from a news ticker data set from Thomson Reuters. Changes in sovereign risk associated with these events are computed as the change in Italian bond prices in very narrow time windows around the event's materialization relative to the change in German bond prices. Since we are measuring risk, the change is recorded relative to the safe asset.

The instrument is constructed based on intraday bond prices provided by Refinitiv and is available for constant maturities of 3, 5, 7, 10 years. The series is aggregated to quarterly frequency by taking sums of the respective calendar quarters.

Figure A6: Posterior Distribution Instrument (B)

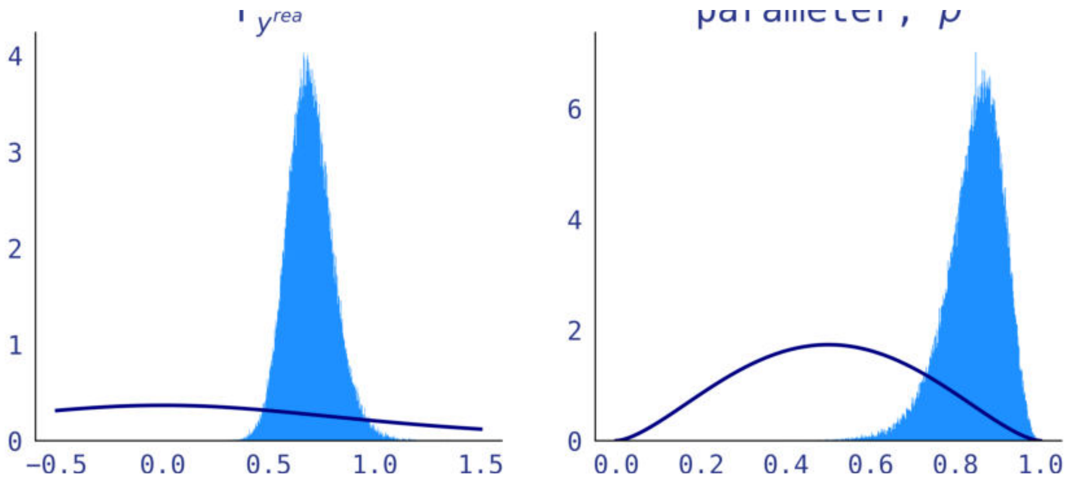


Notes: Posterior distribution for the coefficient, χ^B, instrument regression: $u_t^B = \chi^B z_t^B + v_t^B$.

Table A1: 30 Largest Absolute Shocks

Timestamp (CET)	Story-ID	First Headline	$\Delta\sigma_\tau^{IT}$
2012-06-26 16:27	nR1E8GA02C	ITALY PM MONTI SAYS JOINT EUROPEAN SOLUTIONS NEEDED TO PREVENT SOME COUNTRIES FALLING INTO RECESSION SPIRAL	-0.231
2011-11-07 12:58	nR1E7LJ00Y	ITALY'S BERLUSCONI SAYS RUMOURS OF HIS RESIGNATION UNFOUNDED-ANSA NEWS AGENCY	-0.218
2018-10-08 10:49	nR1N1VZ00V	ITALY DEPUTY PRIME MINISTER SALVINI SAYS MOSCOVICI AND JUNCKER ARE REAL ENEMIES OF EUROPE	-0.188
2011-11-25 10:59	nL5E7MP0XX	ITALY TRYING TO PERSUADE ITS FIRMS TO DIVERSIFY FROM USING IRANIAN OIL -FOREIGN MINISTRY	-0.179
2011-07-14 11:38	nR1E7HU012	ITALIAN GOVT CALLS CONFIDENCE VOTE IN SENATE OVER AUSTERITY PACKAGE	-0.151
2018-06-06 15:53	nL5N1T843R	ITALY'S NEW ENVIRONMENT MINISTER SAYS ITALIAN STAGE OF TAP PIPELINE PROJECT LOOKS 'POINTLESS', WILL BE REVIEWED	-0.142
2018-05-28 10:53	nR1N1SG016	ITALY'S ANTI-ESTABLISHMENT 5-STAR "EVALUATING" POSSIBLE COALITION WITH LEAGUE IN NEXT ELECTIONS - 5-STAR SOURCE	-0.117
2011-11-08 16:11	nR1E7LJ016	ITALIAN LOWER HOUSE SPEAKER OPENS VOTE KEY TO BERLUSCONI'S FUTURE	-0.099
2013-02-14 10:10	nI6E8G700Y	ITALY POLICE ARREST MONTE PASCHI FORMER FINANCIAL DIRECTOR BALDASSARRI - INVESTIGATIVE SOURCES	-0.099
2013-09-30 14:37	nR1N0G102J	AS MANY AS 20 SENATORS FROM FORMER ITALIAN PM BERLUSCONI'S PDL PARTY READY TO FORM BREAKAWAY PARTY - PDL SOURCE	0.087
2011-10-12 10:24	nR1E7KT00C	ITALY'S PRESIDENT SAYS WORRIED ABOUT ACUTE TENSIONS AND UNCERTAINTY IN GOVT AFTER LOSS OF KEY VOTE	0.082
2012-02-08 10:00	nL5E8D82NW	TUNISIA TO TEMPORARILY CEDE ITS SHARE OF ALGERIAN GAS SUPPLIES TO ITALY DUE TO COLD WEATHER, SAYS AN OFFICIAL IN TUNISIAN INDUSTRY MINISTRY	-0.082
2019-06-07 16:22	nR1N20Z014	ITALY'S LEAGUE CABINET UNDERSECRETARY GIORGETTI SAYS "MINI-BOT" SCHEME IS A POSSIBILITY - ITALIAN NEWS AGENCY AGI	-0.074
2018-05-21 09:51	nR1N1SG003	ITALY'S 5-STAR, LEAGUE LEADERS TO SEE PRESIDENT IN THE AFTERNOON, EXPECTED TO PROPOSE PRIME MINISTER OF COALITION GOVT - STATEMENT	0.067
2013-01-03 09:18	nR1N09M00H	ITALY PM MONTI SAYS BOND SPREAD HAS FALLEN DUE TO A RETURN OF FOREIGN, ITALIAN INVESTOR FAITH IN ITALY, SAYS HOPES TREND CONTINUES	-0.067
2013-10-02 09:43	nR1N0HR006	ITALY PM LETTA SAYS FUTURE OF GOVERNMENT MUST BE KEPT SEPARATE FROM BERLUSCONI LEGAL PROBLEMS	0.067
2013-03-07 12:03	nI6N0BJ012	ITALY COURT SENTENCES BERLUSCONI TO 1 YEAR IN JAIL IN WIRETAP TRIAL - JUDGE SAYS IN COURT	-0.064
2018-09-17 11:01	nEMN2TQZOM	NHC SAYS TROPICAL DEPRESSION FLORENCE CONTINUES TO PRODUCE WIDESPREAD HEAVY RAINS OVER PARTS OF NORTH CAROLINA AND NORTHEASTERN SOUTH CAROLINA INTO WESTERN VIRGINIA. FLASH FLOODING WILL CONTINUE OVER PORTIONS OF THE WESTERN MID-ATLANTIC REGION	0.064
2011-12-16 13:07	nR1E7ML01P	ITALY GOVERNMENT WINS CONFIDENCE VOTE IN LOWER HOUSE ON AUSTERITY MEASURES, PACKAGE MOVES TO SENATE	0.063
2013-03-01 11:21	nR4E8JL02D	RUSSIAN FOREIGN MINISTRY SAYS DECISIONS MADE AT "FRIENDS OF SYRIA" MEETING IN ROME ENCOURAGE EXTREMISTS TO SEEK THE GOVERNMENT'S OVERTHROW	0.059
2011-10-14 14:22	nR1E7KT011	ITALIAN PM BERLUSCONI WINS GOVT CONFIDENCE VOTE	0.059
2011-02-02 10:11	nLDE7110MR	SPANISH 5-YEAR CREDIT DEFAULT SWAPS FALL TO 209 BPS, DOWN 20 BPS ON DAY - MARKIT	-0.057
2014-02-13 15:58	nI6N0LB010	ITALY'S BLUE-CHIP INDEX AND ITALY'S 10-YR BTP CUT LOSSES, TRADERS CITE RENZI'S WORDS ON NEED FOR POLITICAL CHANGE	0.056
2019-05-14 13:47	nS8N22507X	ITALY'S DEPUTY PM SALVINI SAYS GOVT READY TO EXCEED 3% BUDGET DEFICIT LIMIT OR ALLOW DEBT TO SURPASS 130-140% IF NECESSARY TO SPUR JOBS	-0.054
2012-02-17 09:38	nB4E8CG01O	GERMANY'S MERKEL POSTPONES PLANNED FRIDAY TRIP TO ROME AND MEETING WITH ITALY'S MONTI -GOVT SOURCE	-0.053
2019-06-05 08:58	nR1N20Z00S	ITALY'S LEAGUE WANTS END TO STRUCTURAL DEFICIT CALCULATIONS, ONLY DEFICIT RULE SHOULD BE 3% HEADLINE DEFICIT CAP - BORGHI	0.053
2012-08-29 14:33	nB4E7HM020	GERMANY'S MERKEL SAYS CONVINCED THAT ITALIAN REFORMS WILL BEAR FRUIT	0.051
2018-05-23 10:50	nR1N1SG00B	ITALY 5-STAR LEADER DI MAIO SAYS GIUSEPPE CONTE "ABSOLUTELY" REMAINS PM CANDIDATE	-0.051

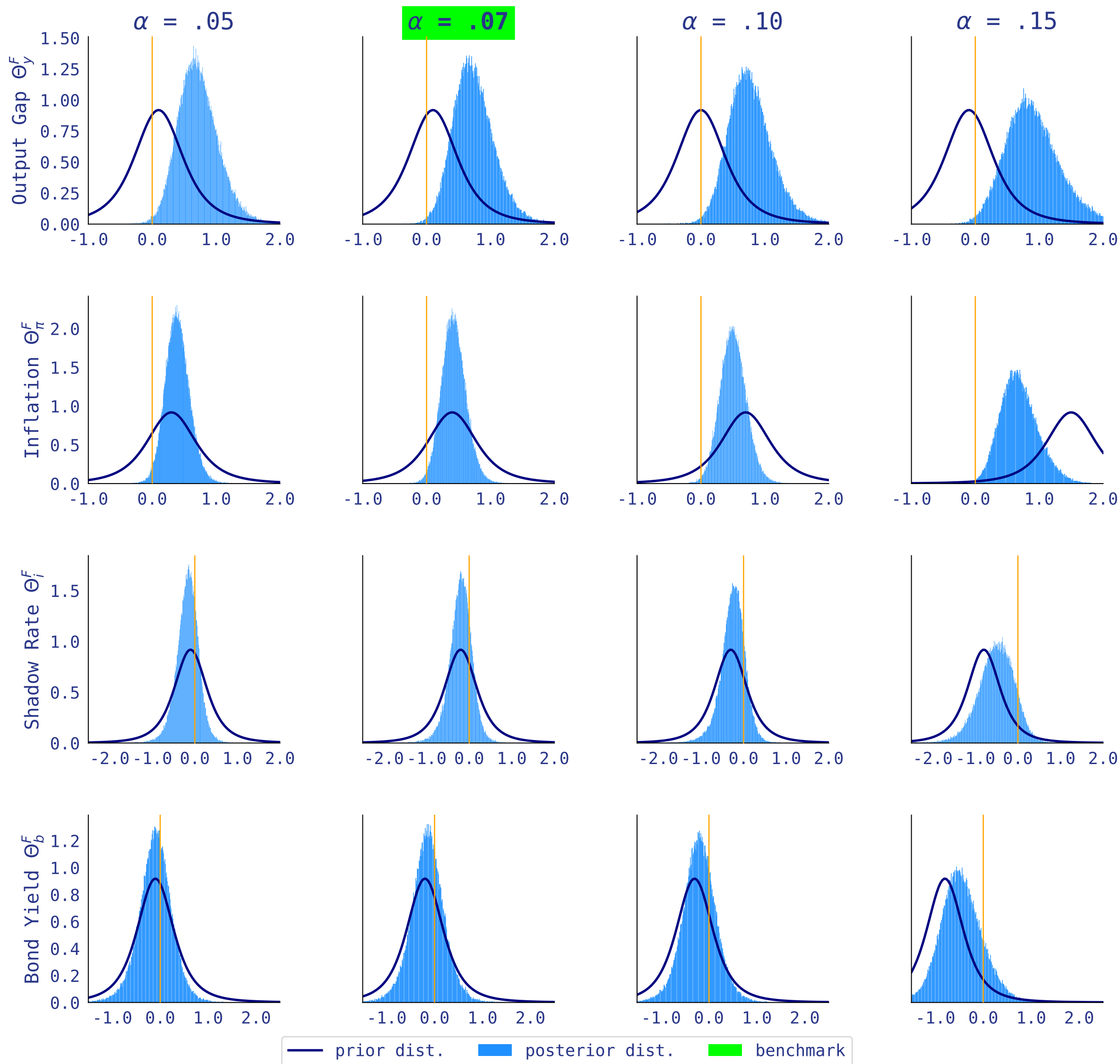
Figure A7: Interest Rate Smoothing (M)



Notes: Left panel shows the posterior distribution of coefficient of rest of euro area output gap on Italian demand. The right panel shows the posterior distribution of smoothing parameter in monetary policy equation (M). Prior distribution (line) and posterior distribution (histogram) are displayed in dark blue and light blue, respectively.

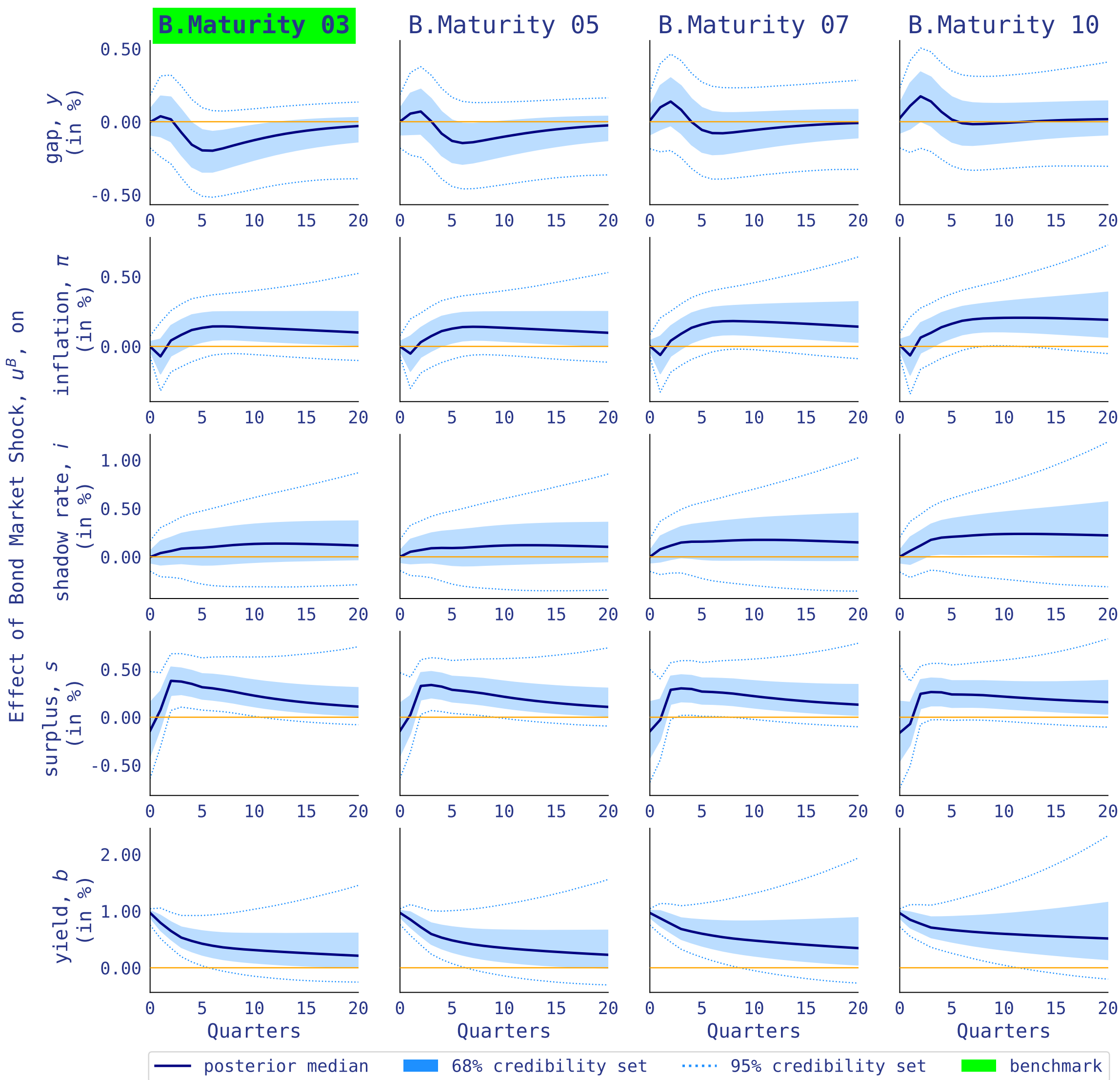
C Sensitivity Analysis: Additional Results

Figure A8: Rob.α: Cont.Effects Aggregate Supply (F)



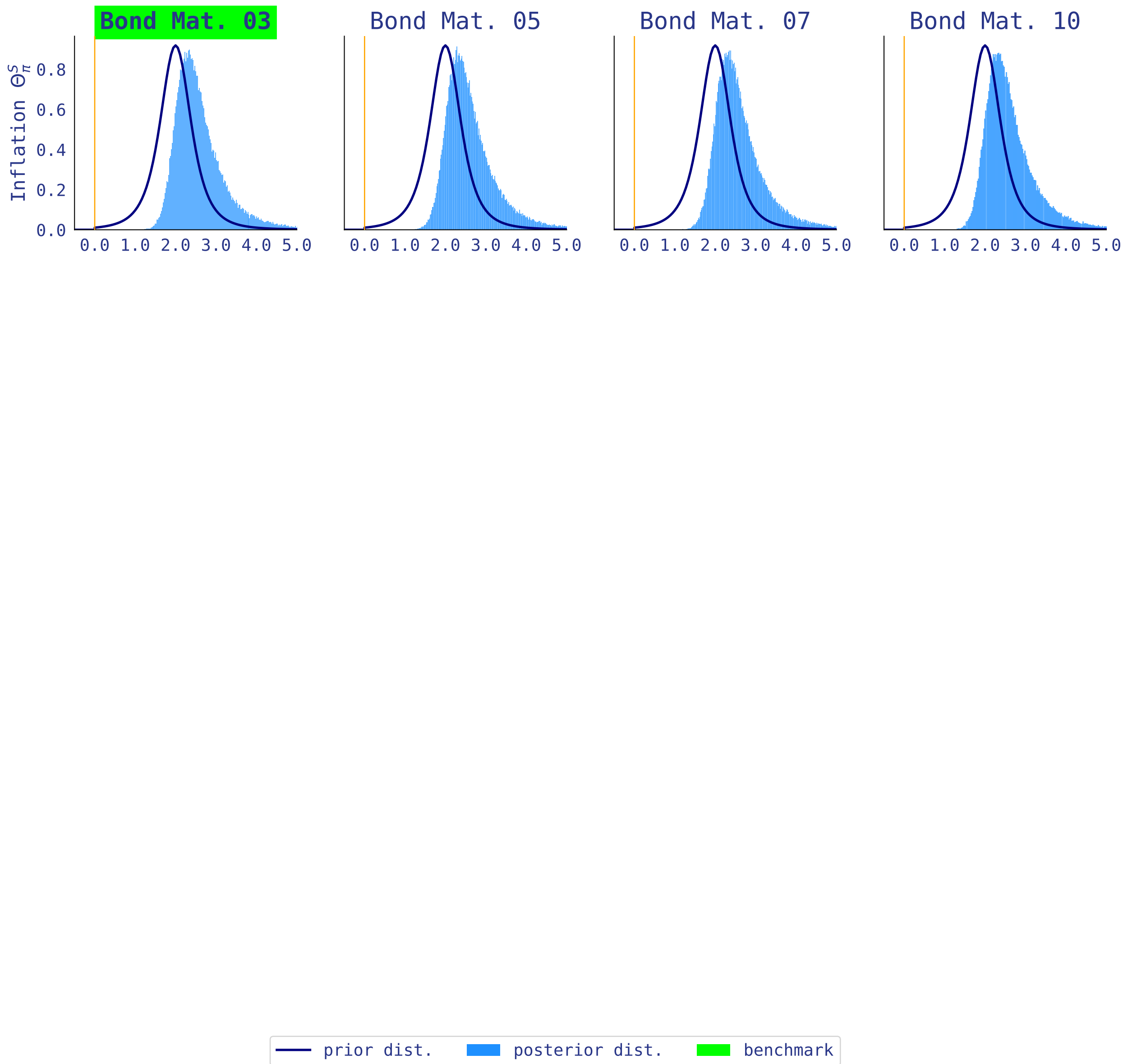
Notes: Robustness check with respect to the structural parameter α that controls the intensity with which a sovereign reacts to increases in the market value of government debt (cf. Cochrane (2022)). For comparison, we include the posterior results from our benchmark specification (green tag).

Figure A9: Rob.Maturity: IRF's Bond Demand (B)



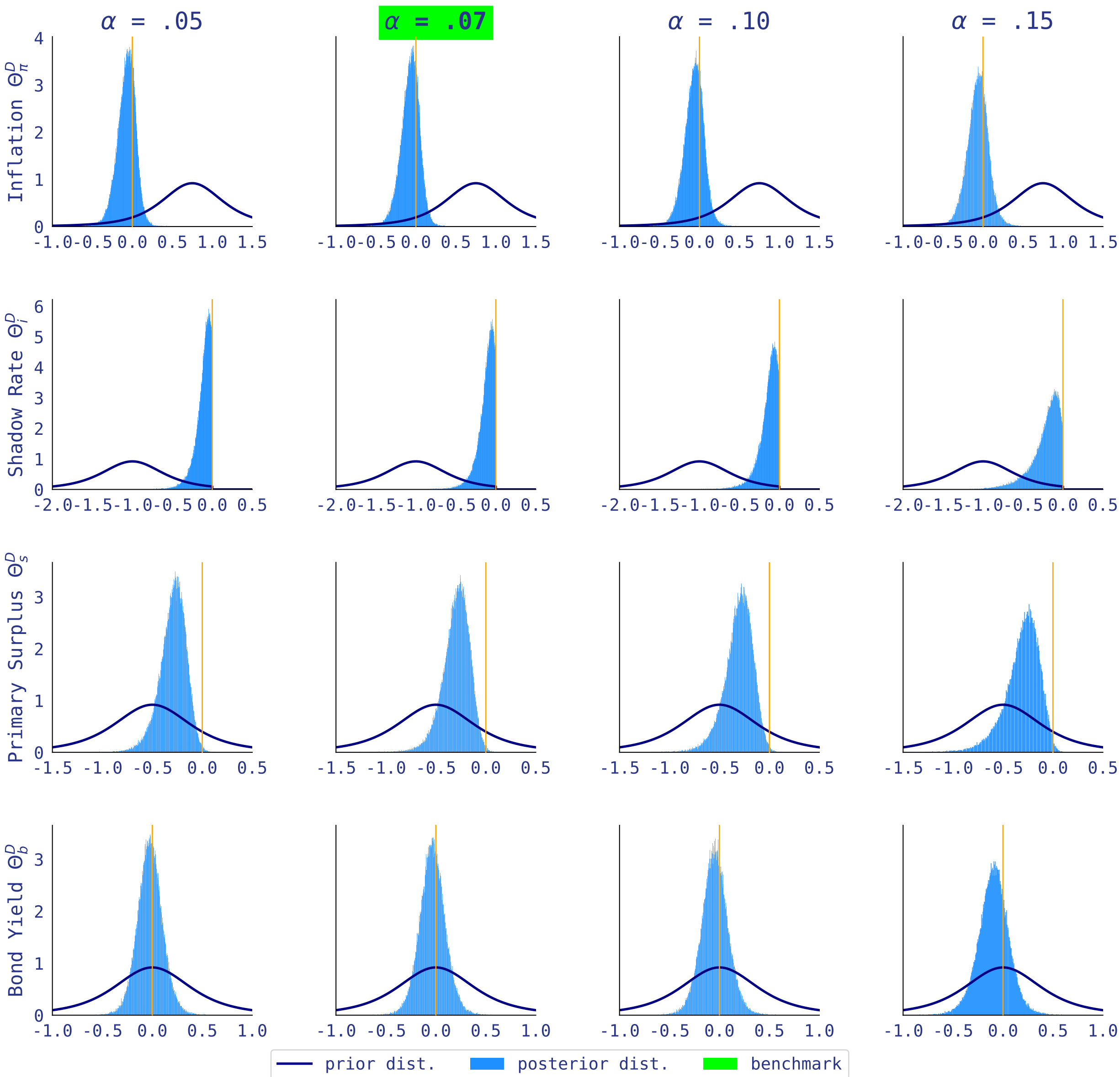
Notes: Bond demand shock: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For comparison, we include the posterior results from our benchmark specification (green tag).

Figure A10: Rob.α: Cont.Effects Aggregate Supply (S)



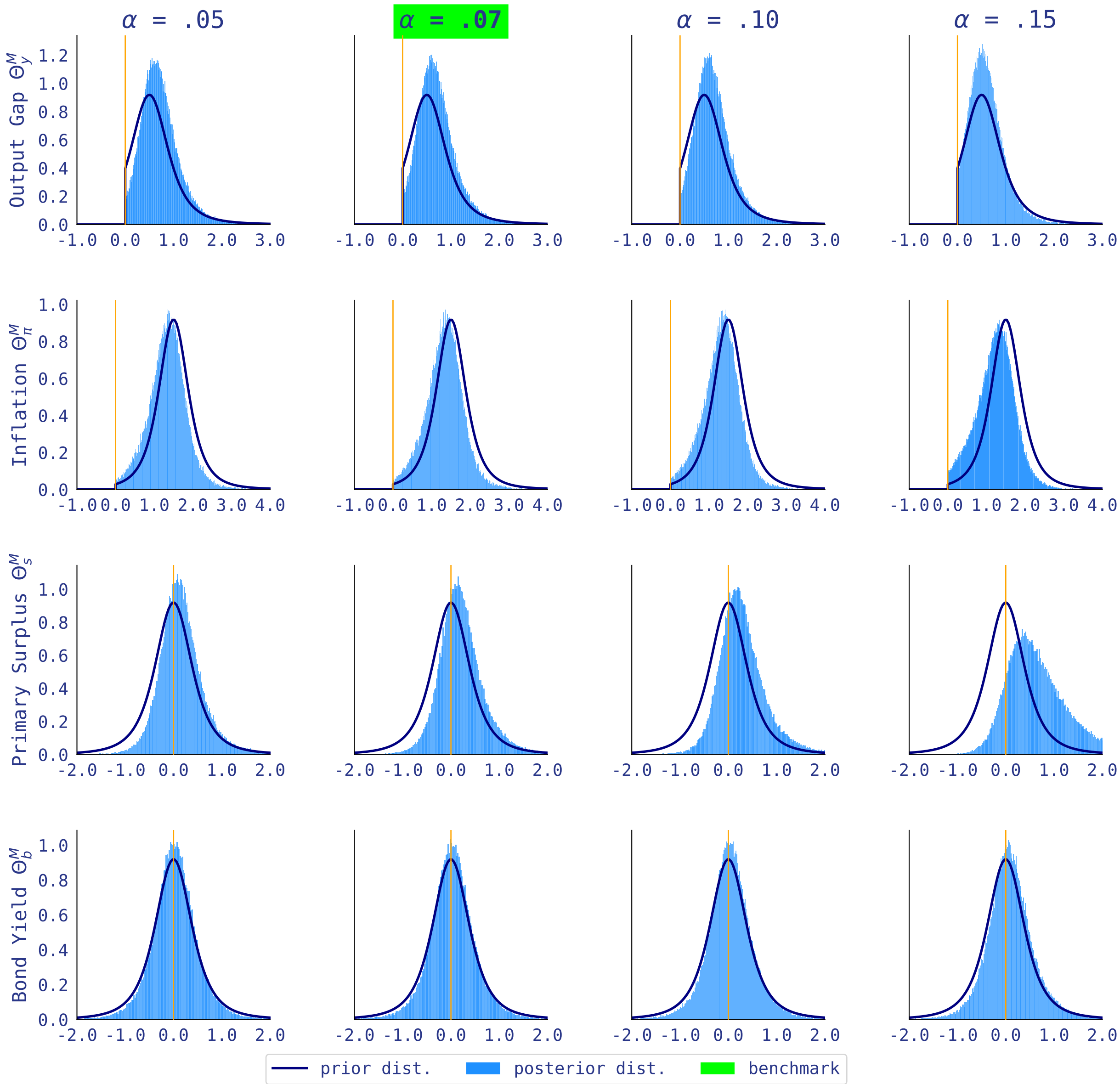
Notes: Contemporaneous effects from equation: $y_t = \Theta_\pi^S \pi_t + \text{lag terms} + u_t^S$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A11: Rob.α: Cont.Effects Aggregate Demand (D)



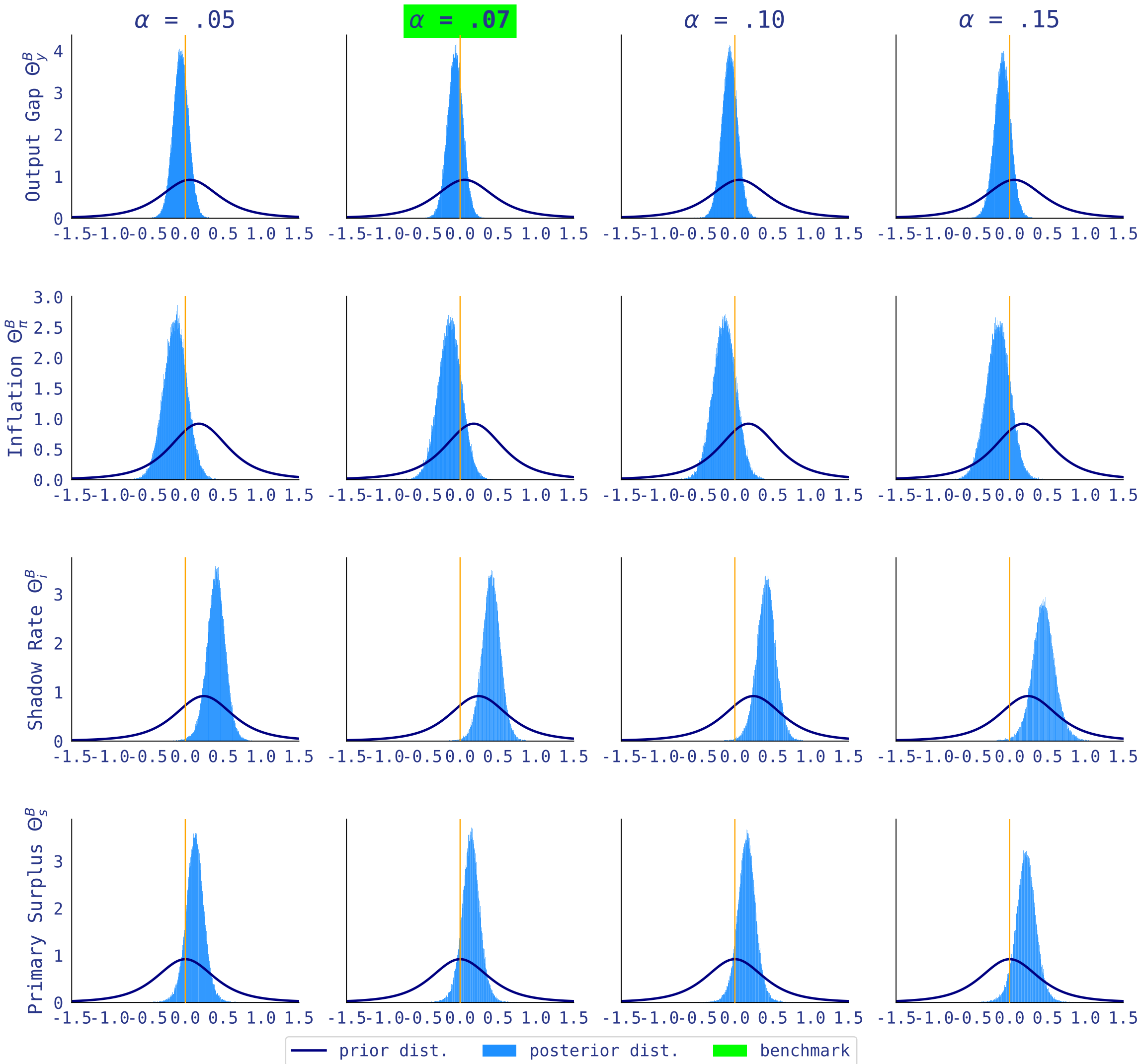
Notes: Contemporaneous effects from equation: $y_t = \Theta_\pi^D \pi_t + \Theta_i^D i_t + \Theta_s^D s_t + \Theta_b^D b_t + \Gamma_y^D y_t^{rea} +$ lag terms $+ u_t^D$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

FIGURE A12: ROB.α: CONT.EFFECTS MONETARY POLICY (M)



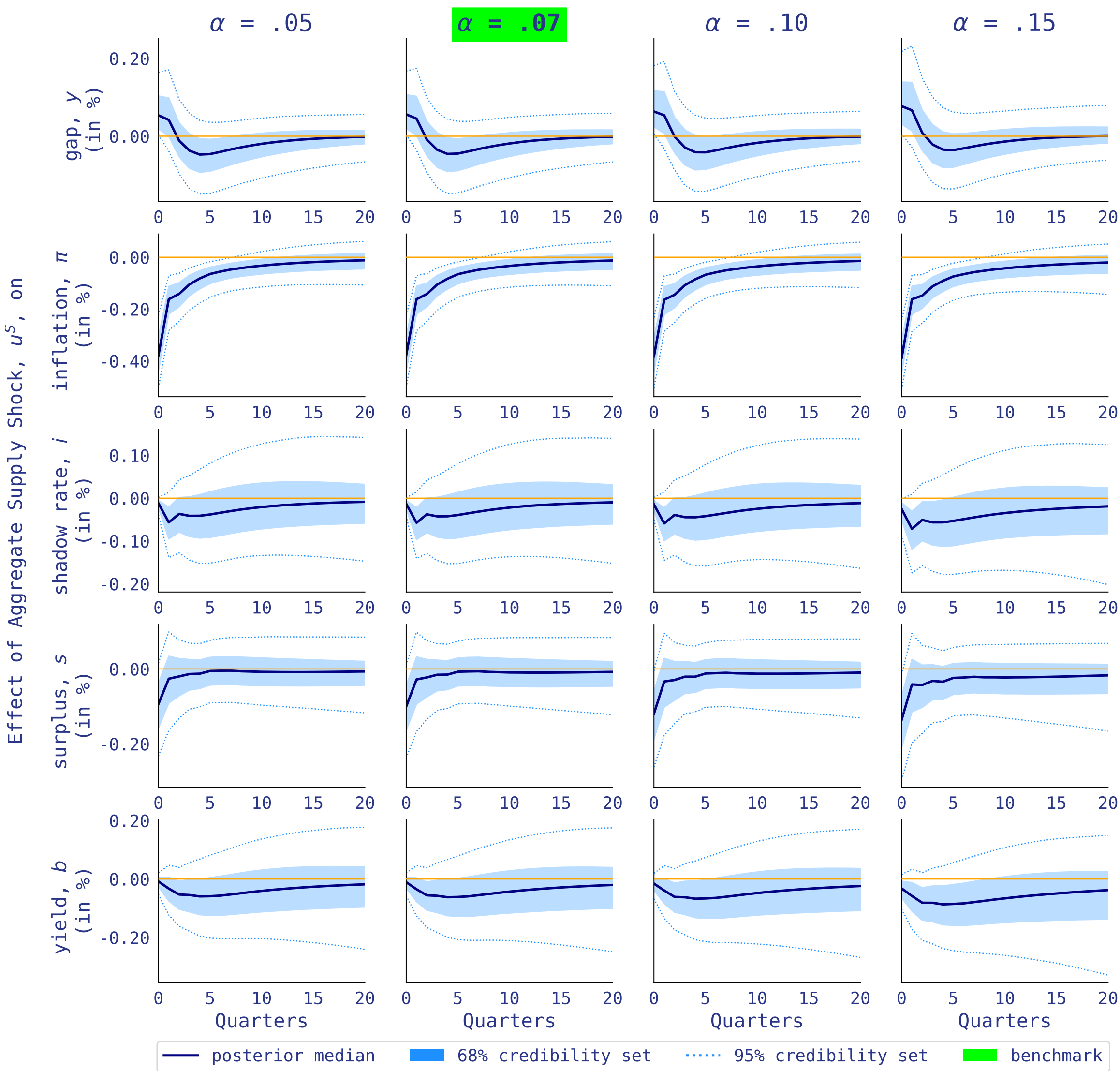
Notes: Contemporaneous effects from equation: $i_t = (1 - \rho)\left[\Theta_y^M\left(\omega y_t + (1-\omega)y_t^{rea}\right) + \Theta_\pi^M\left(\omega \pi_t + (1-\omega)\pi_t^{rea}\right) + \Theta_s^M s_t + \Theta_b^M b_t\right] + \text{lag terms} + u_t^M$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A13: Rob.α: Cont.Effects Bond Demand (B)



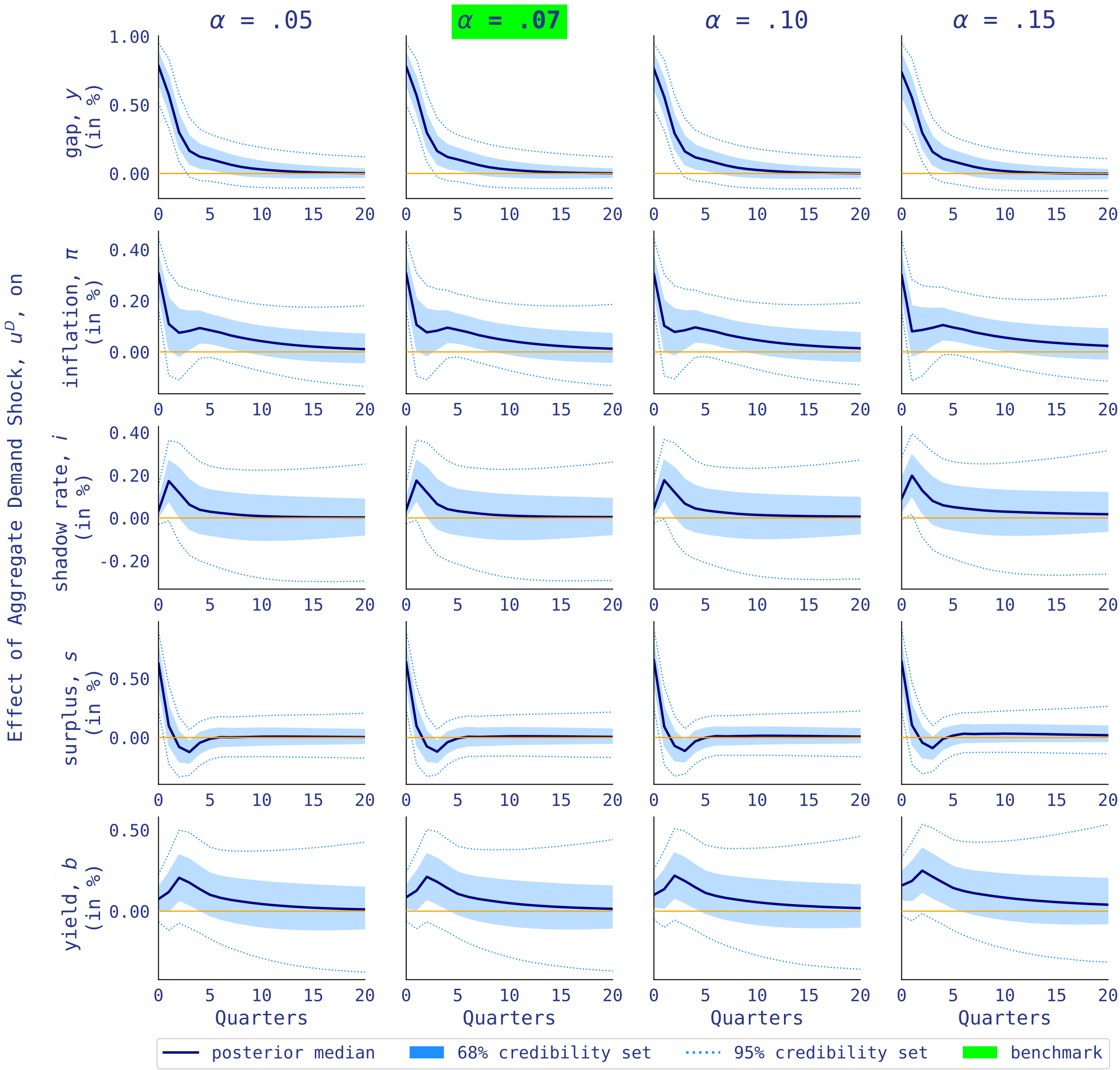
Notes: Contemporaneous effects from equation: $b_t = \Theta_y^B f y_t + \Theta_\pi^B f \pi_t + \Theta_i^B i_t + \Theta_s^B s_t + \left(\Theta_y^B(1-f)y_t^{rea} + \Theta_\pi^B(1-f)\pi_t^{rea}\right) + \left[\mathbf{b}^B\right]' \mathbf{x}_{t-1} + u_t^B$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A14: Rob.α: IRF's Supply (S)



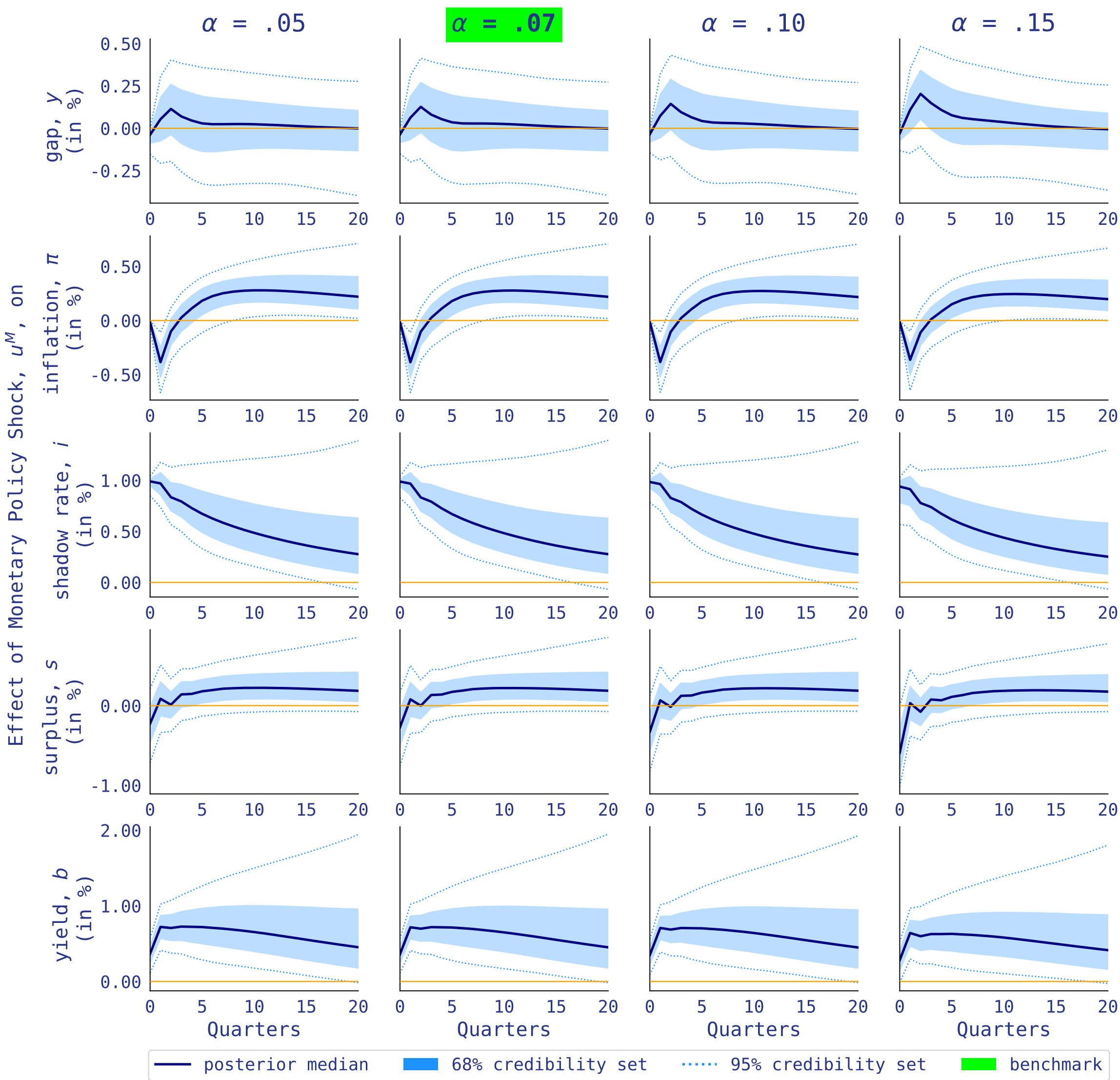
Notes: Supply shock, u^S: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A15: Rob.α: IRF's Demand (D)



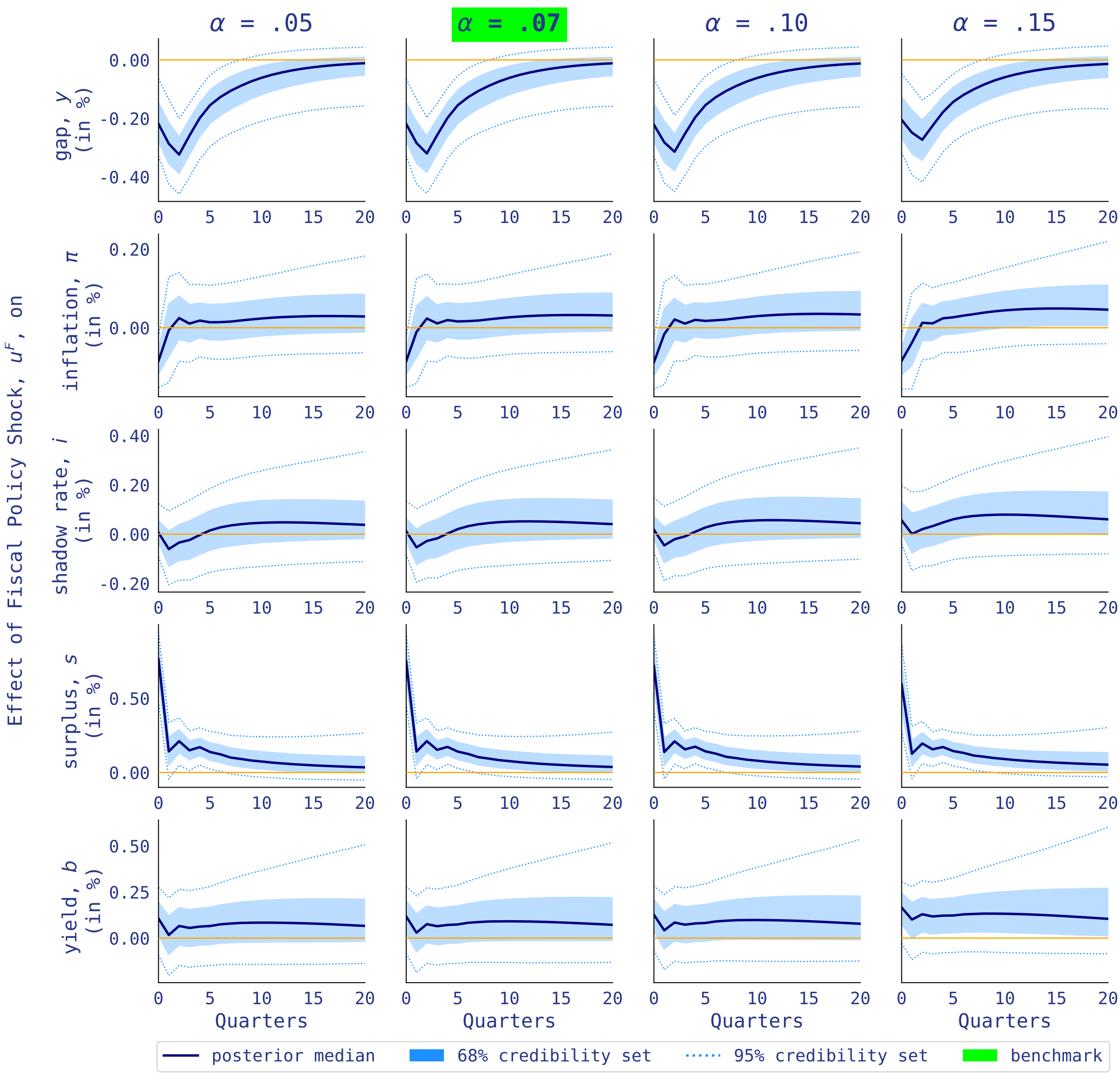
Notes: Demand shock, u^D: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A16: Rob.α: IRF's Monetary Policy (M)



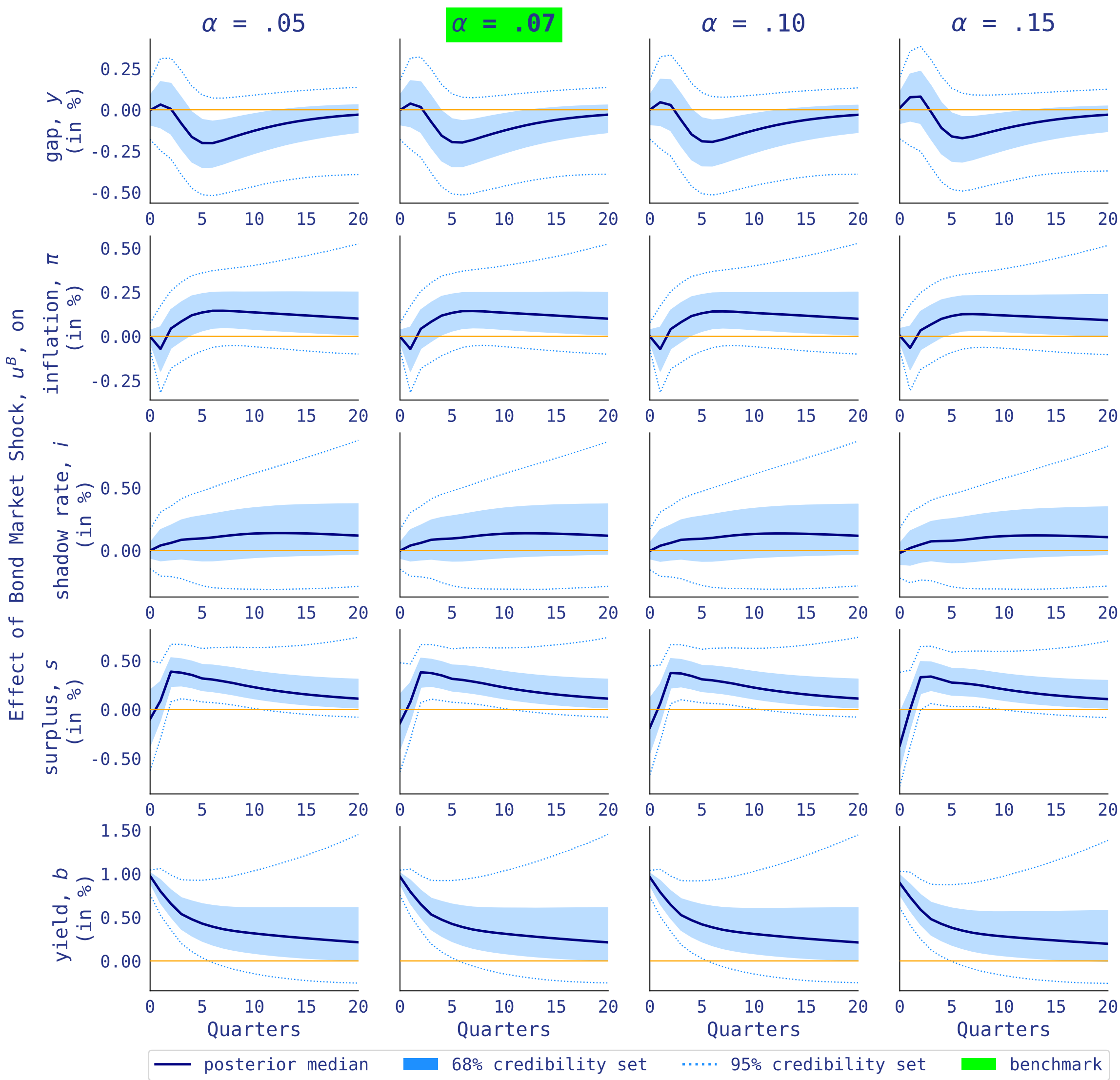
Notes: Monetary policy shock, u^M: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

FIGURE A17: ROB.α: IRF'S FISCAL POLICY (F)



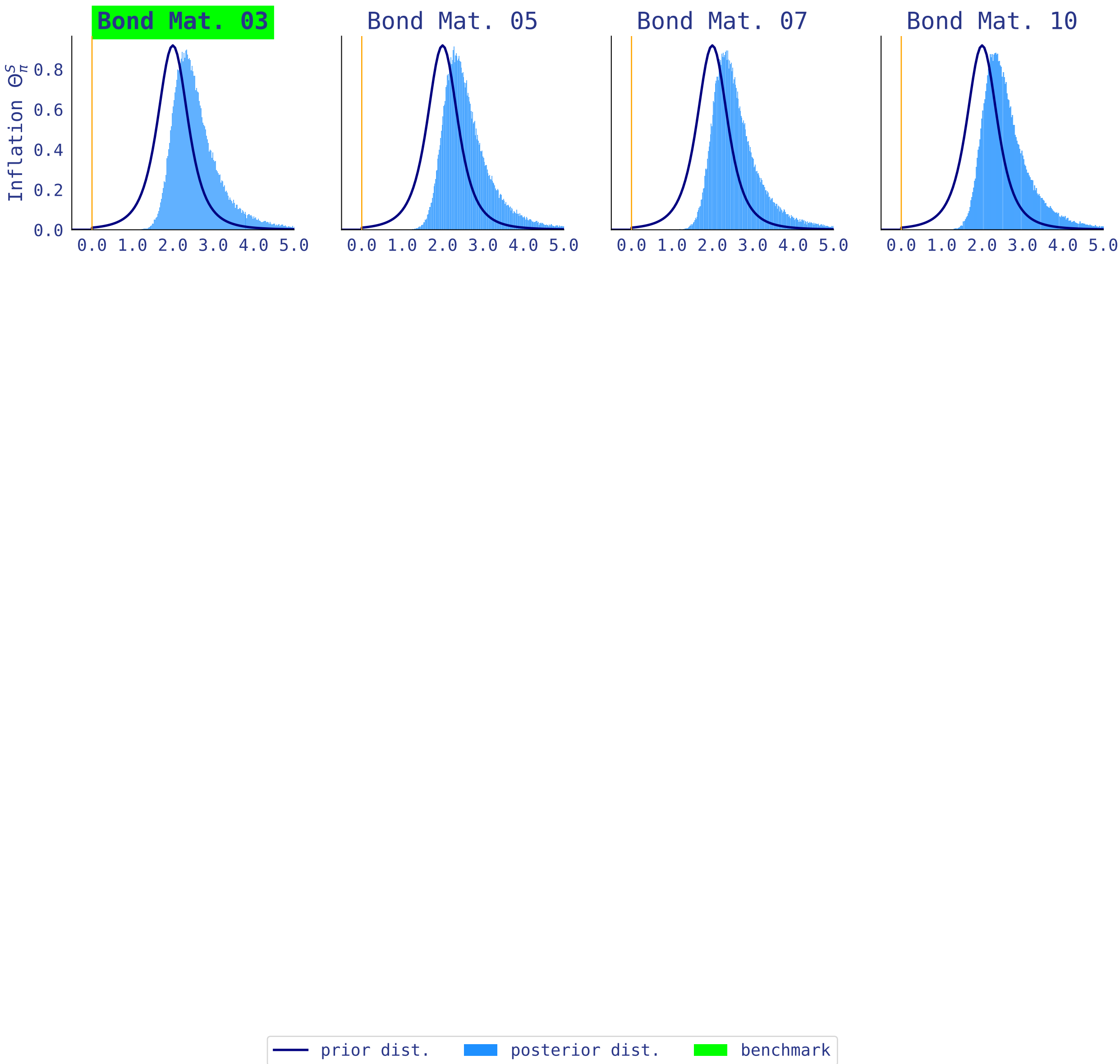
Notes: Fiscal policy shock, u^F: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A18: Rob.α: IRF's Bond Demand (B)



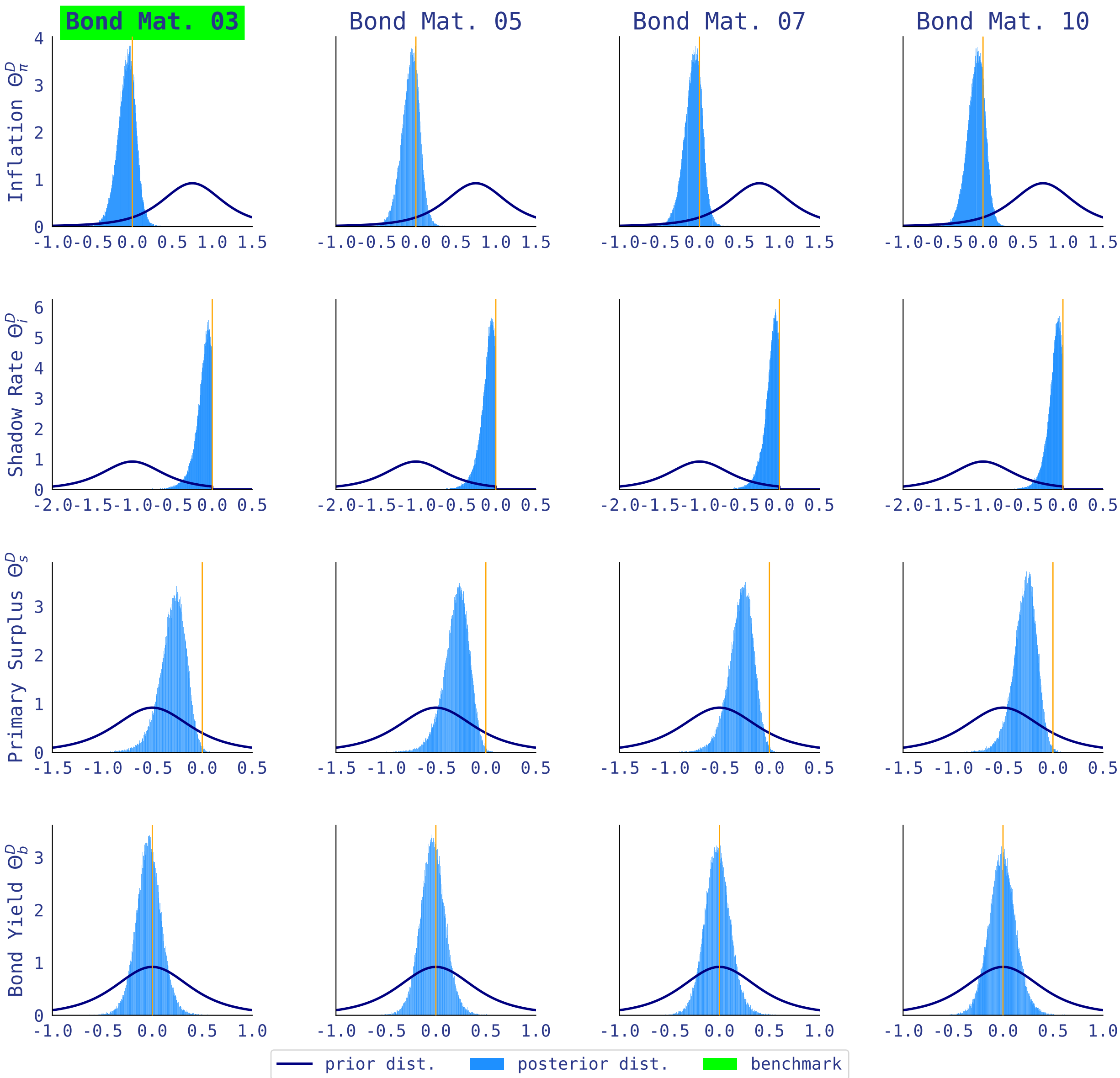
Notes: Bond demand shock, u^B: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A19: Rob.Maturity: Cont.Effects Aggregate Supply (S)



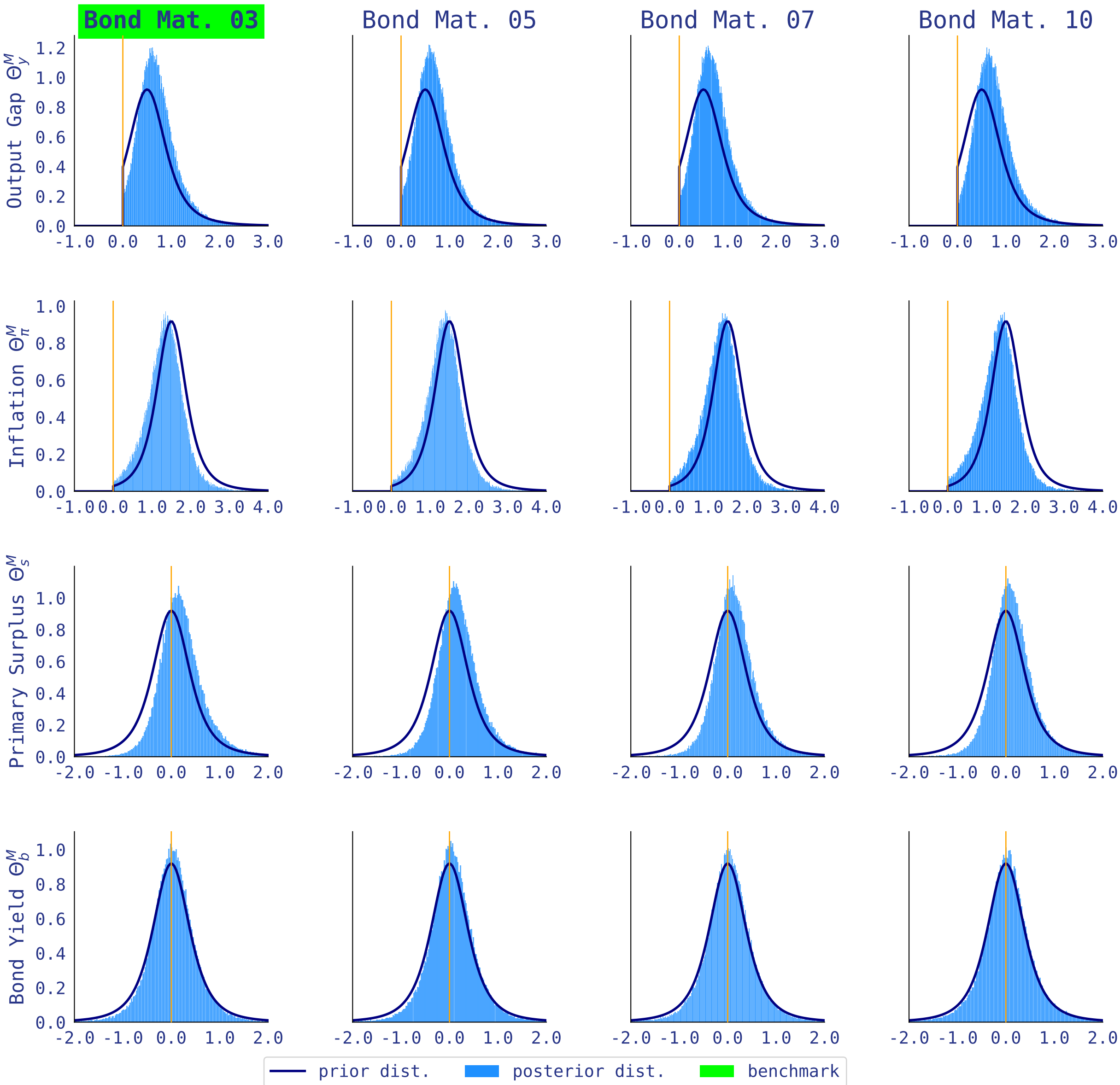
Notes: Contemporaneous effects from equation: $y_t = \Theta_\pi^S \pi_t + \text{lag terms} + u_t^S$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A20: Rob.Maturity: Cont.Effects Aggregate Demand (D)



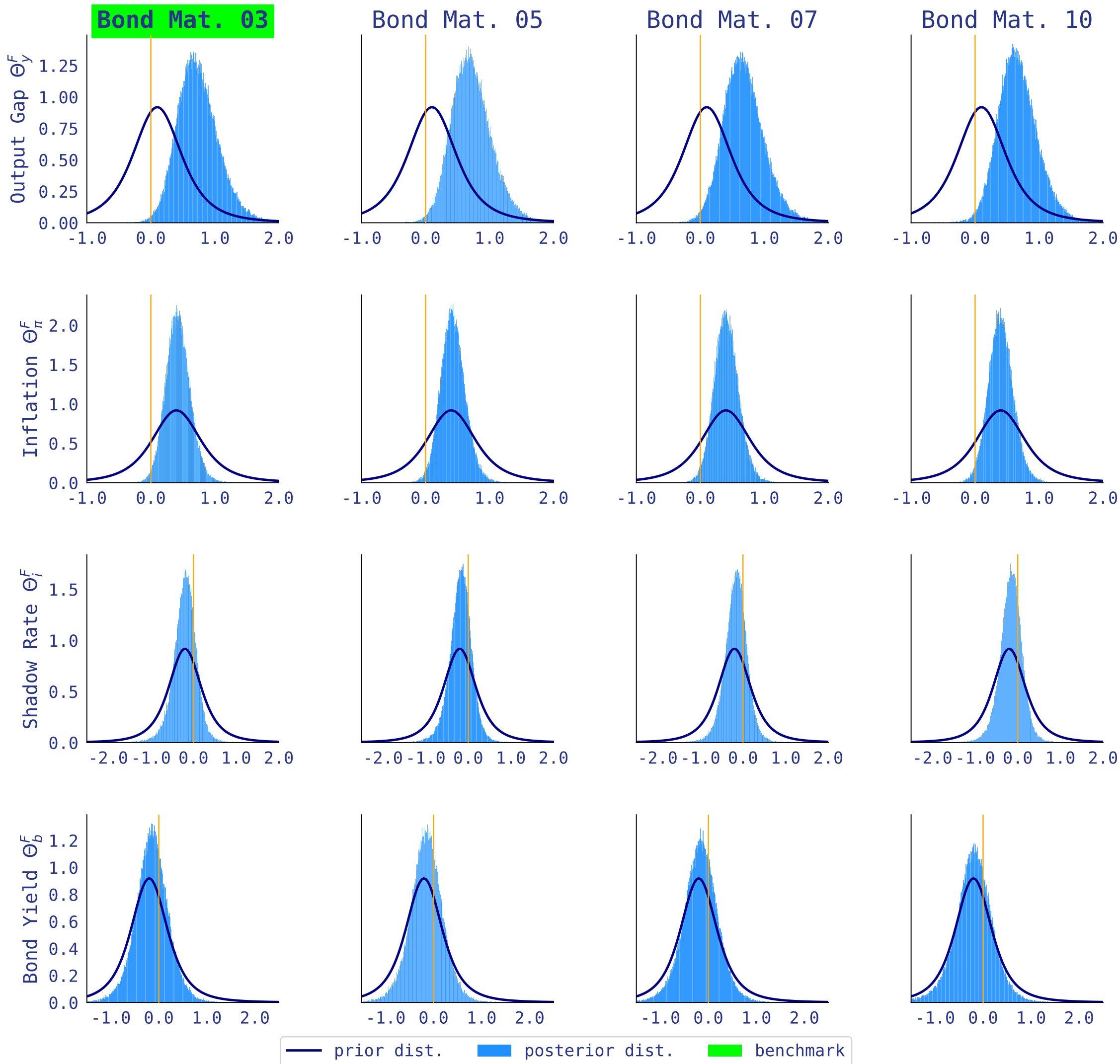
Notes: Contemporaneous effects from equation: $y_t = \Theta_\pi^D \pi_t + \Theta_i^D i_t + \Theta_s^D s_t + \Theta_b^D b_t + \Gamma_y^D y_t^{rea} +$ lag terms $+ u_t^D$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A21: Rob.Maturity: Cont.Effects Monetary Policy (M)



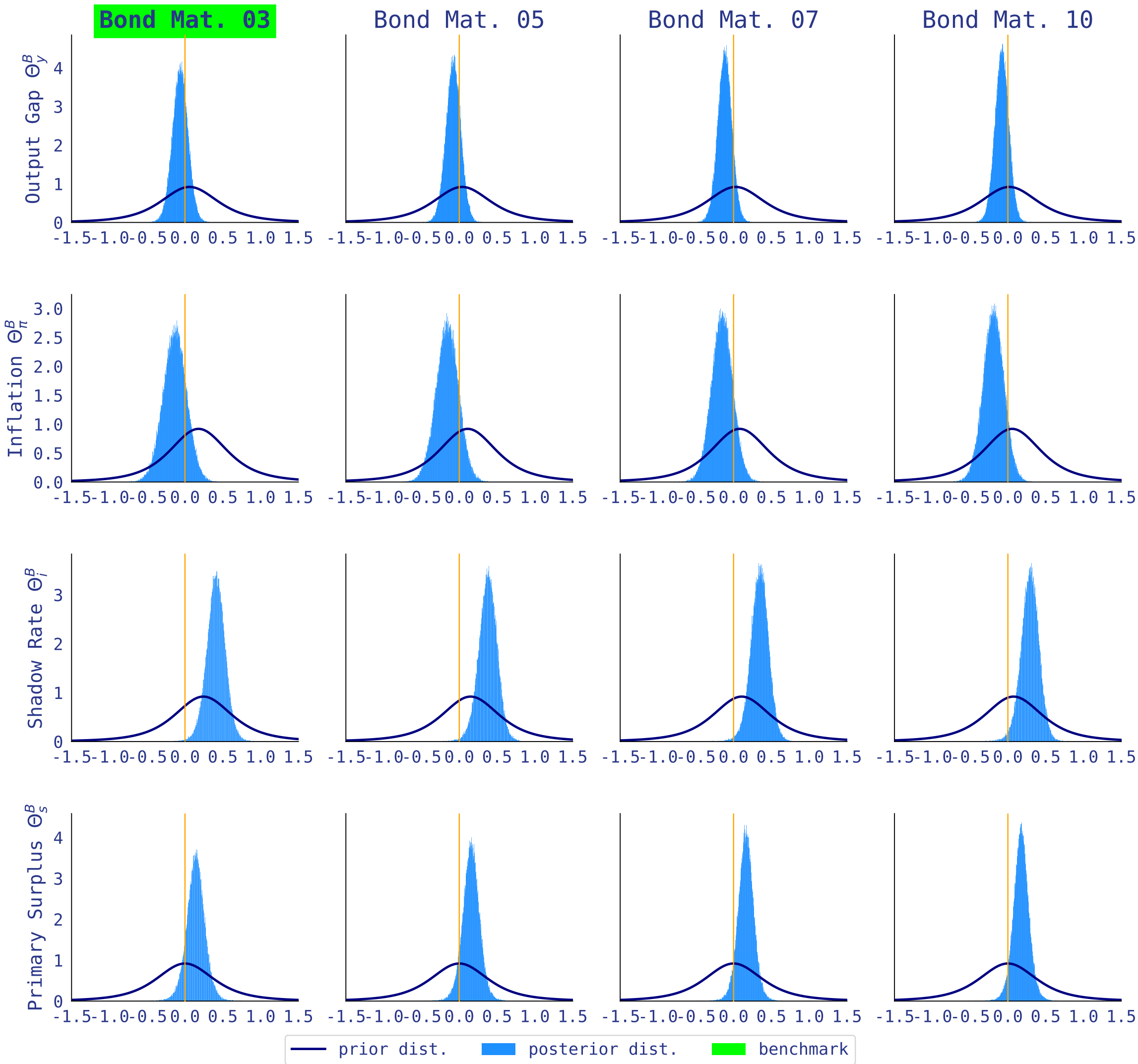
Notes: Contemporaneous effects from equation: $i_t = (1 - \rho)\left[\Theta_y^M\left(\omega y_t + (1-\omega)y_t^{rea}\right) + \Theta_\pi^M\left(\omega\pi_t + (1-\omega)\pi_t^{rea}\right) + \Theta_s^M s_t + \Theta_b^M b_t\right]$ + lag terms + u_t^M. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A22: Rob.Maturity: Cont.Effects Fiscal Policy (F)



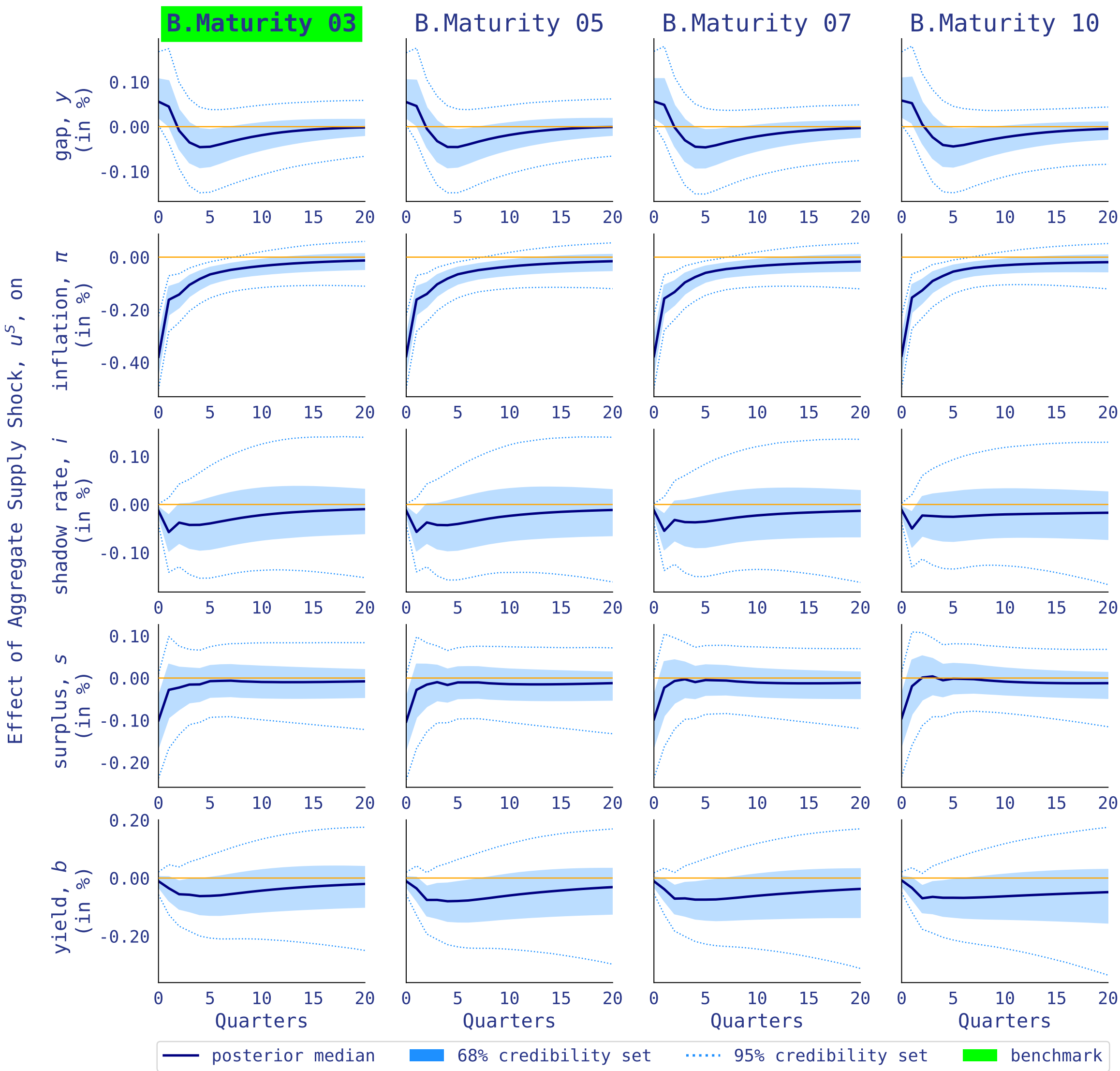
Notes: Contemporaneous effects from equation: $s_t = \Theta_y^F y_t + \Theta_\pi^F \pi_t + \Theta_i^F i_t + \Theta_b^F b_t + \text{lag terms} + u_t^F$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A23: Rob.Maturity: Cont.Effects Bond Demand (B)



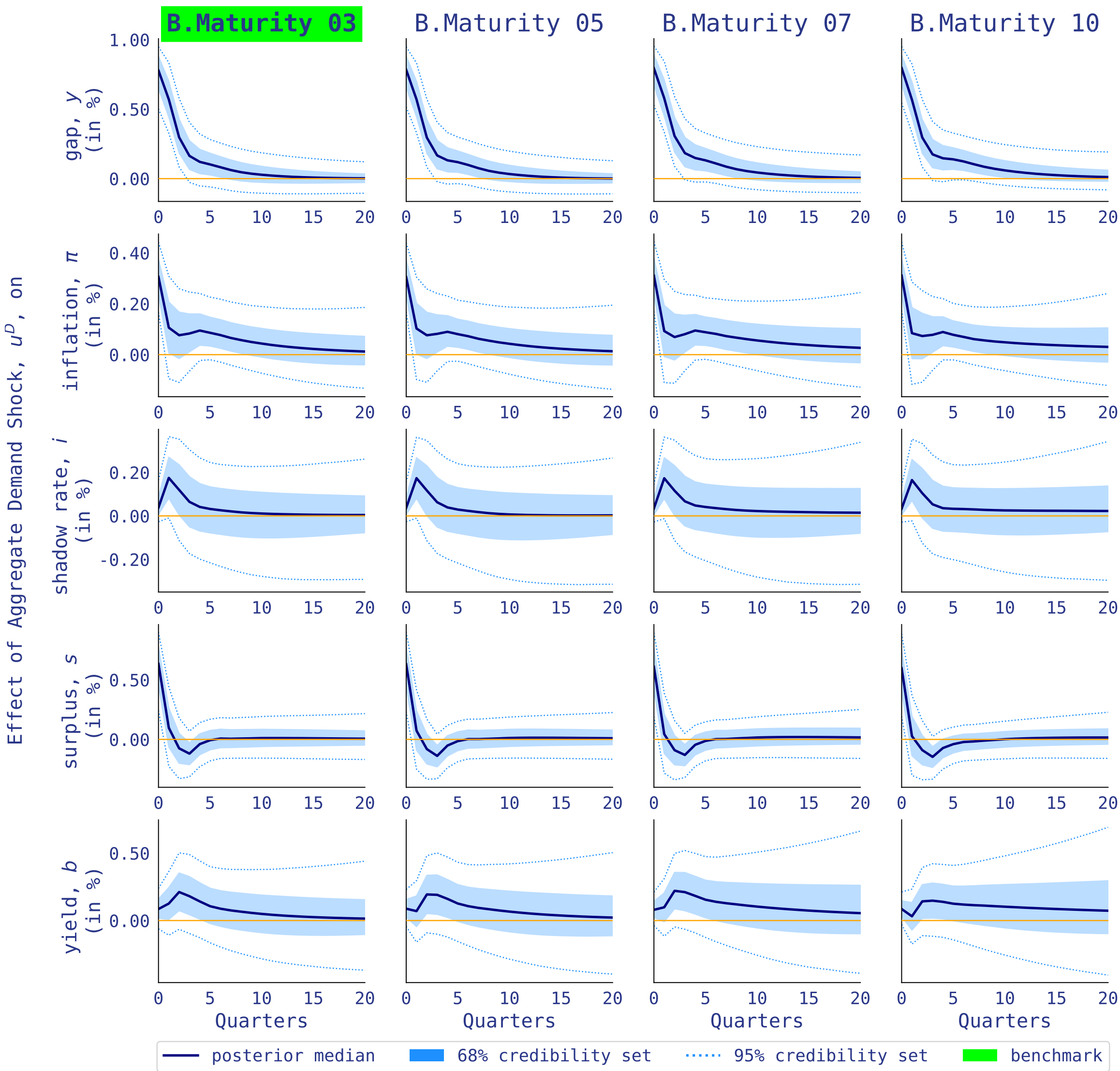
Notes: Contemporaneous effects from equation: $b_t = \Theta_y^B f y_t + \Theta_\pi^B f \pi_t + \Theta_i^B i_t + \Theta_s^B s_t + \left(\Theta_y^B(1-f)y_t^{rea} + \Theta_\pi^B(1-f)\pi_t^{rea}\right) + \left[\mathbf{b}^B\right]' \mathbf{x}_{t-1} + u_t^B$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A24: Rob.Maturity: IRF's Supply (S)



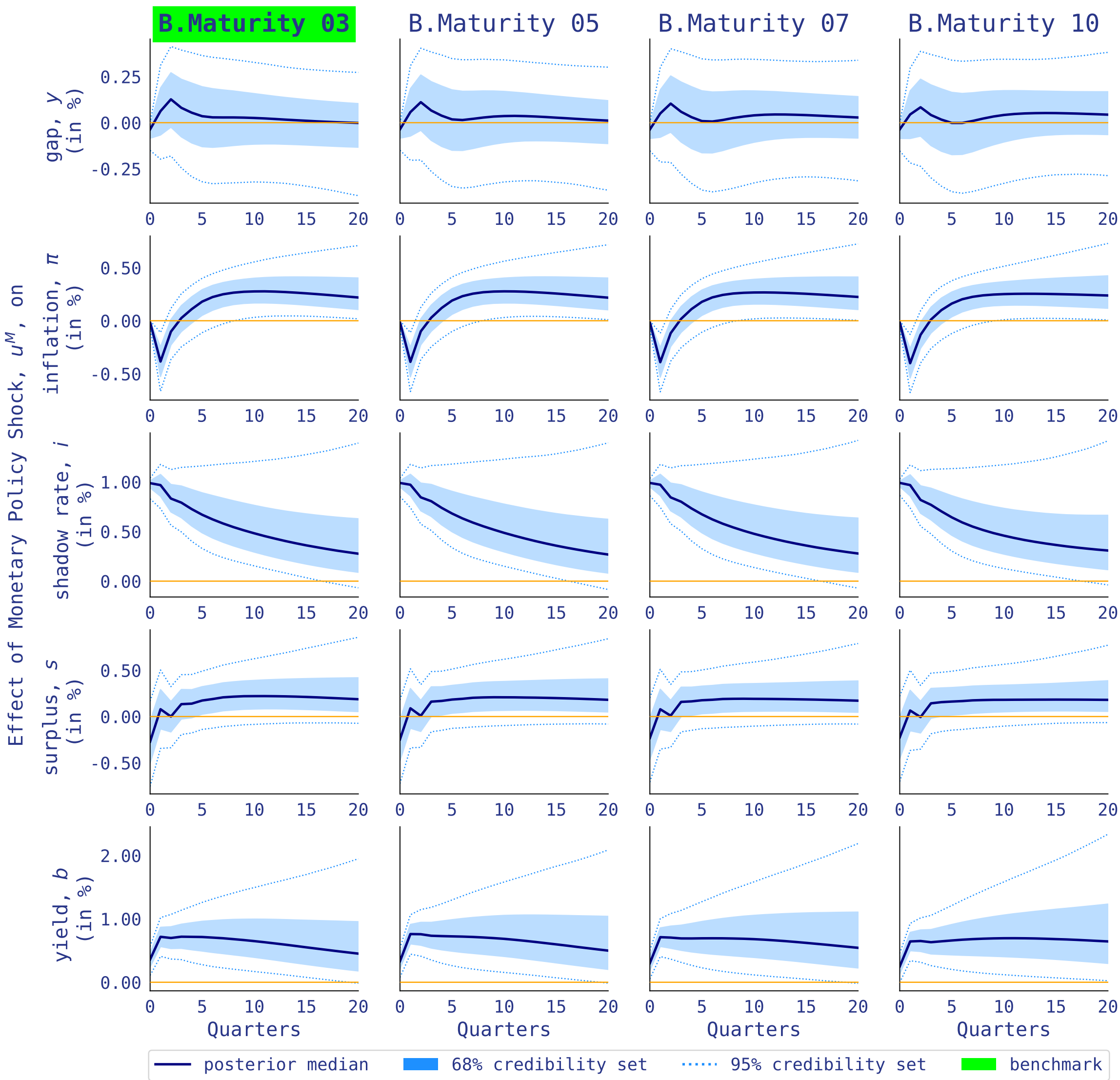
Notes: Supply shock, u^S: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A25: Rob.Maturity: IRF's Demand (D)



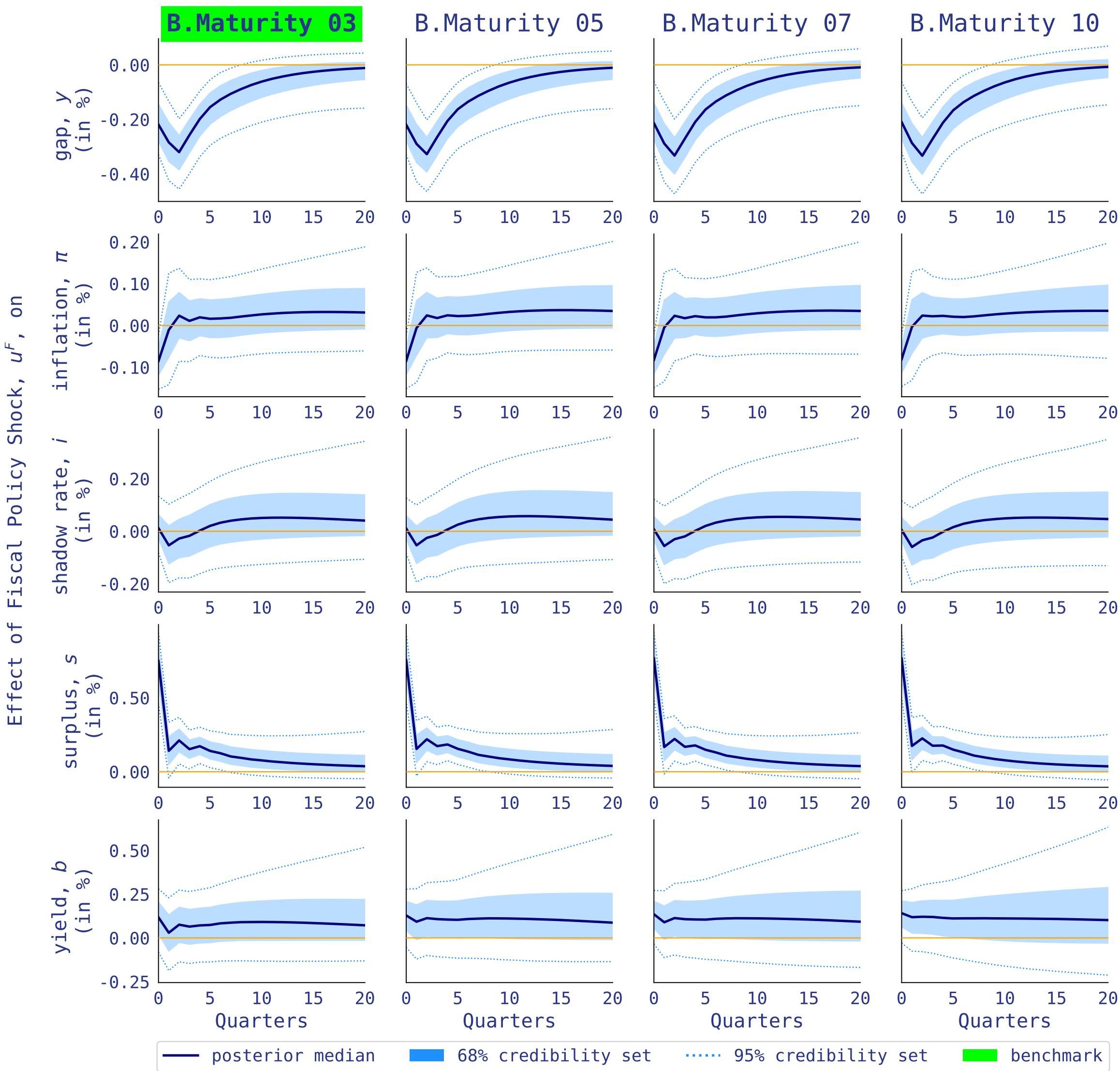
Notes: Demand shock, u^D: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A26: Rob.Maturity: IRF's Monetary Policy (M)



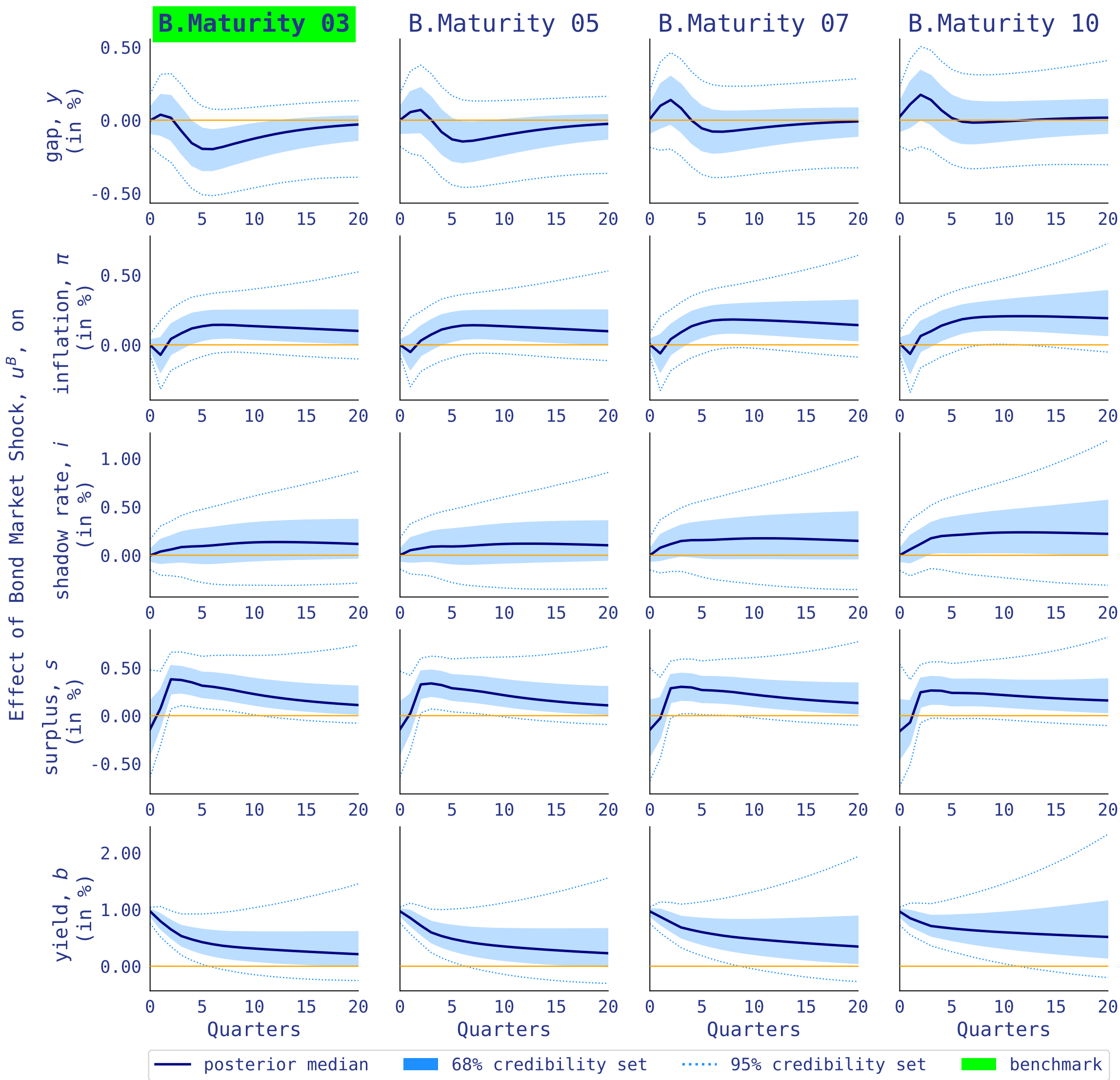
Notes: Monetary policy shock, u^M: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A27: Rob.Maturity: IRF's Fiscal Policy (F)



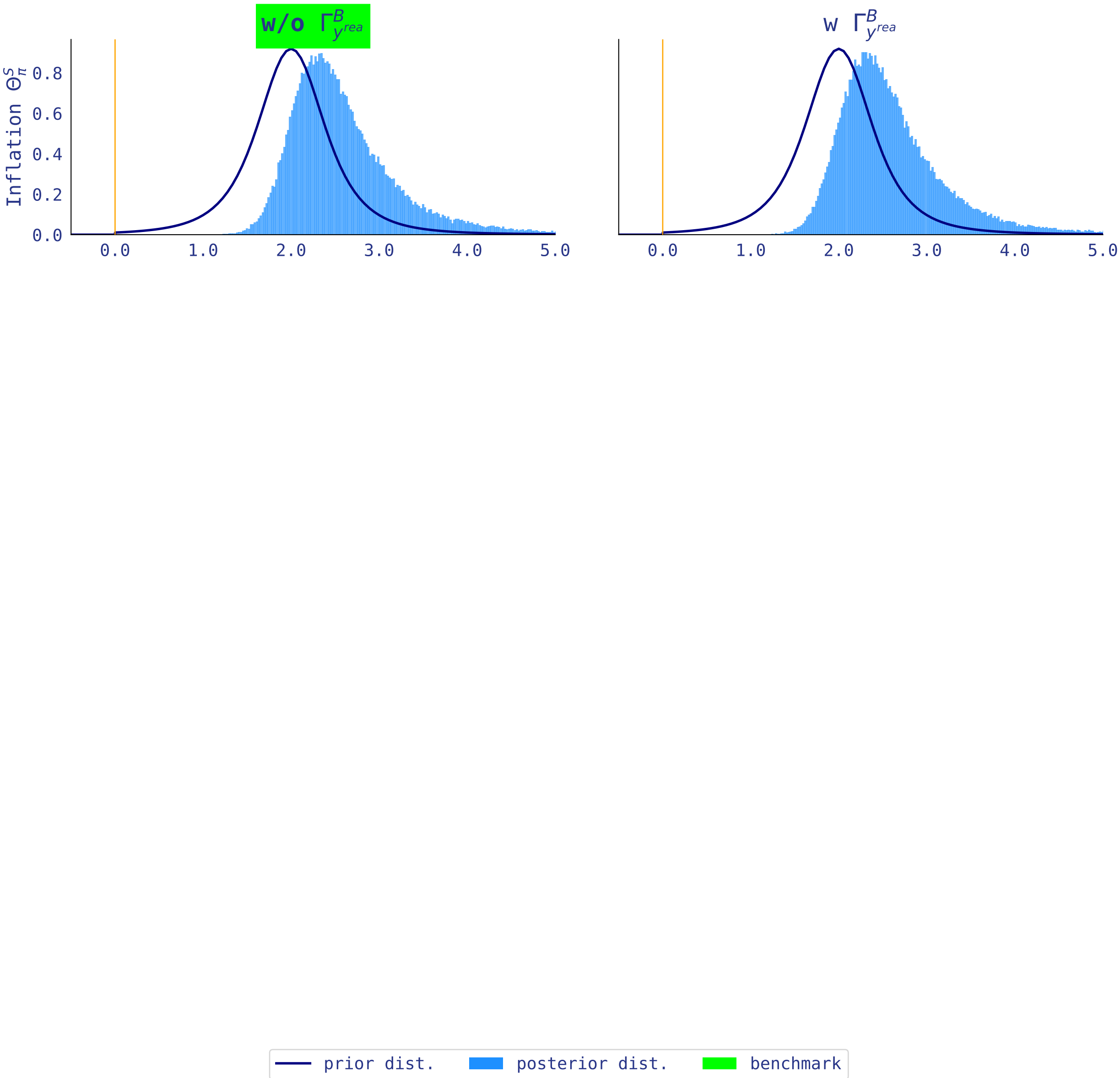
Notes: Fiscal policy shock, u^F: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

FIGURE A28: ROB.MATURITY: IRF'S BOND DEMAND (B)



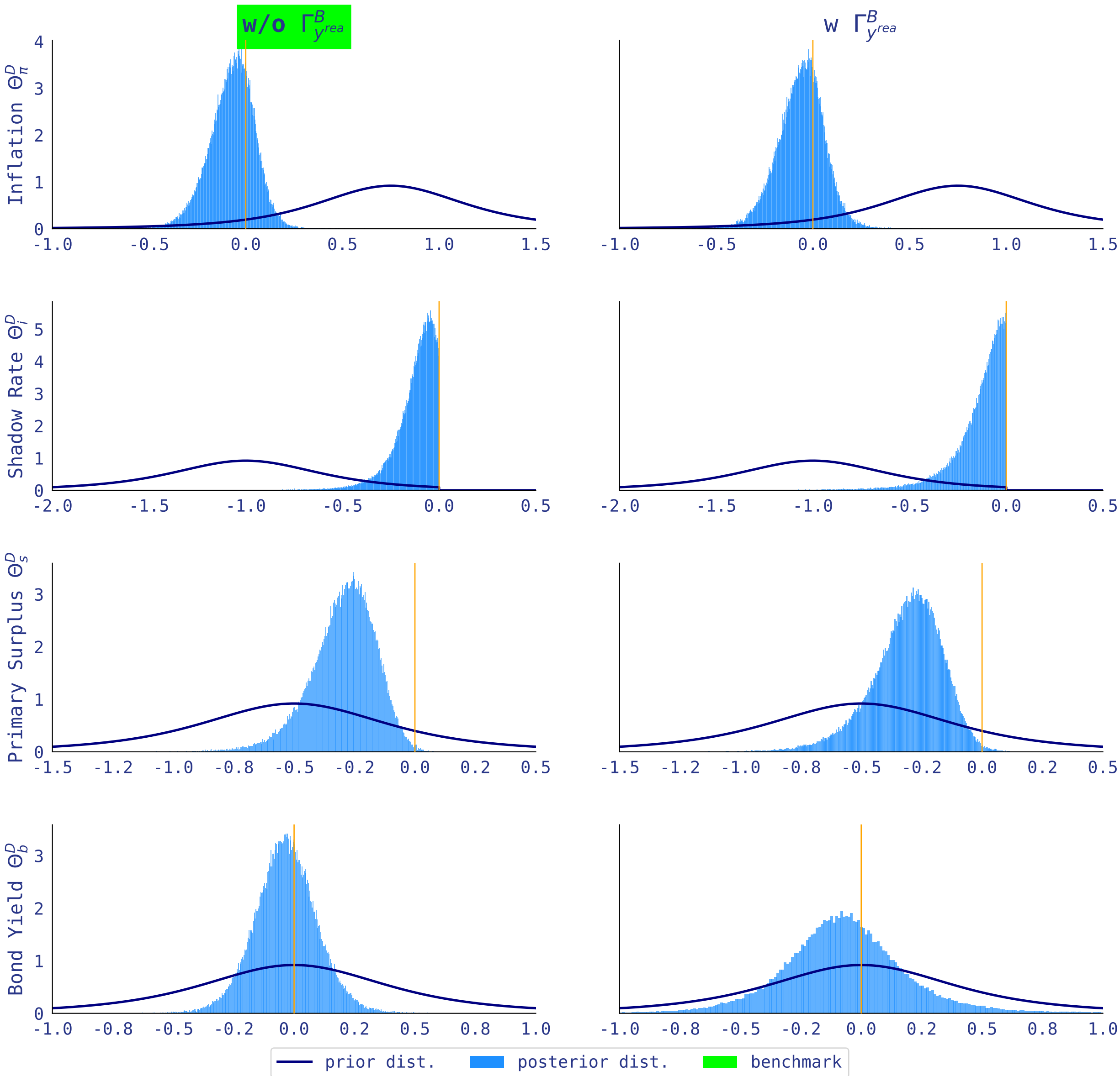
Notes: Bond demand shock, u^B: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A29: Rob.BondDemand: Cont.Effects Aggregate Supply (S)



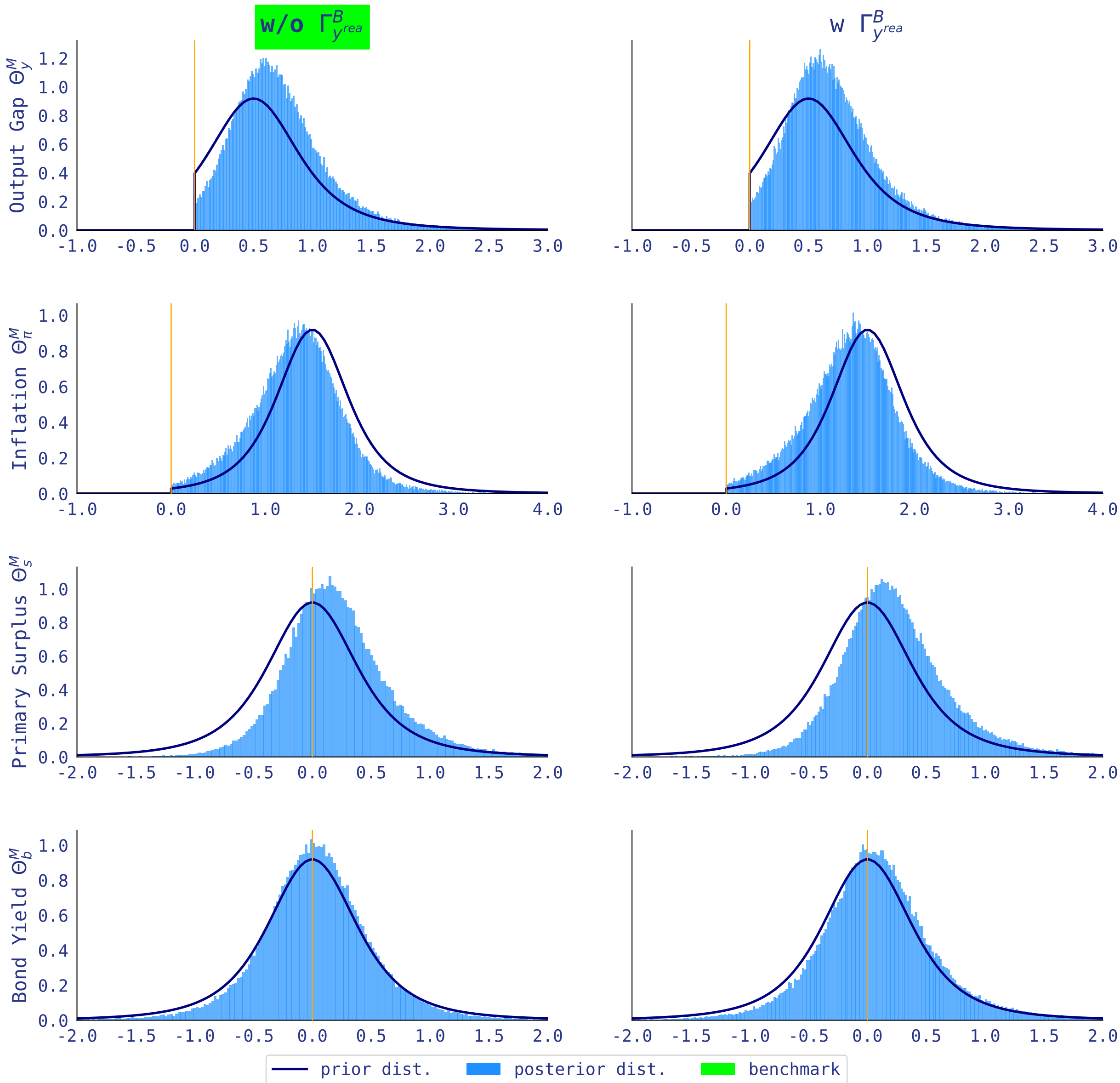
Notes: ontemporaneous effects from equation: $y_t = \Theta^{S}_{\pi}\pi_t$+lag terms+$u^{S}_{t}$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

FIGURE A30: ROB.BONDDEMAND: CONT.EFFECTS AGGREGATE DEMAND (D)



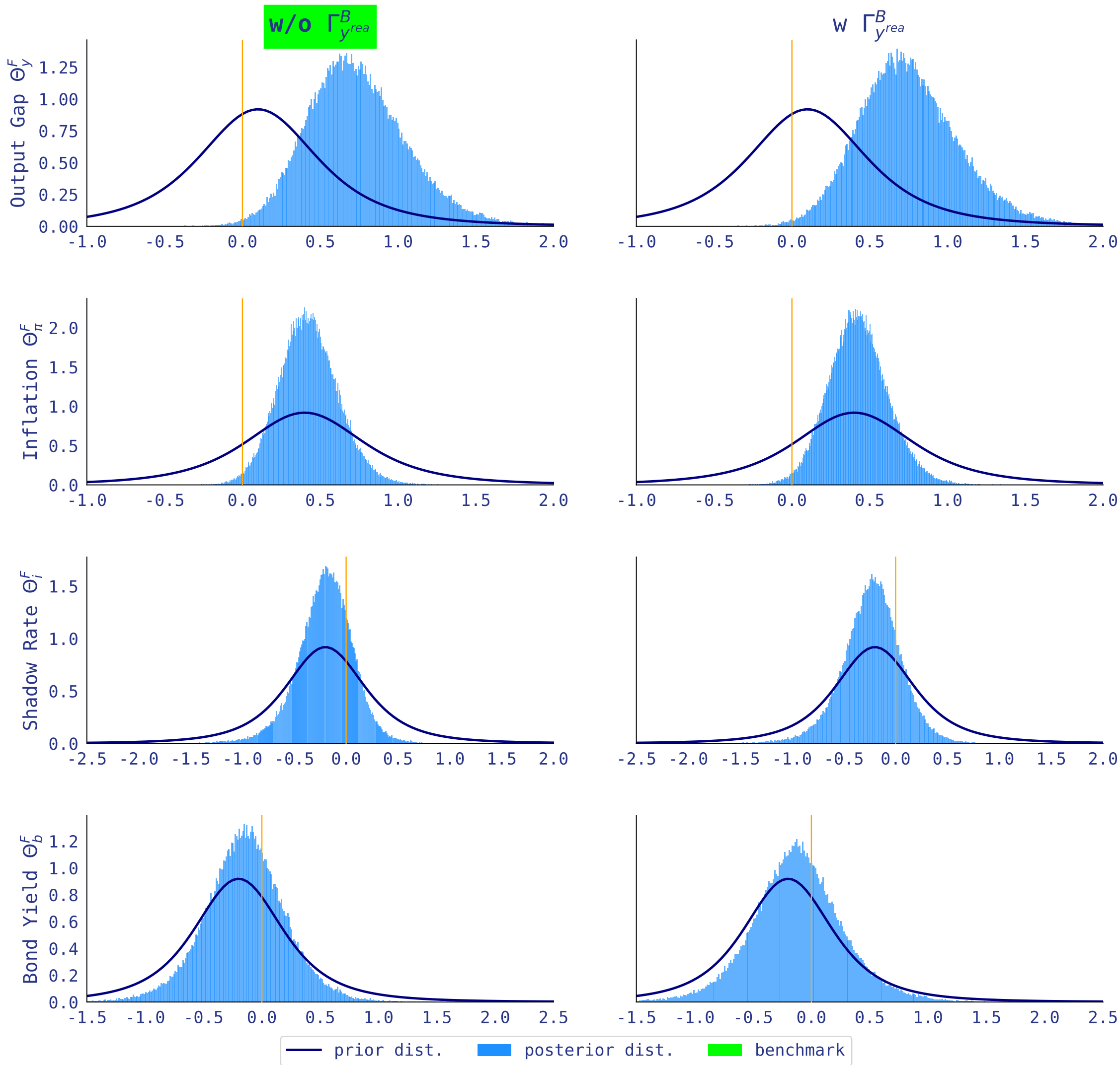
Notes: Contemporaneous effects from equation: $y_t = \Theta^D_\pi \pi_t + \Theta^D_i i_t + \Theta^D_s s_t + \Theta^D_b b_t + \Gamma^D_y y^{rea}_t +$ lag terms $+ u^D_t$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

FIGURE A31: ROB.BONDDEMAND: CONT.EFFECTS MONETARY POLICY (M)



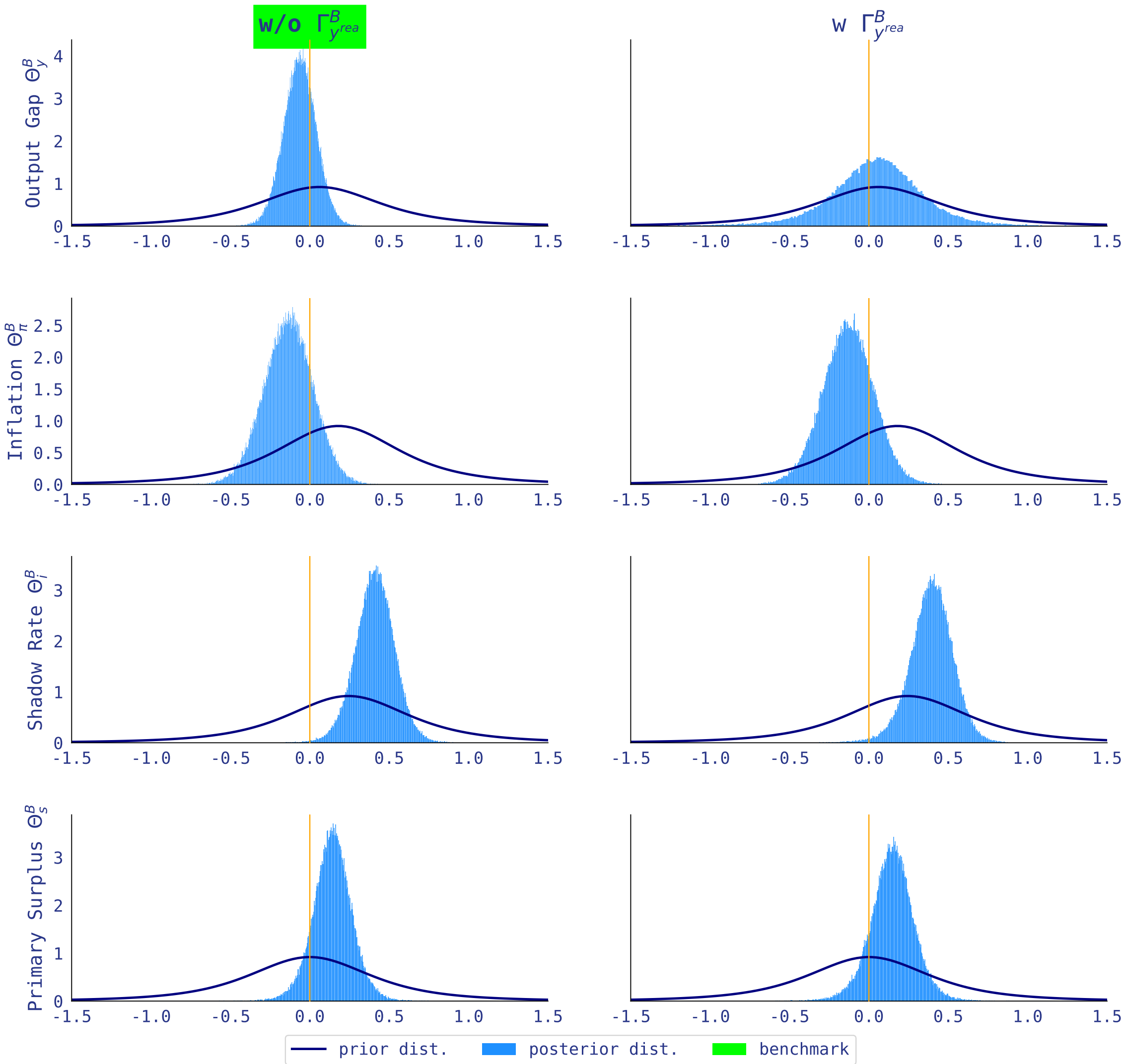
Notes: Contemporaneous effects from equation: $i_t = (1 - \rho)\left[\Theta^M_y\left(\omega y_t + (1-\omega)y^{rea}_t\right) + \Theta^M_\pi\left(\omega\pi_t + (1-\omega)\pi^{rea}_t\right) + \Theta^M_s s_t + \Theta^M_b b_t\right]$ + lag terms + u^M_t. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A32: Rob.BondDemand: Cont.Effects Fiscal Policy (F)



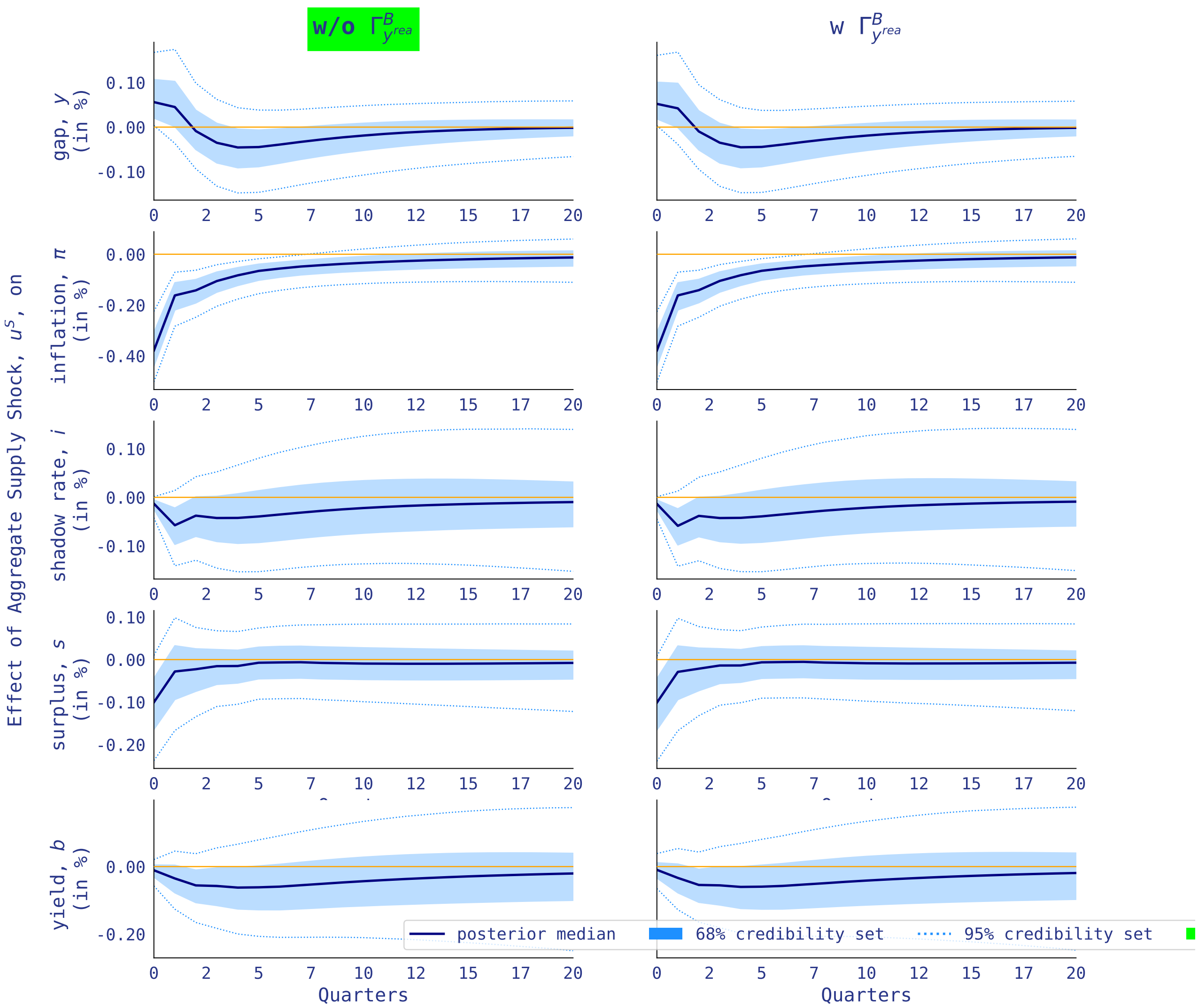
Notes: Contemporaneous effects from equation: $s_t = \Theta^F_y y_t + \Theta^F_\pi \pi_t + \Theta^F_i i_t + \Theta^F_b b_t + \text{lag terms} + u^F_t$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A33: Rob.BondDemand: Cont.Effects Bond Demand (B)



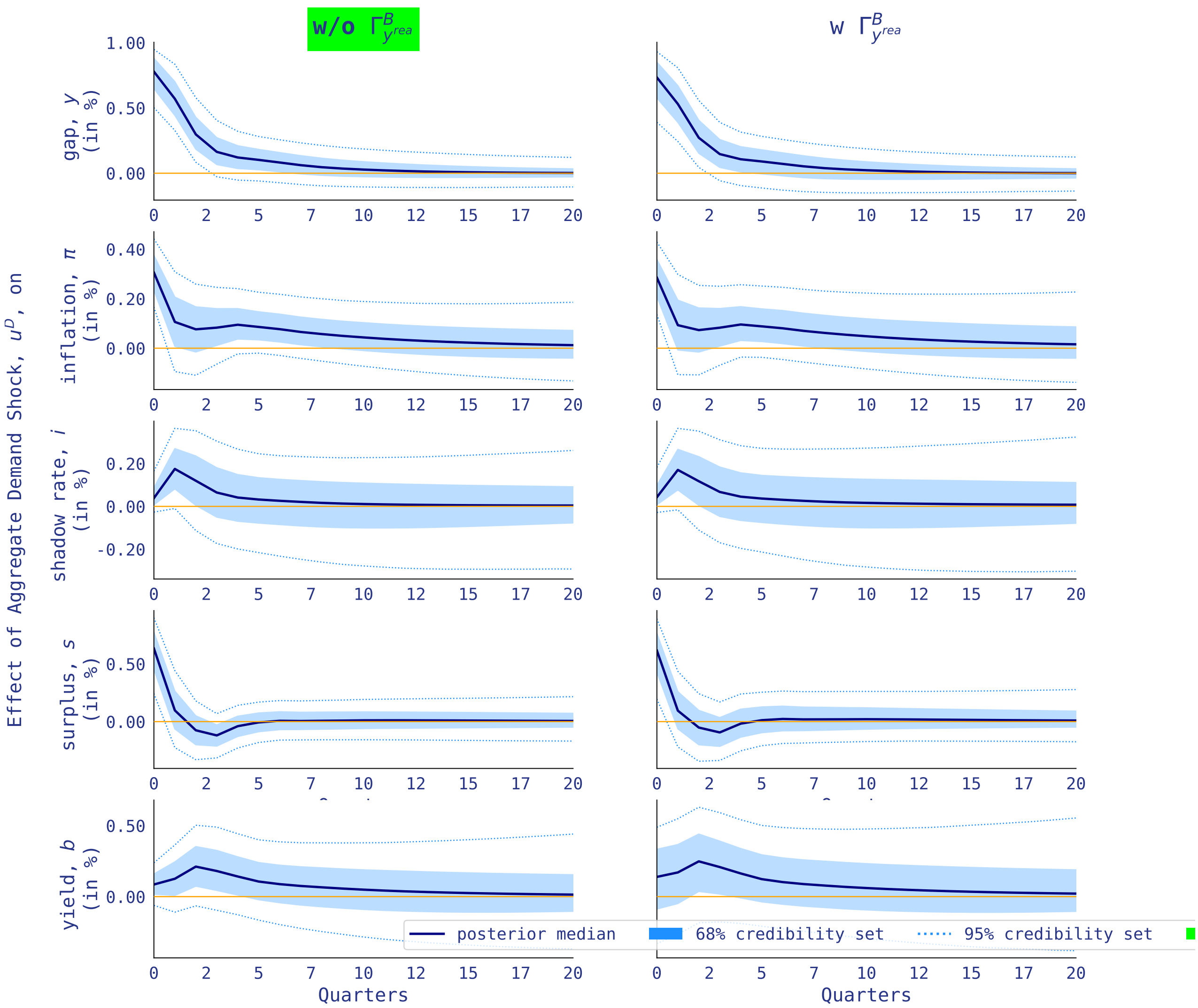
Notes: Contemporaneous effects from equation: $b_t = \Theta^B_y y_t + \Gamma^B_{y^{rea}} y^{rea}_t + \Theta^B_\pi (\omega \pi_t + (1-\omega)\pi^{rea}_t) + \Theta^B_i i_t + \Theta^B_s s_t + \text{lag terms} + u^B_t$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A34: Rob.BondDemand: IRF's Supply (S)



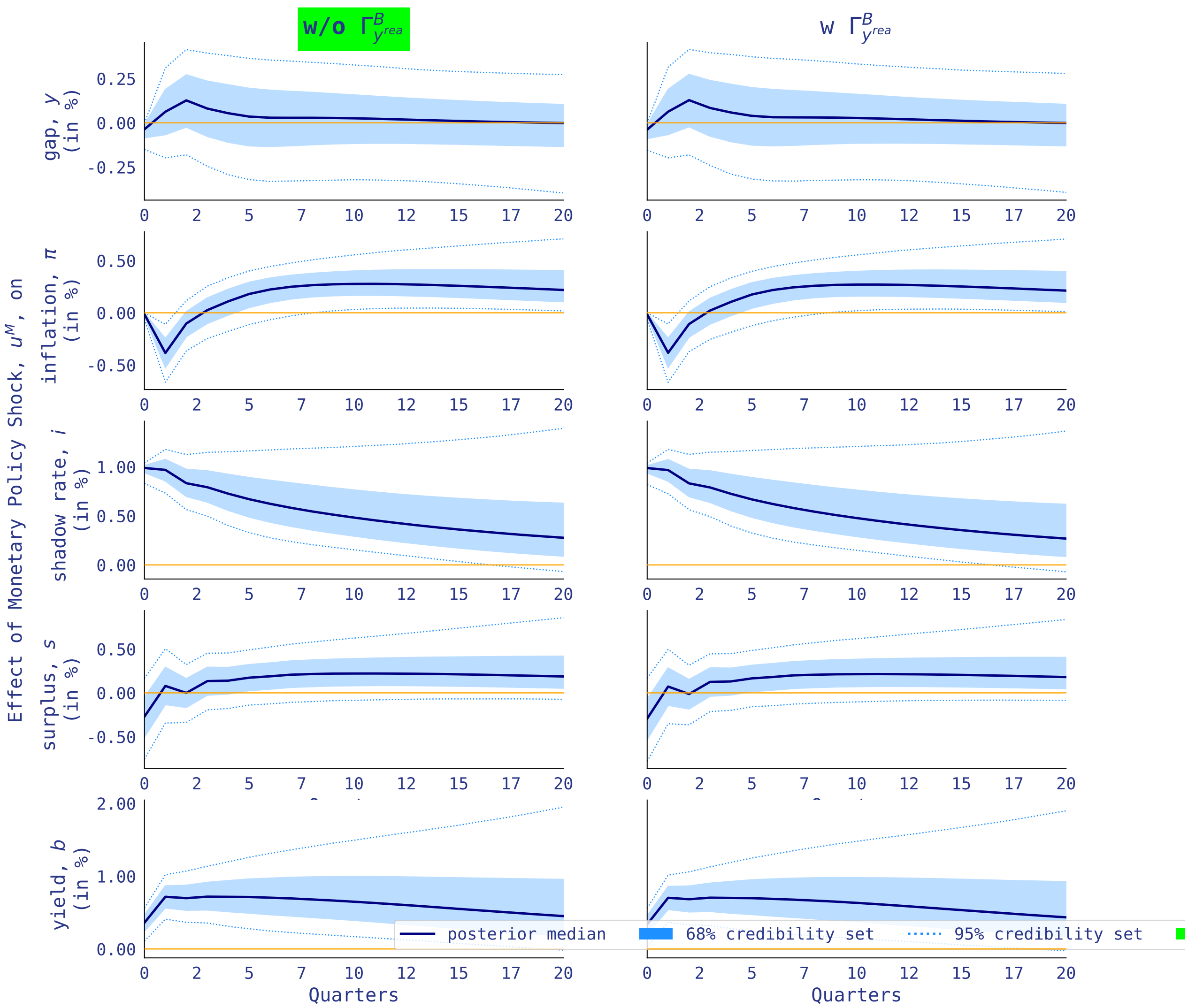
Notes: Supply shock, u^S: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

FIGURE A35: ROB.BONDDEMAND: IRF'S DEMAND (D)



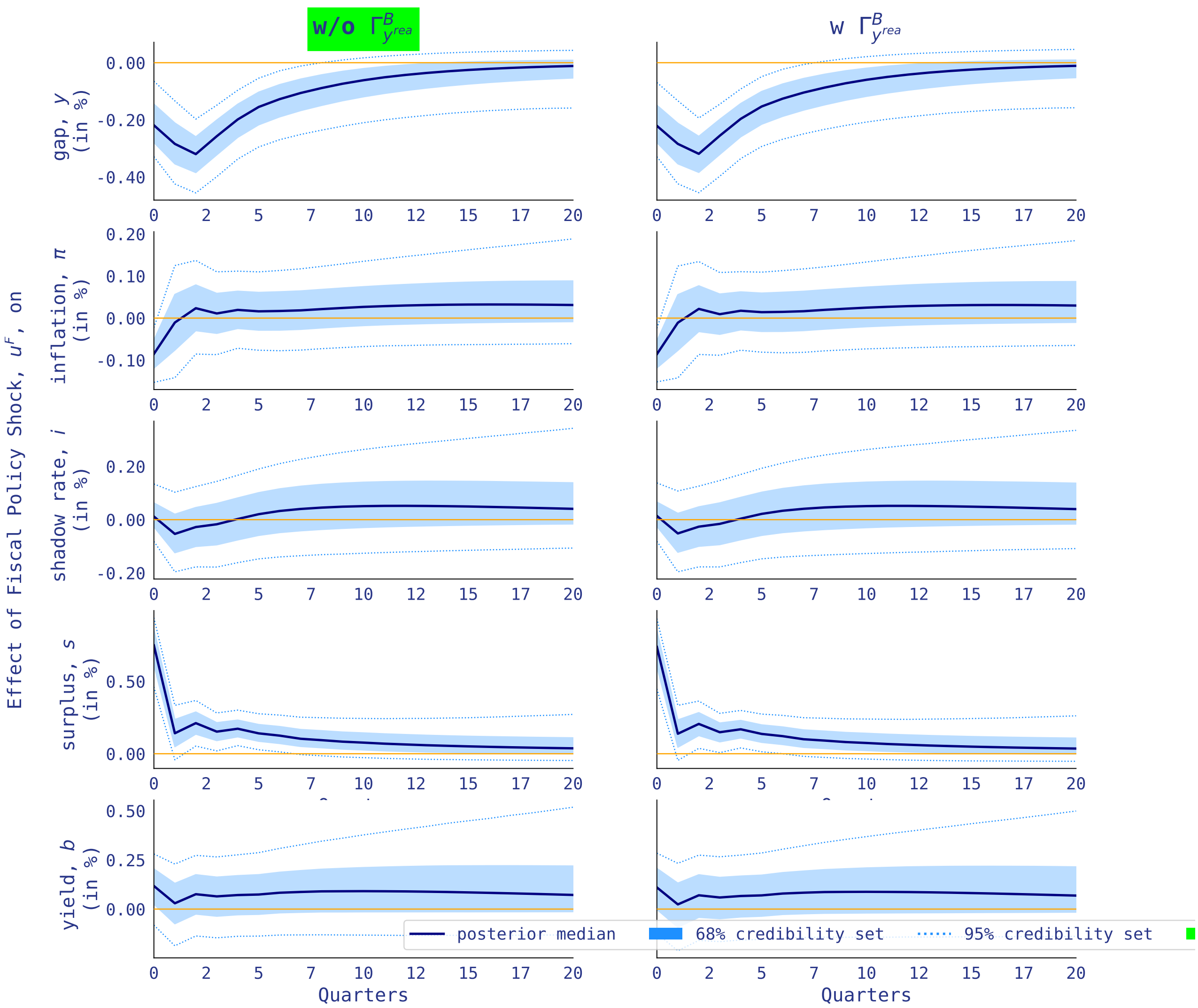
Notes: Demand shock, u^D: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A36: Rob.BondDemand: IRF's Monetary Policy (M)



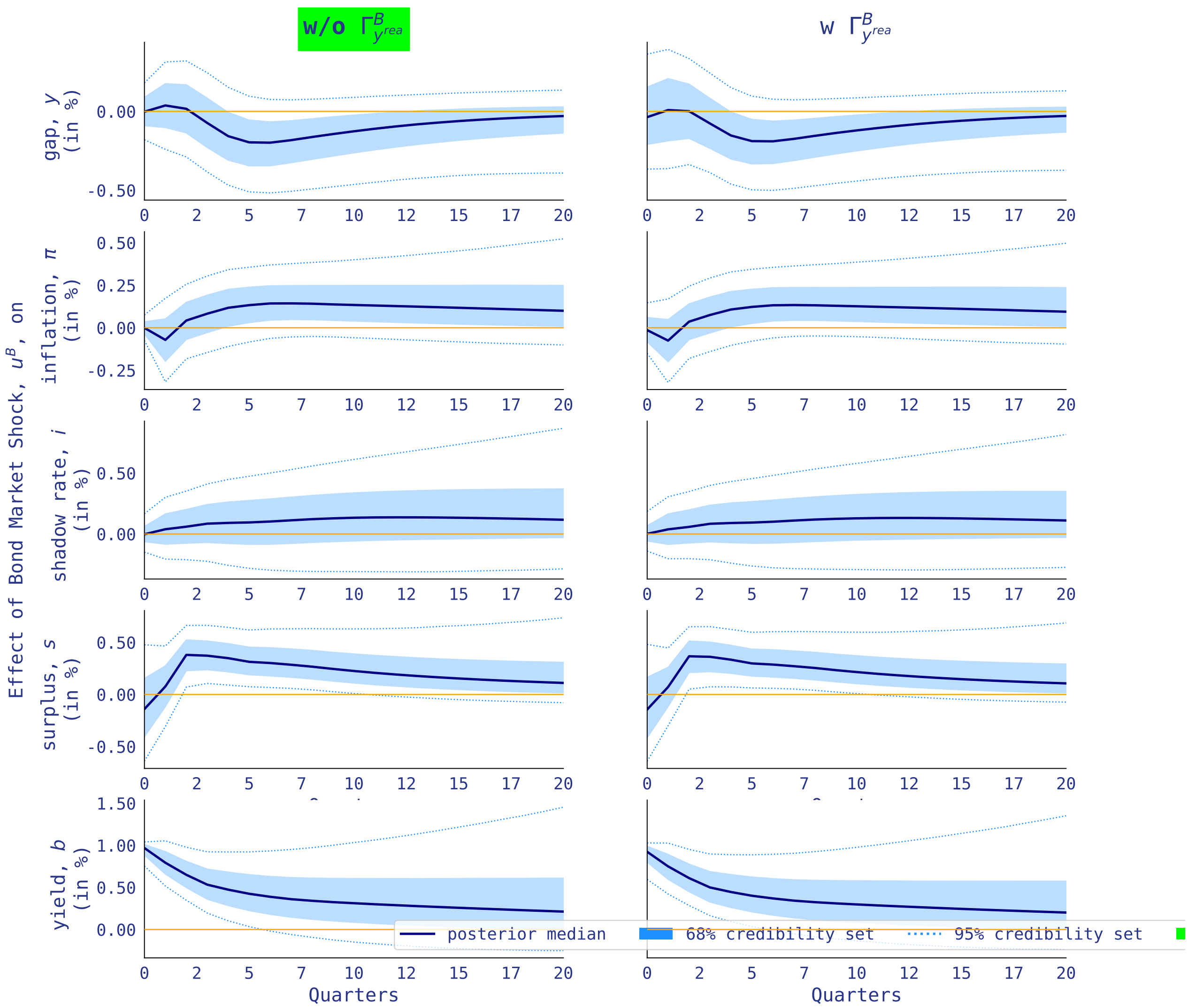
Notes: Monetary policy shock, u^M: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A37: Rob.BondDemand: IRF's Fiscal Policy (F)



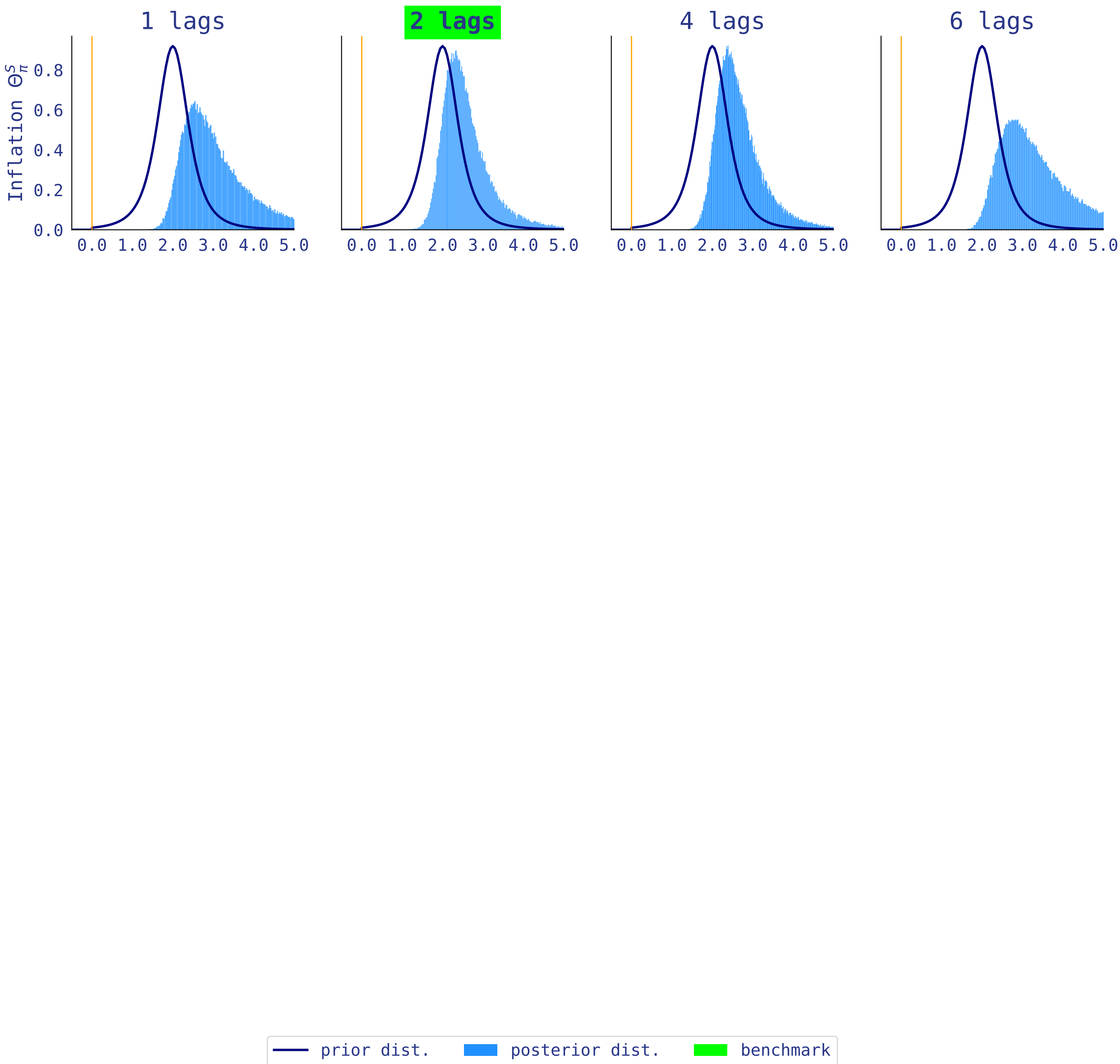
Notes: Fiscal policy shock, u^F: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A38: Rob.BondDemand: IRF's Bond Demand (B)



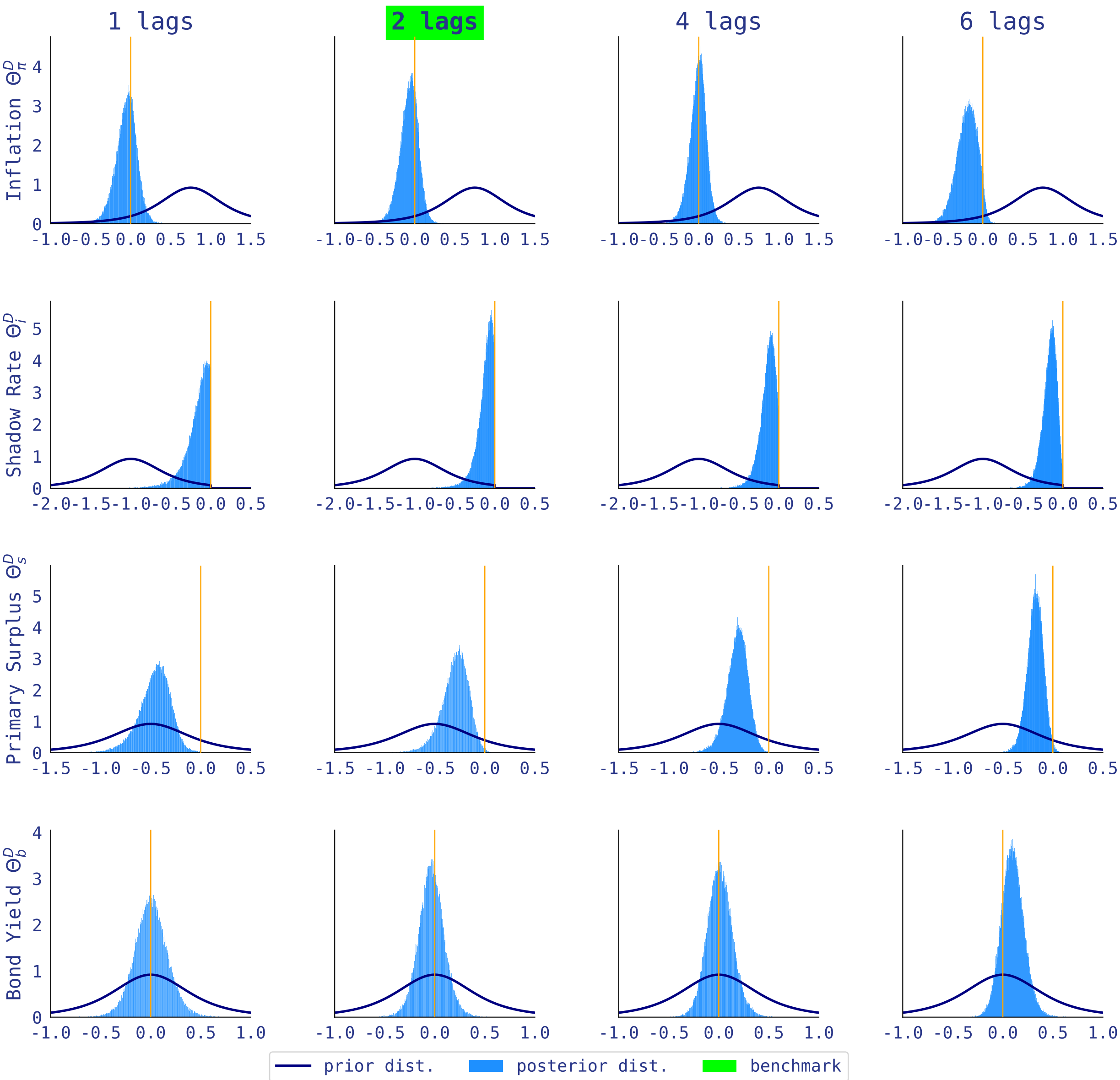
Notes: Bond demand shock, u^B: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

FIGURE A39: ROB.LAGS: CONT.EFFECTS AGGREGATE SUPPLY (S)



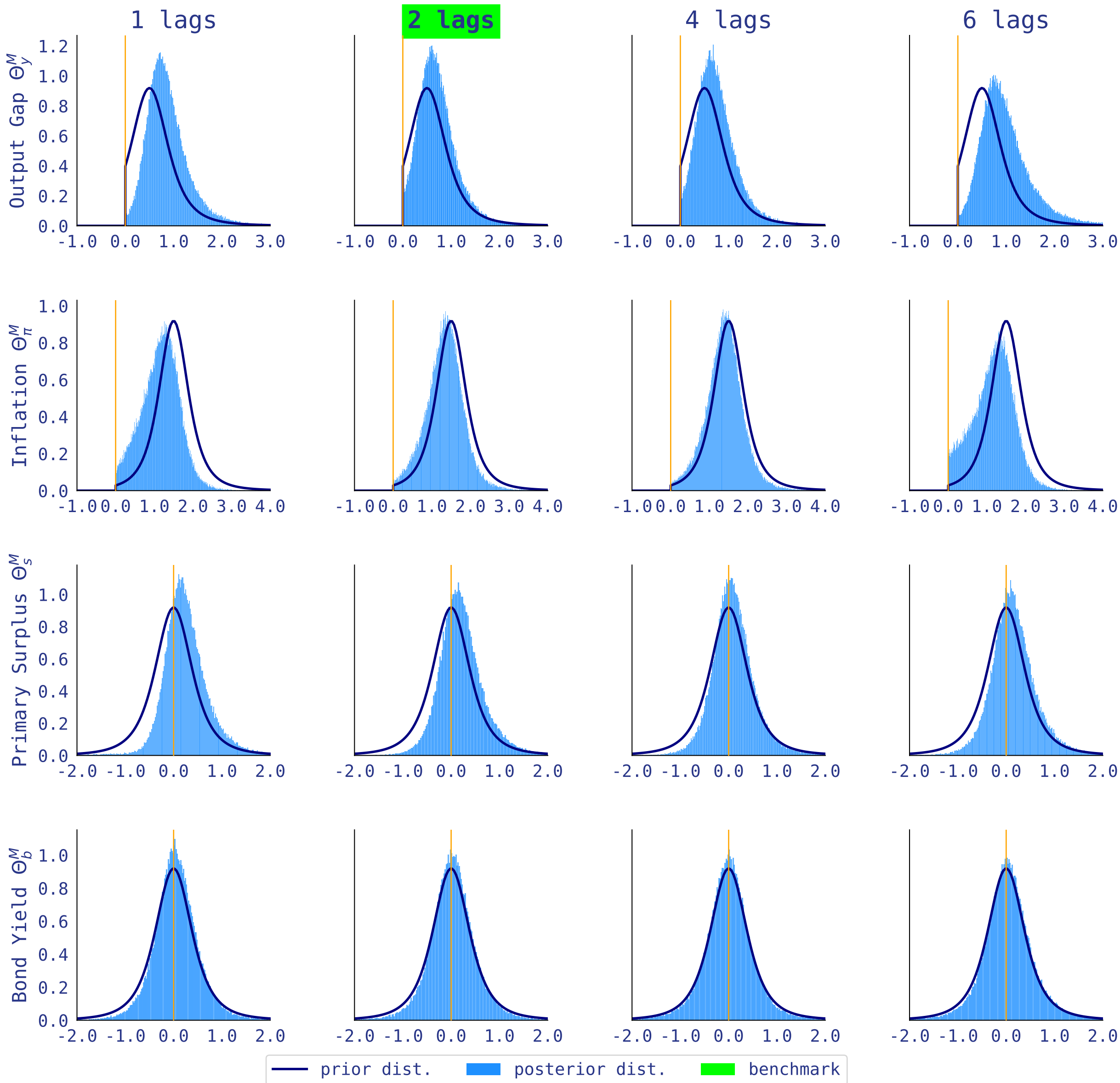
Notes: Contemporaneous effects from equation: $y_t = \Theta_\pi^S \pi_t + \text{lag terms} + u_t^S$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A40: Rob.Lags: Cont.Effects Aggregate Demand (D)



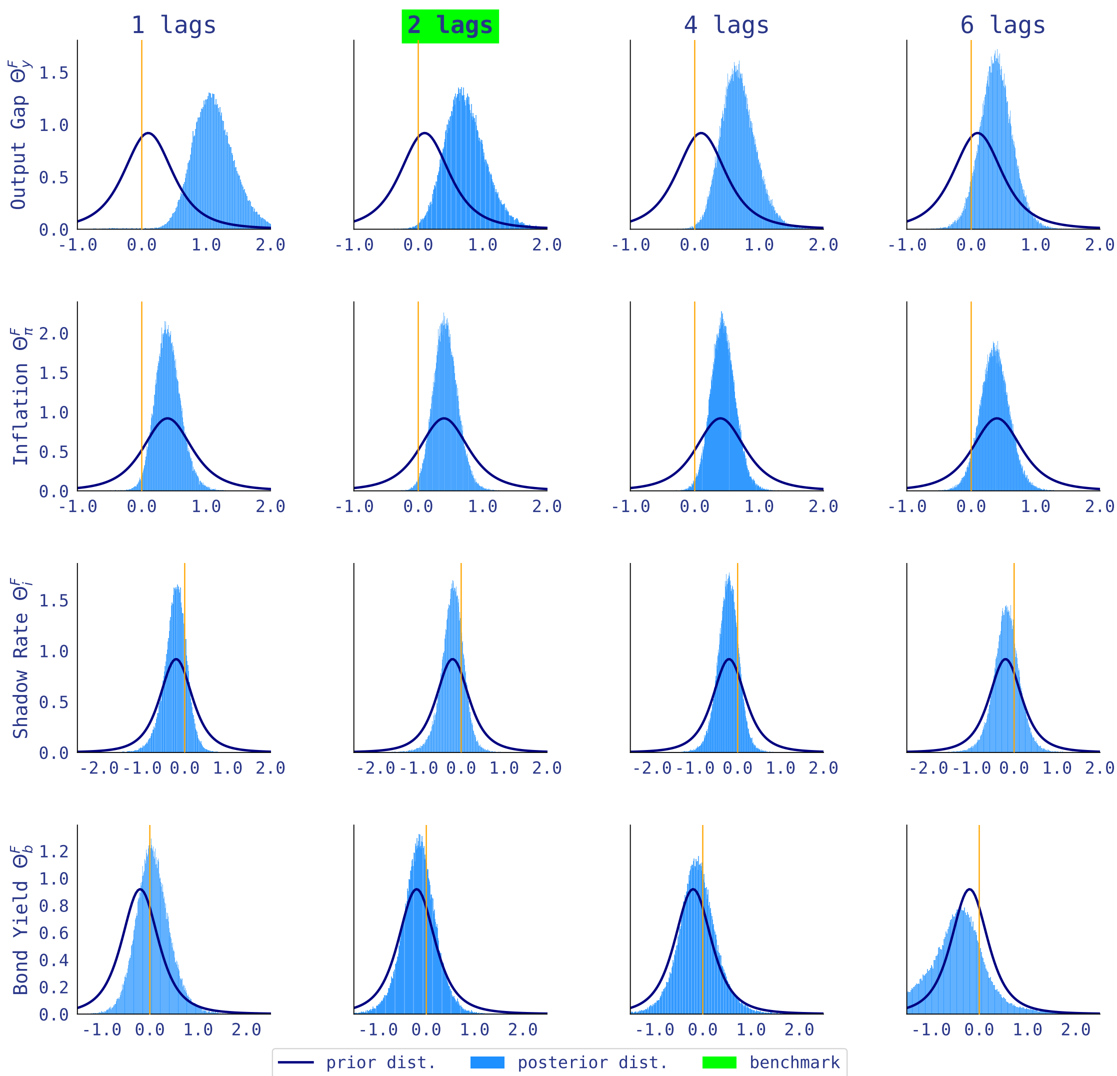
Notes: Contemporaneous effects from equation: $y_t = \Theta_\pi^D \pi_t + \Theta_i^D i_t + \Theta_s^D s_t + \Theta_b^D b_t + \Gamma_y^D y_t^{rea} +$ lag terms $+ u_t^D$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A41: Rob.Lags: Cont.Effects Monetary Policy (M)



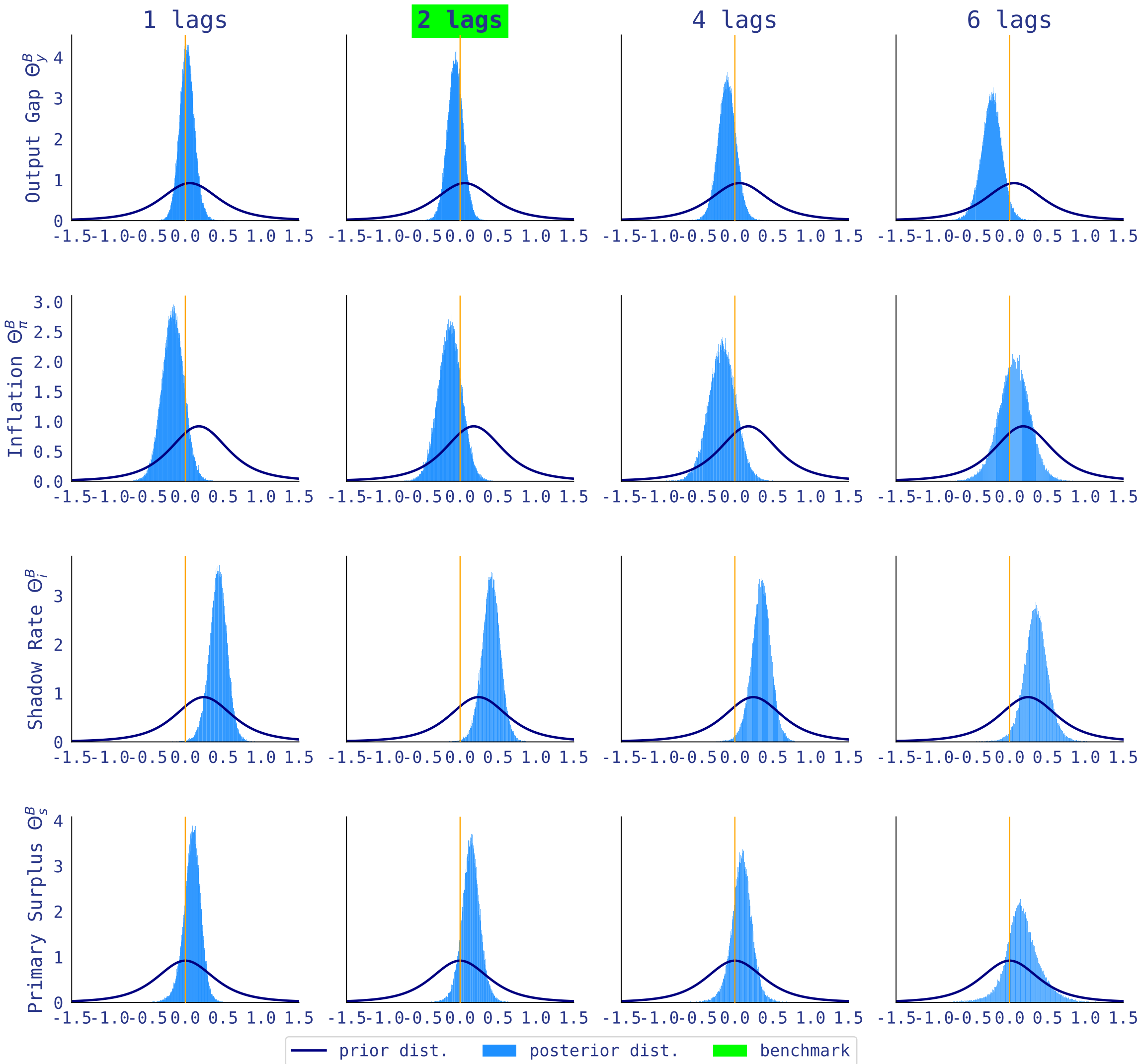
Notes: Contemporaneous effects from equation: $i_t = (1 - \rho)\left[\Theta_y^M(\omega y_t + (1-\omega)y_t^{rea}) + \Theta_\pi^M(\omega\pi_t + (1-\omega)\pi_t^{rea}) + \Theta_s^M s_t + \Theta_b^M b_t\right]$ + lag terms + u_t^M. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A42: Rob.Lags: Cont.Effects Fiscal Policy (F)



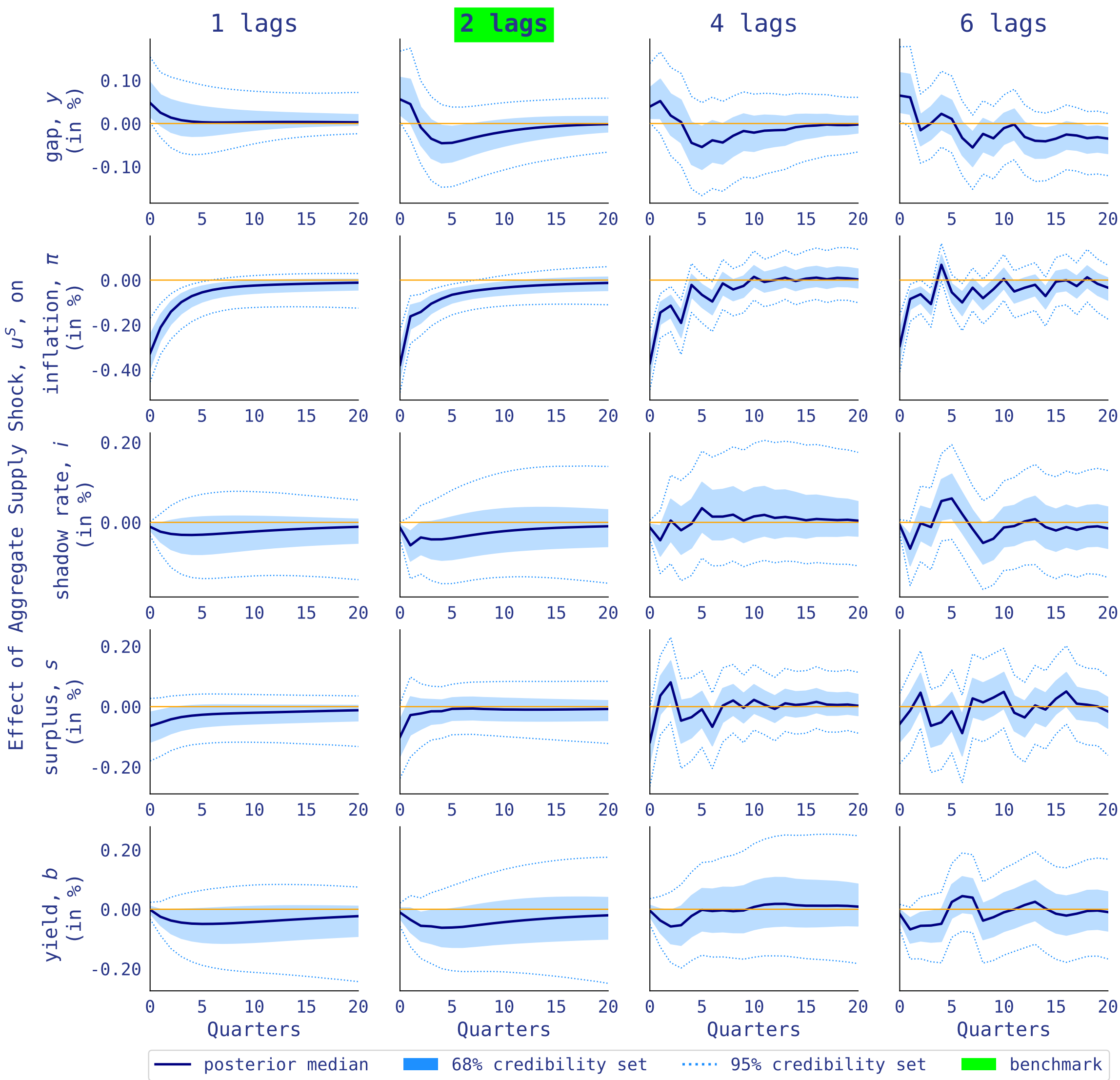
Notes: Contemporaneous effects from equation: $s_t = \Theta_y^F y_t + \Theta_\pi^F \pi_t + \Theta_i^F i_t + \Theta_b^F b_t + \text{lag terms} + u_t^F$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A43: Rob.Lags: Cont.Effects Bond Demand (B)



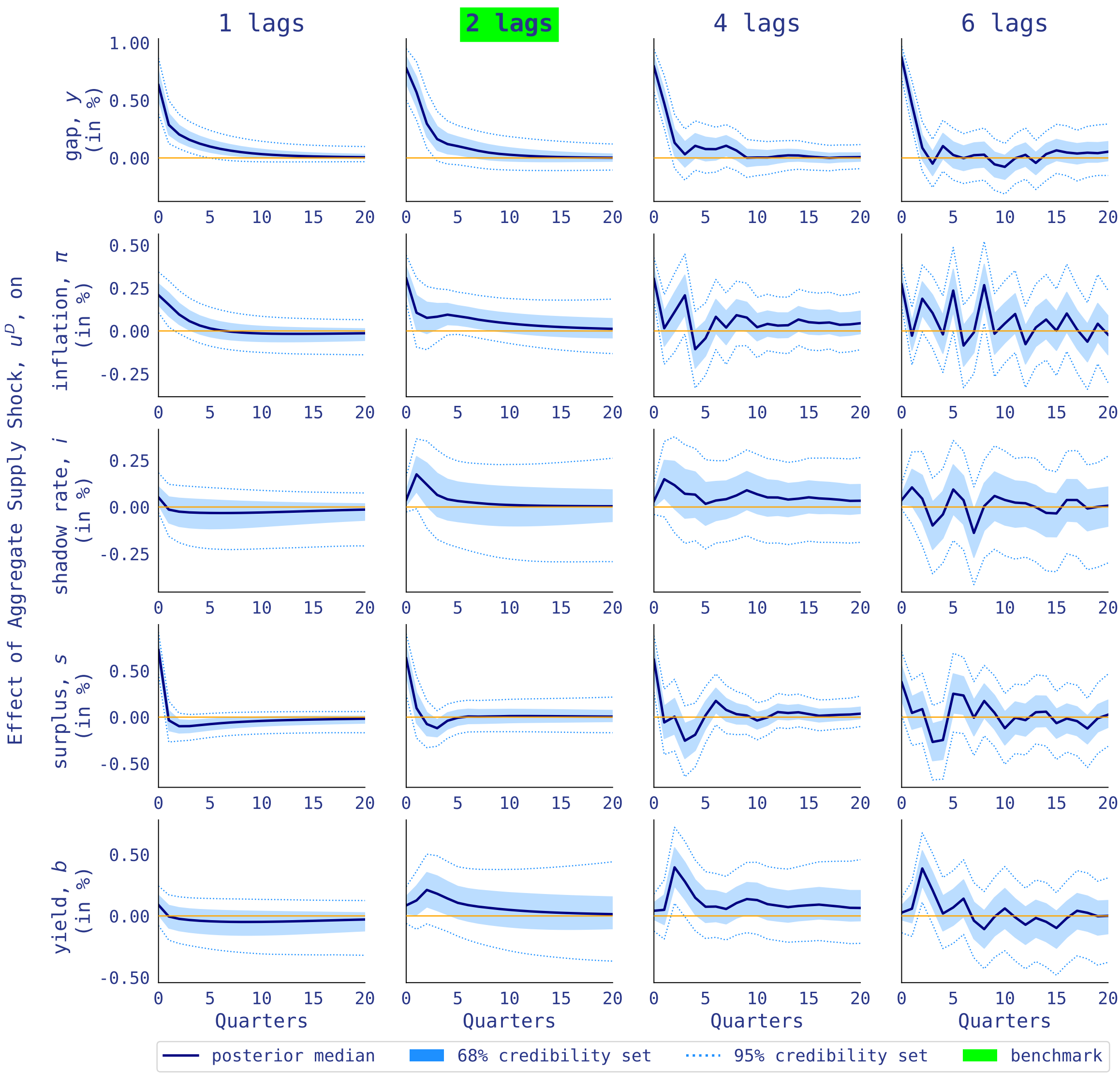
Notes: Contemporaneous effects from equation: $b_t = \Theta_y^B f y_t + \Theta_\pi^B f \pi_t + \Theta_i^B i_t + \Theta_s^B s_t + \left(\Theta_y^B(1-f)y_t^{rea} + \Theta_\pi^B(1-f)\pi_t^{rea}\right) + \left[\mathbf{b}^B\right]'\mathbf{x}_{t-1} + u_t^B$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

FIGURE A44: ROB.LAGS: IRF's SUPPLY (S)



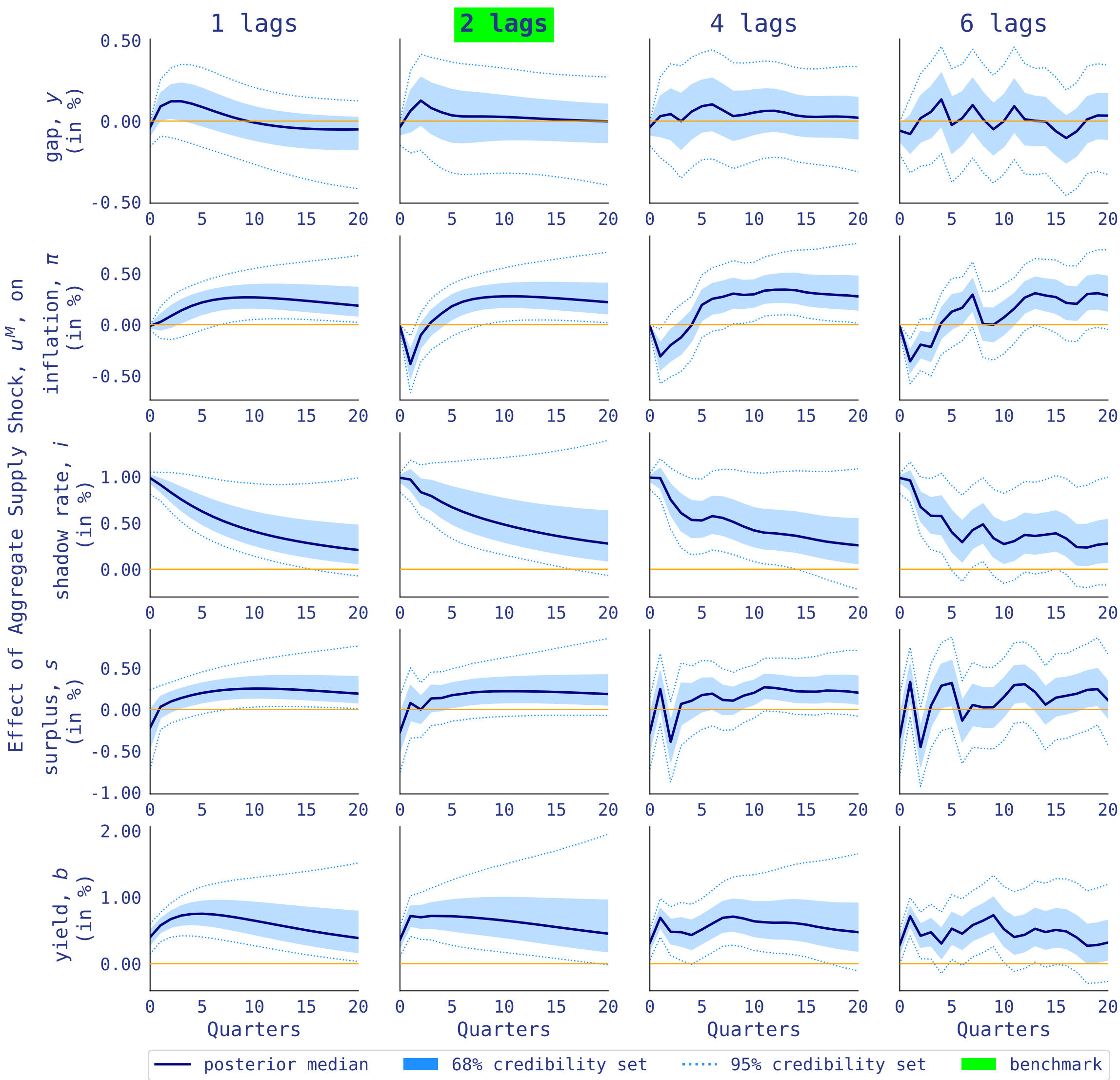
Notes: Supply shock, u^S: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A45: Rob.Lags: IRF's Demand (D)



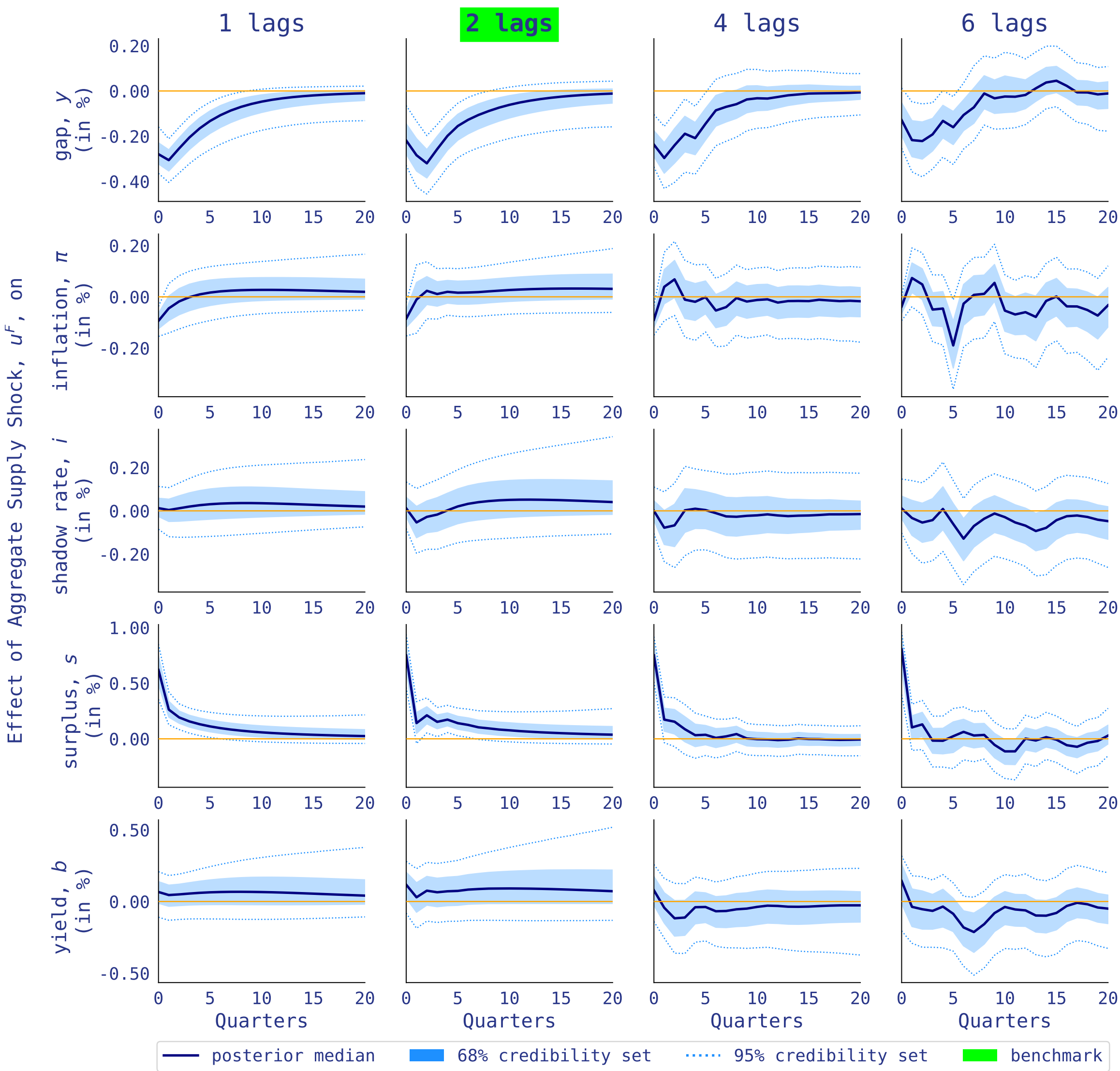
Notes: Demand shock, u^D: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A46: Rob.Lags: IRF's Monetary Policy (M)



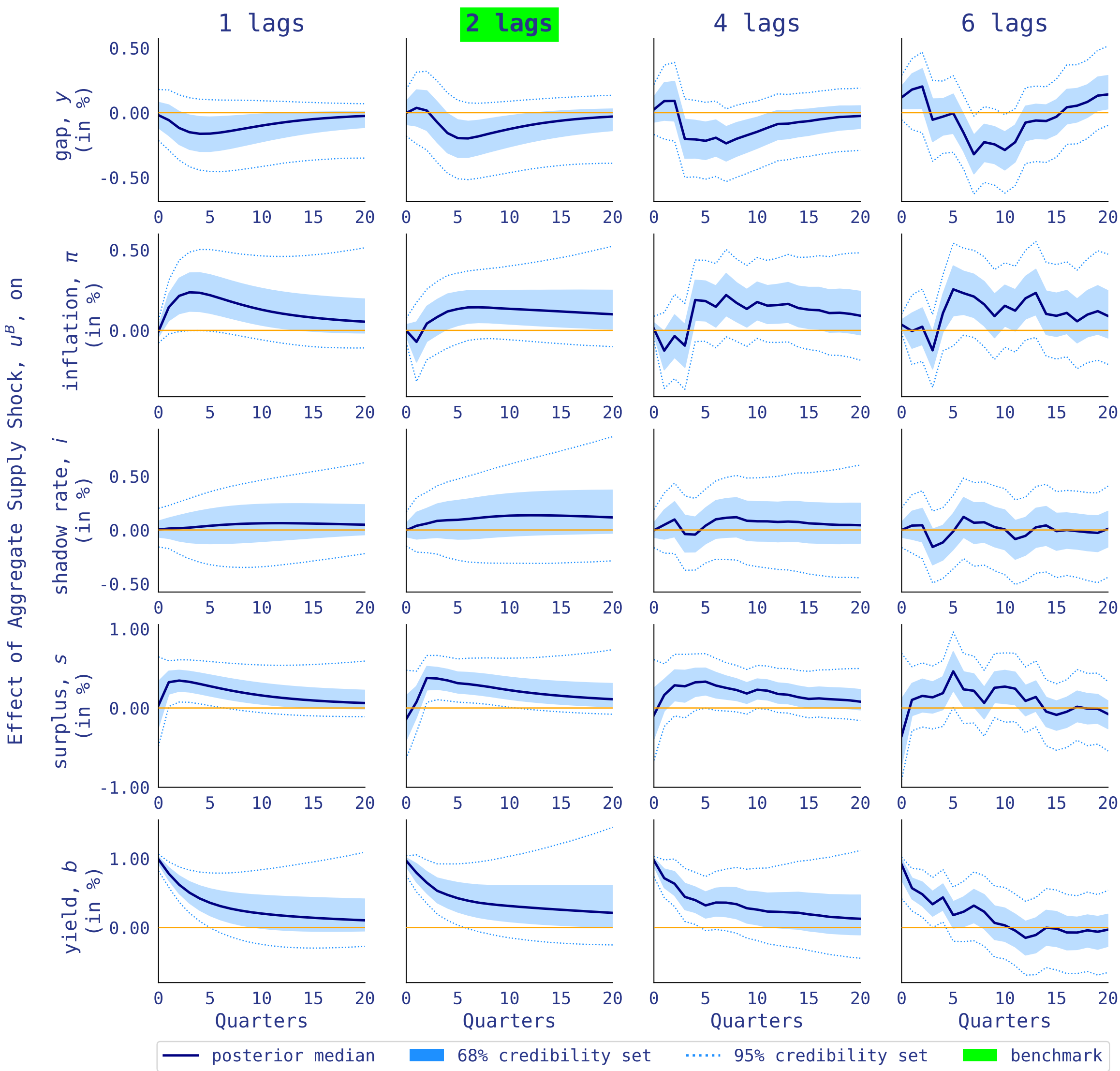
Notes: Monetary policy shock, u^M: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A47: Rob.Lags: IRF's Fiscal Policy (F)



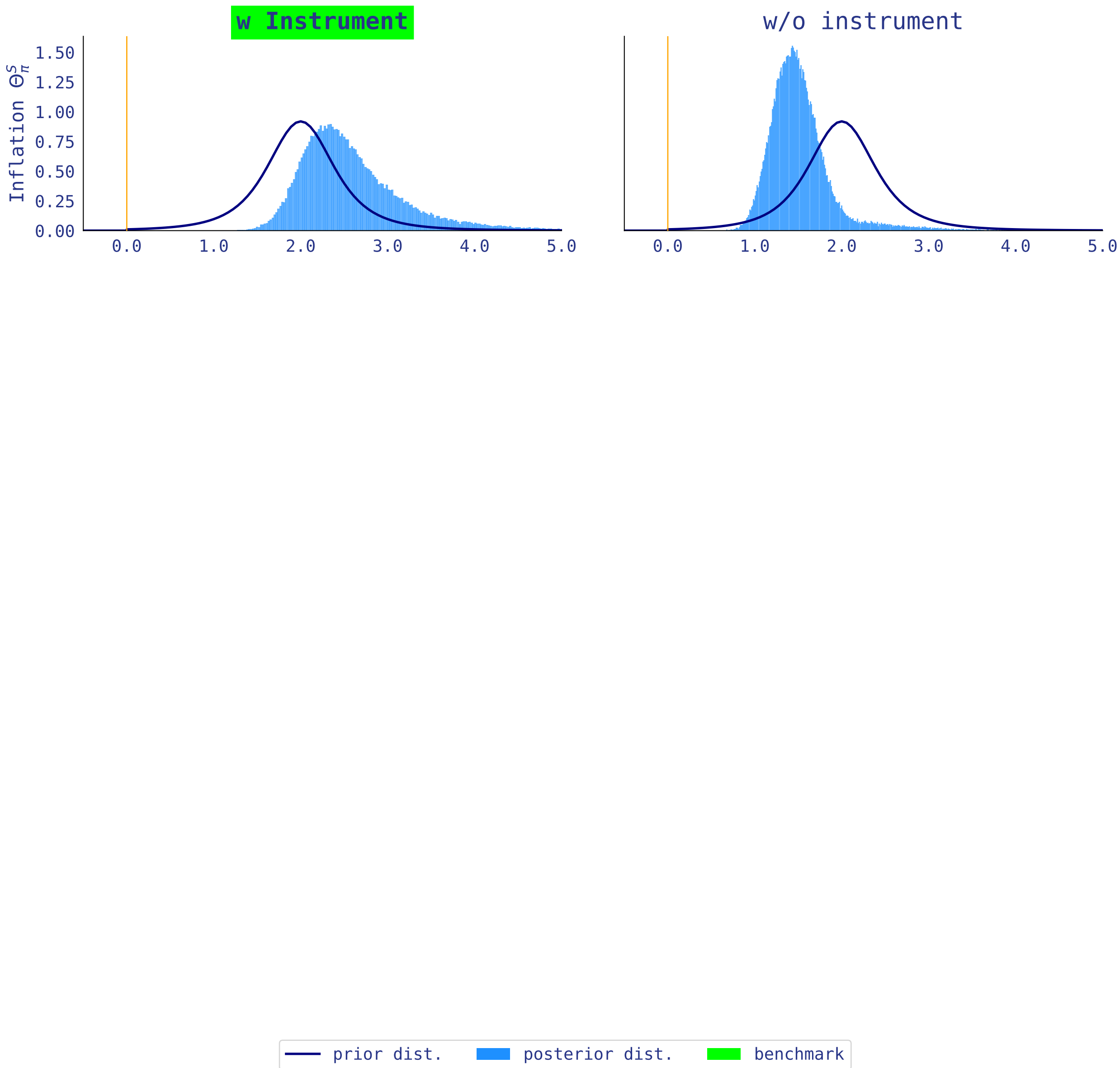
Notes: Fiscal policy shock, u^F: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A48: Rob.Lags: IRF's Bond Demand (B)



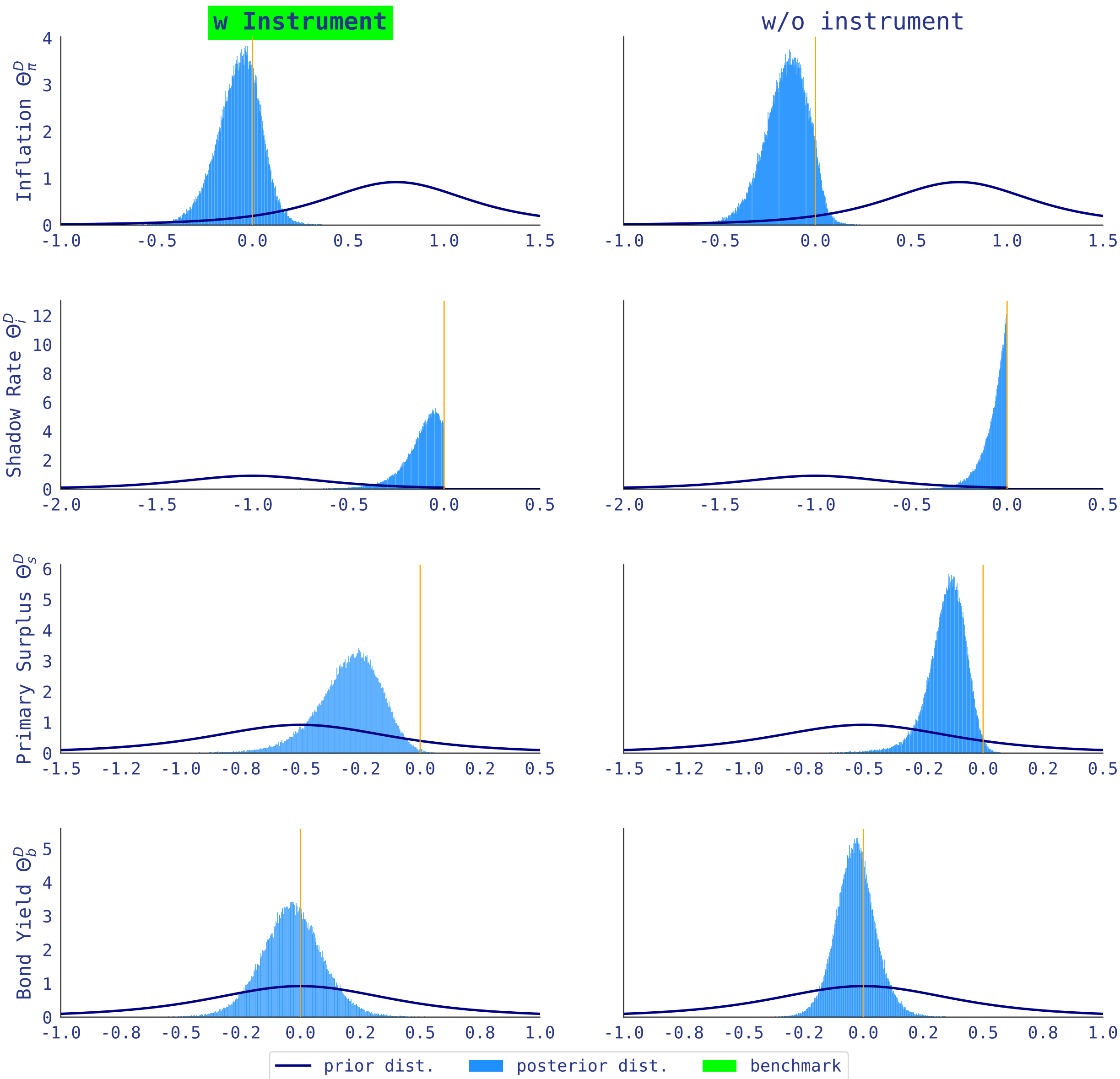
Notes: Fiscal policy shock, u^F: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A49: Rob.IV: Cont.Effects Aggregate Supply (S)



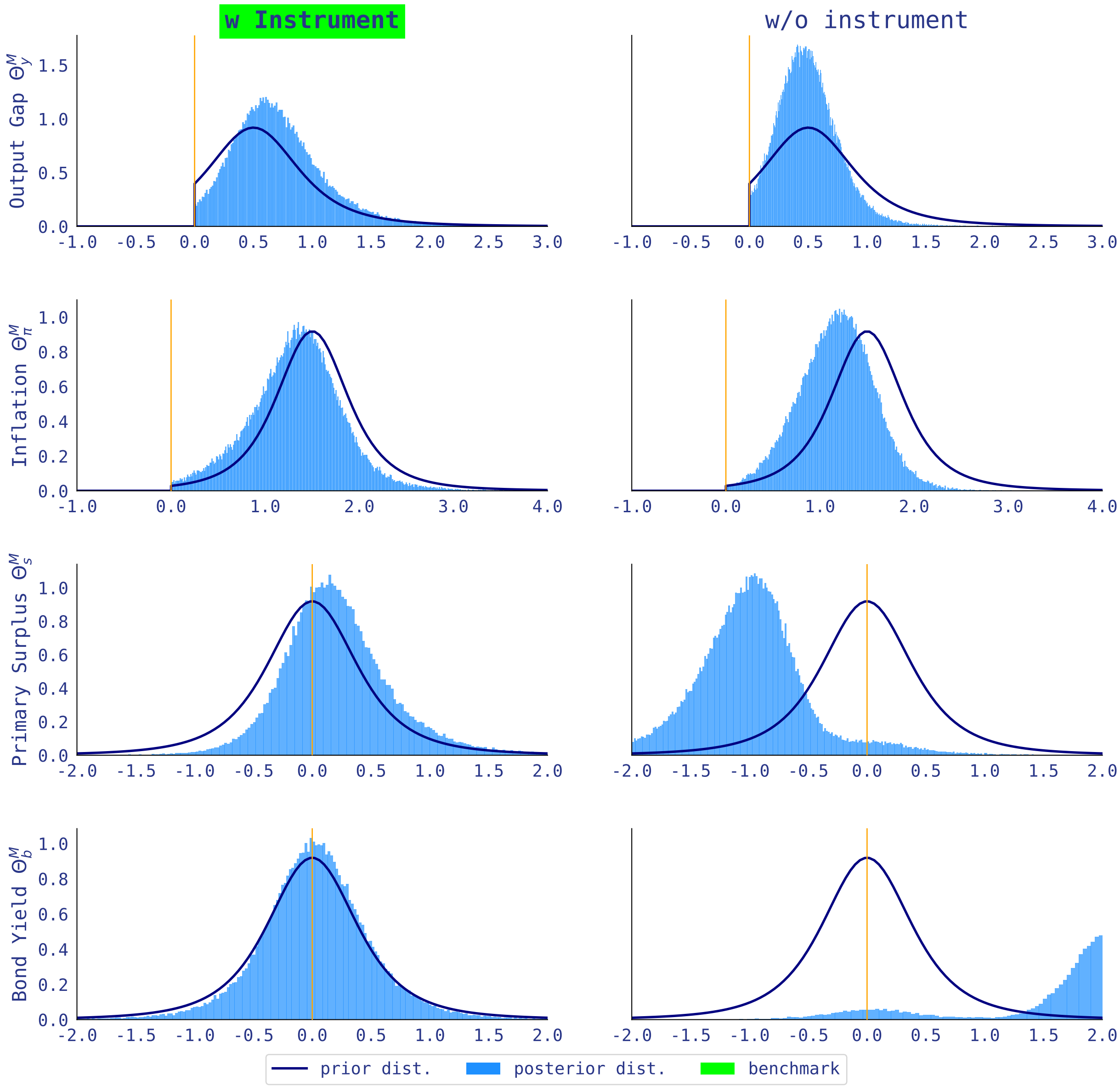
Notes: Contemporaneous effects from equation: $y_t = \Theta_\pi^S \pi_t + \text{lag terms} + u_t^S$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

FIGURE A50: ROB.IV: CONT.EFFECTS AGGREGATE DEMAND (D)



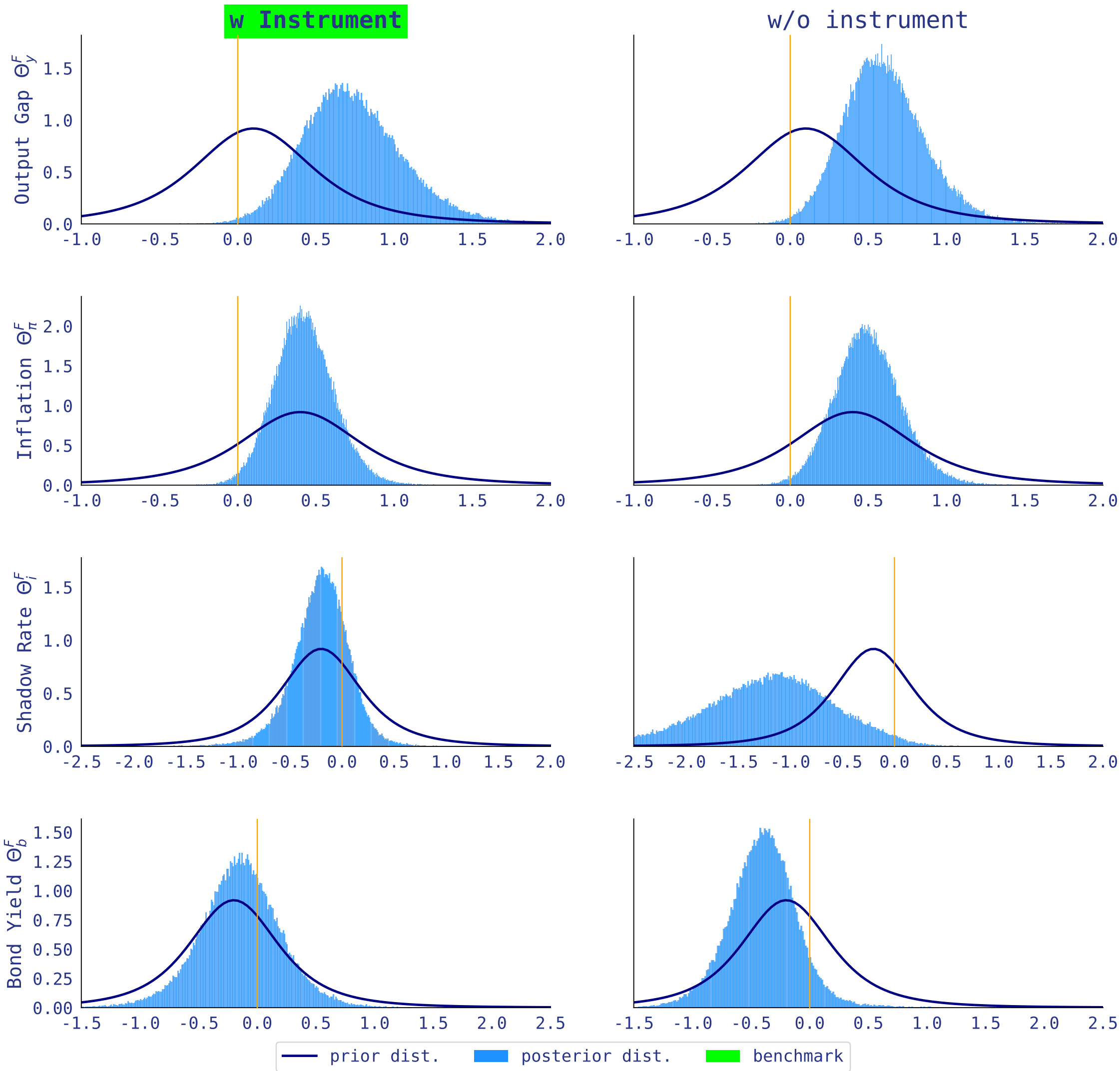
Notes: Contemporaneous effects from equation: $y_t = \Theta_\pi^D \pi_t + \Theta_i^D i_t + \Theta_s^D s_t + \Theta_b^D b_t + \Gamma_y^D y_t^{rea} +$ lag terms $+ u_t^D$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A51: Rob.IV: Cont.Effects Monetary Policy (M)



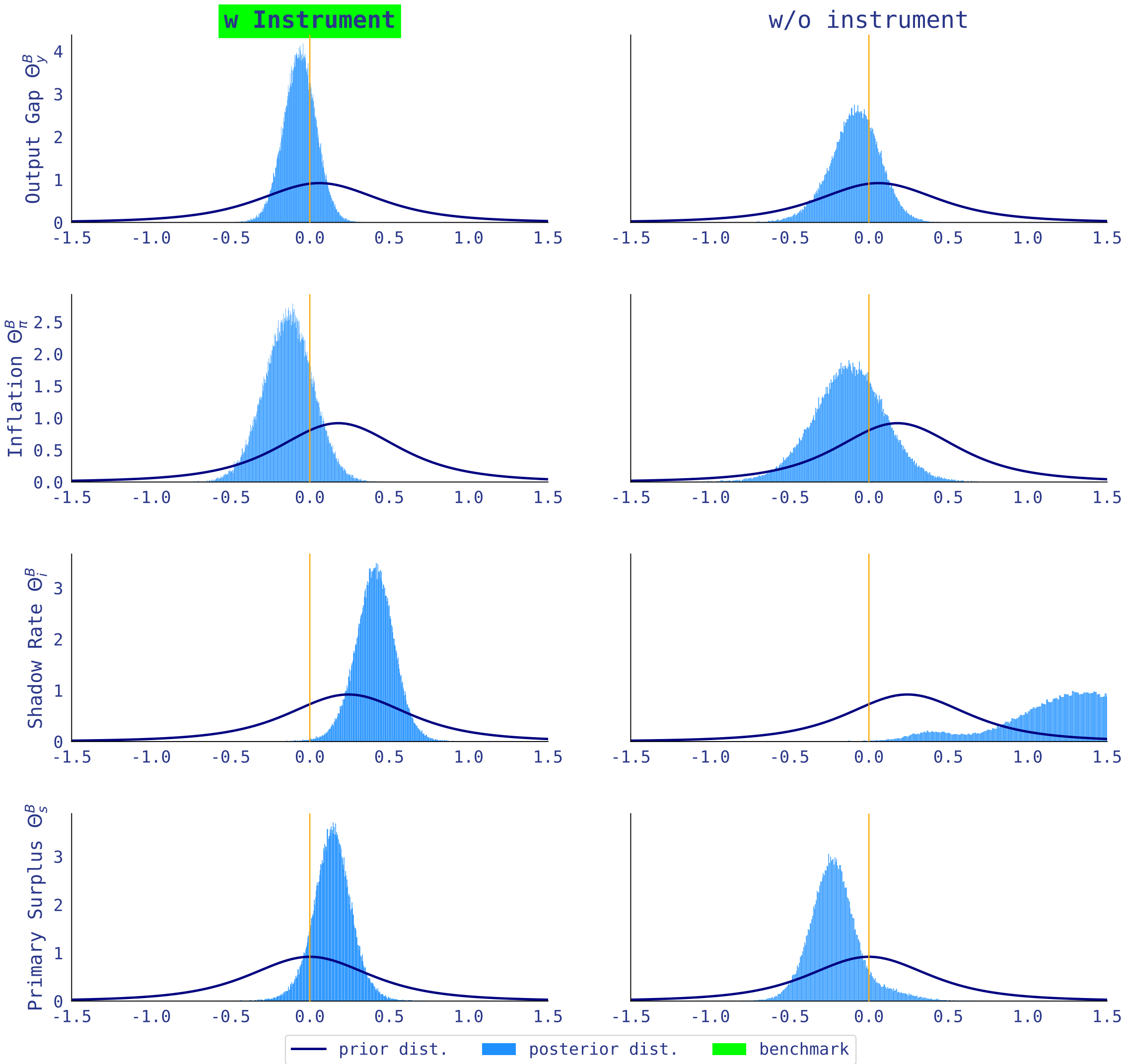
Notes: Contemporaneous effects from equation: $i_t = (1 - \rho)\left[\Theta_y^M\left(\omega y_t + (1-\omega)y_t^{rea}\right) + \Theta_\pi^M\left(\omega \pi_t + (1-\omega)\pi_t^{rea}\right) + \Theta_s^M s_t + \Theta_b^M b_t\right]$ + lag terms + u_t^M. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A52: Rob.IV: Cont.Effects Fiscal Policy (F)



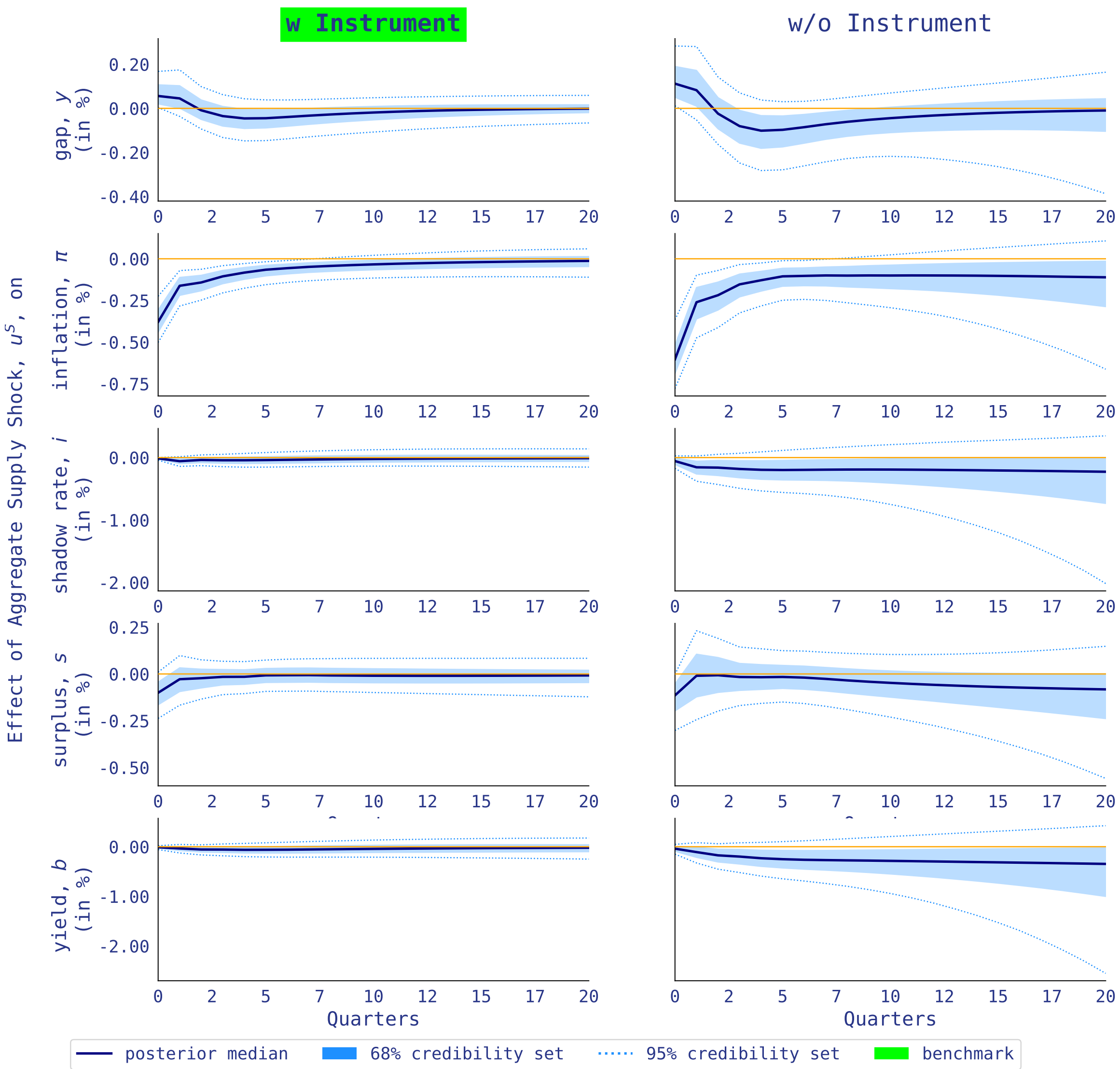
Notes: Contemporaneous effects from equation: $s_t = \Theta^F_y y_t + \Theta^F_\pi \pi_t + \Theta^F_i i_t + \Theta^F_b b_t + \text{lag terms} + u^F_t$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

FIGURE A53: ROB.IV: CONT.EFFECTS BOND DEMAND (B)



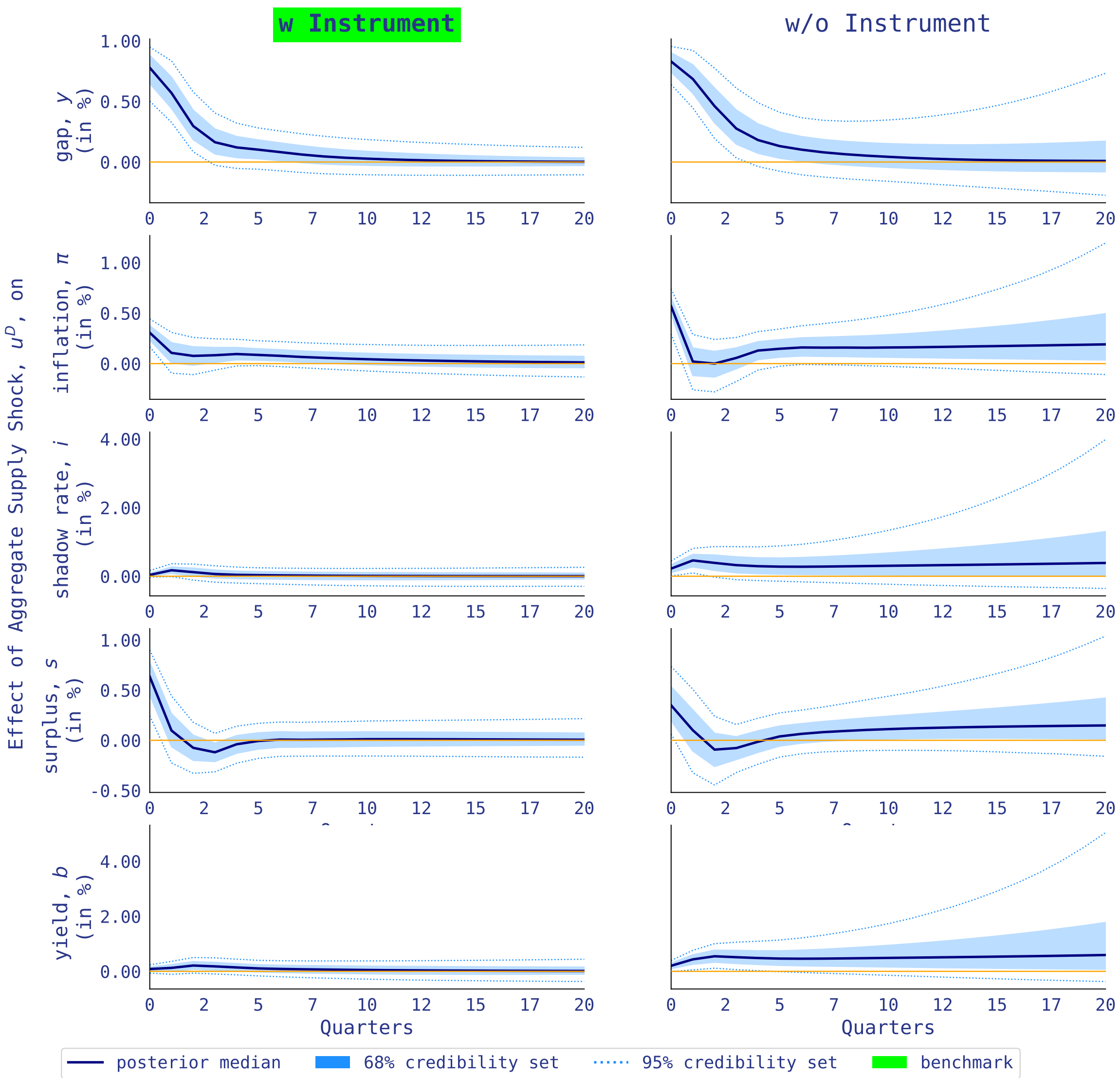
Notes: Contemporaneous effects from equation: $b_t = \Theta_y^B f y_t + \Theta_\pi^B f \pi_t + \Theta_i^B i_t + \Theta_s^B s_t + \left(\Theta_y^B(1-f)y_t^{rea} + \Theta_\pi^B(1-f)\pi_t^{rea}\right) + \left[\mathbf{b}^B\right]' \mathbf{x}_{t-1} + u_t^B$. Prior distributions (dark blue lines) and posterior distributions (light blue histogram) for contemporaneous coefficients.

Figure A54: Rob.IV: IRF's Supply (S)



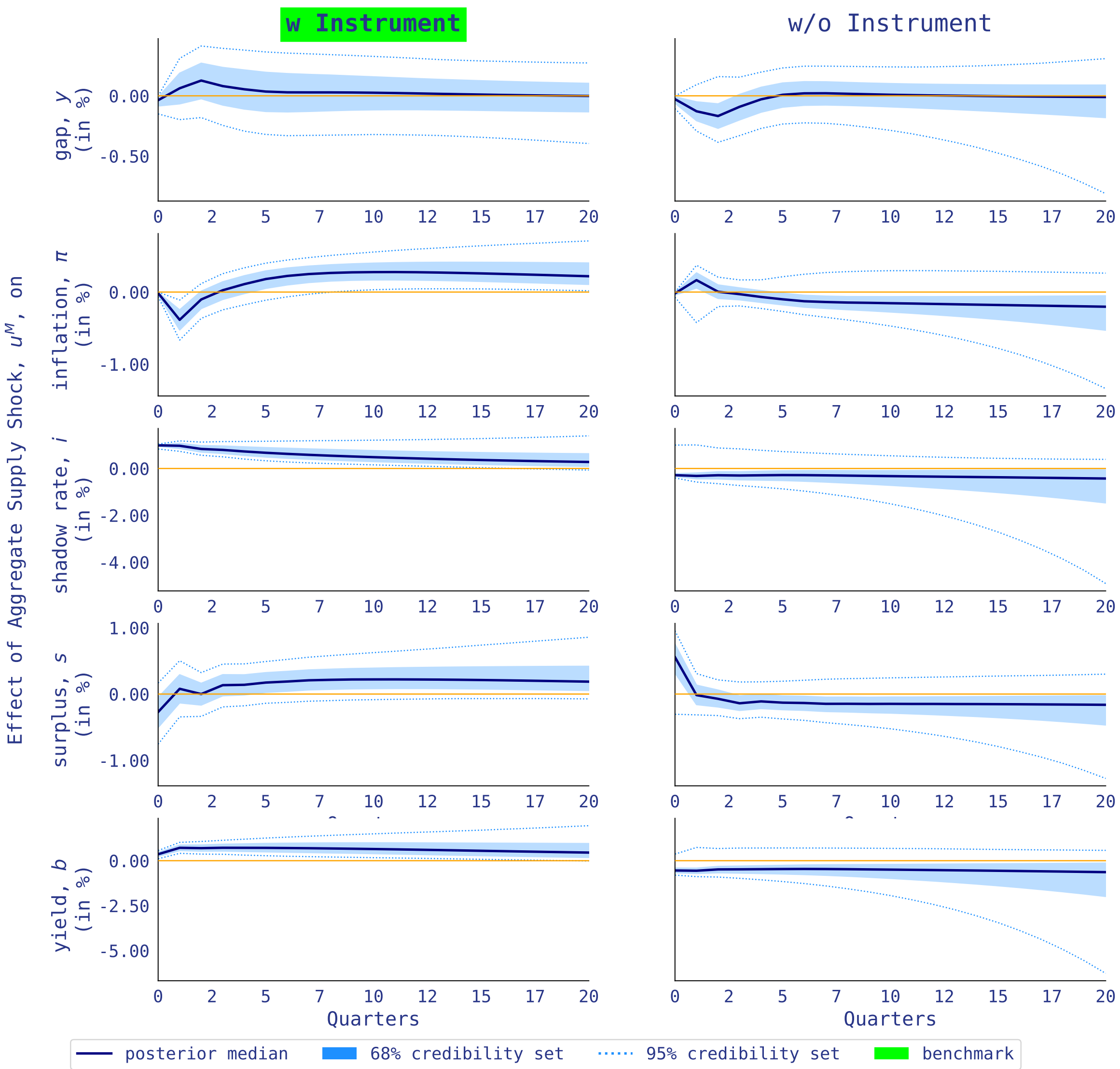
Notes: Supply shock, u^S: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A55: Rob.IV: IRF's Demand (D)



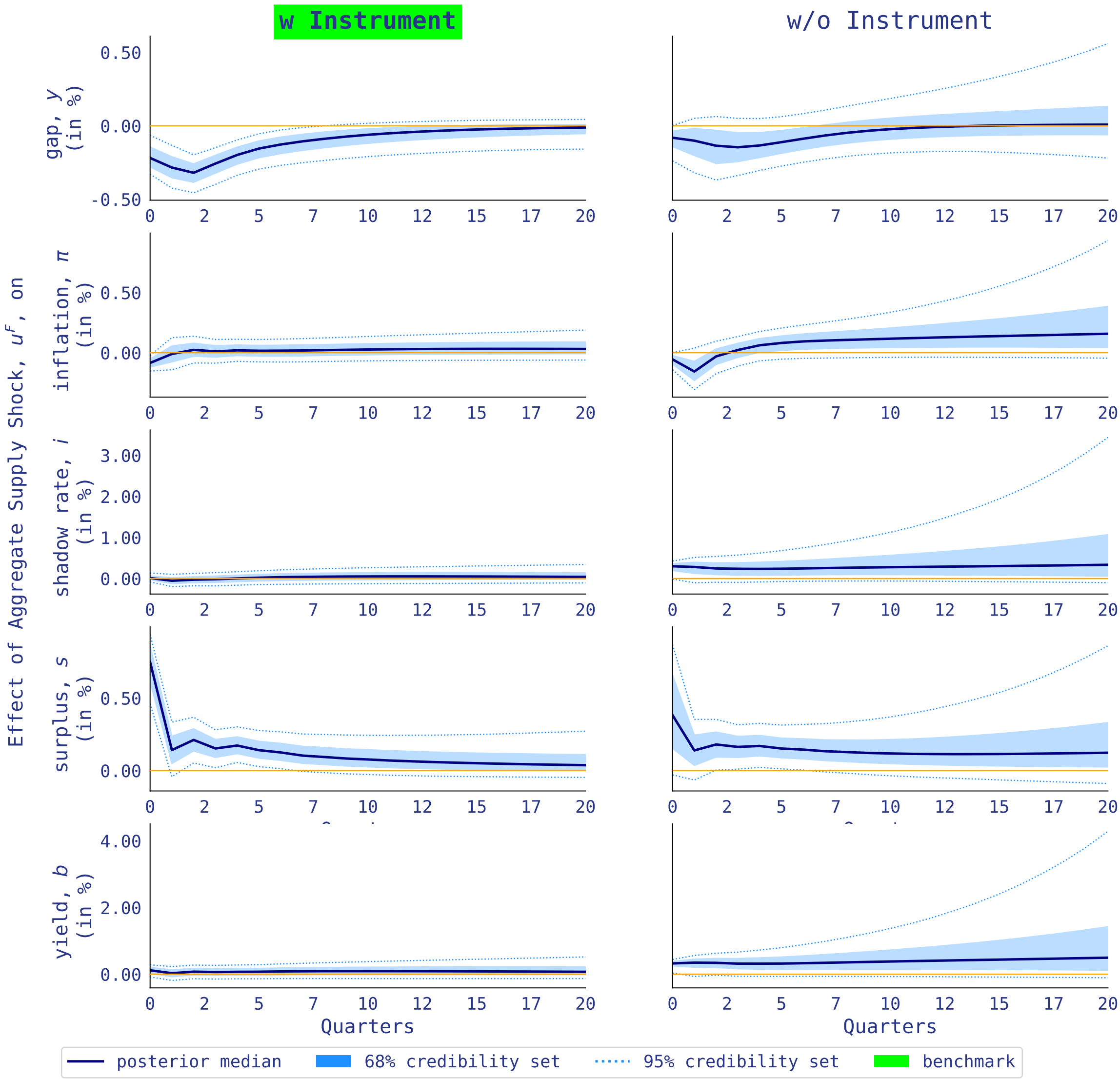
Notes: Demand shock, u^D: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A56: Rob.IV: IRF's Monetary Policy (M)



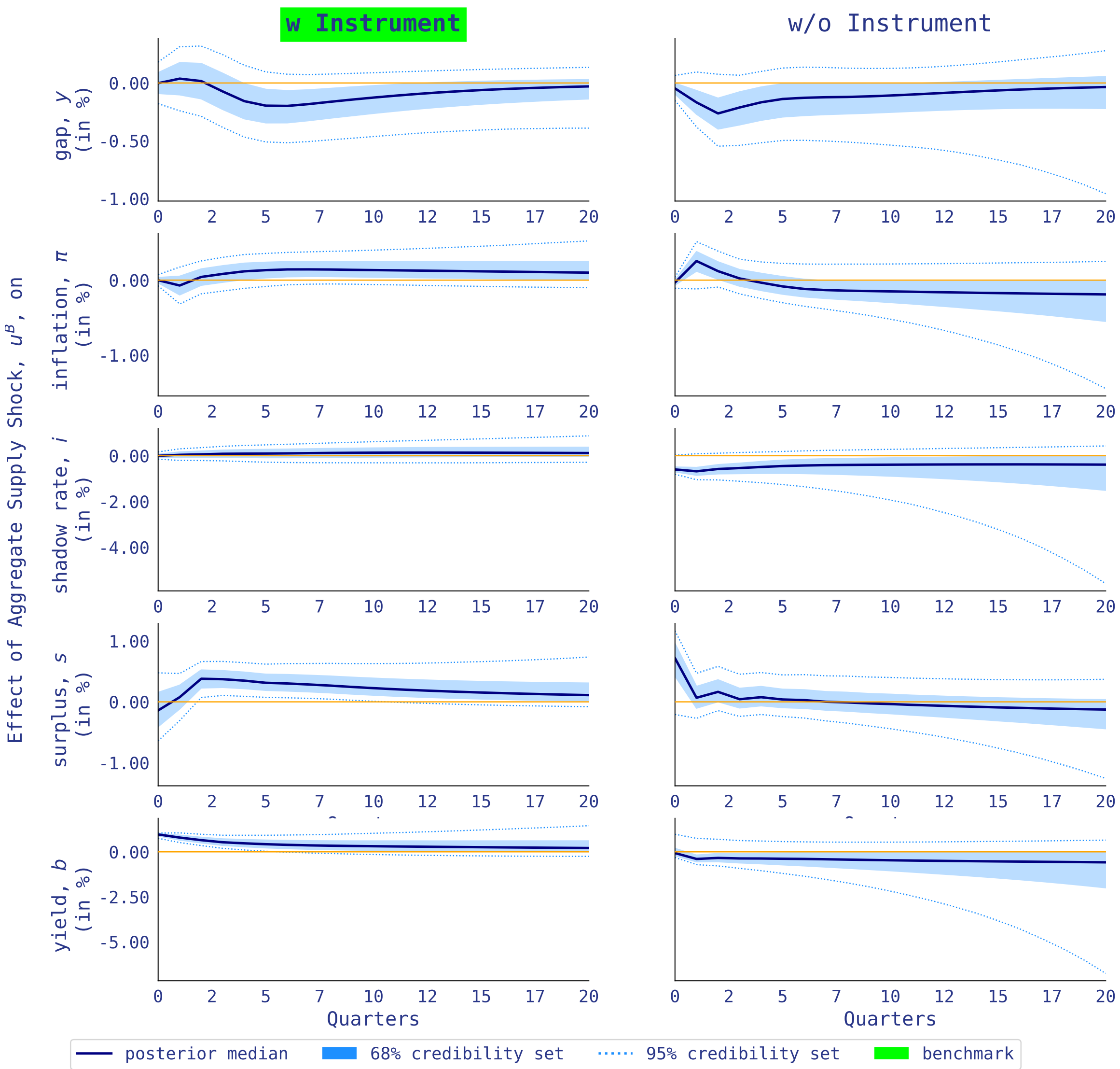
Notes: Monetary policy shock, u^M: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A57: Rob.IV: IRF's Fiscal Policy (F)



Notes: Fiscal policy shock, u^F: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

Figure A58: Rob.IV: IRF's Bond Demand (B)



Notes: Bond demand shock, u^B: Structural IRF's for 5-variable VAR($p^{AICC} = 2$). For better comparison, we include the posterior results from our benchmark specification, identified with the corresponding green tag.

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ISSN 2194-2188

The IWH is funded by the federal government and the German federal states.