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Fiscal backing, inflation and US business cycles

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Abstract

Monetary and fiscal-led equilibria in New Keynesian models (Leeper, 1991) are extreme regimes. A realistic model of monetary and fiscal policy interaction should allow for intermediate regimes where fiscal policy generally commits to serve current debt by running future surpluses, but it may not take the full burden of fiscal adjustment, whereas monetary policy is geared towards stabilising inflation, but it may have to face the inflationary consequences of partially unfunded government debt. Cochrane (2022) describes this as a regime of partial fiscal backing. This paper estimates an extended Smets and Wouters (2007) model for the US economy which allows for partial fiscal backing to answer three main questions. What has been the average degree of fiscal backing in the US economy? How does partial fiscal backing affect the transmission of various business cycle shocks to economic activity and inflation? And what are the most important drivers of inflation and are they monetary or fiscal? We find that on average 80 percent of the fiscal implications of business cycle shocks, including fiscal shocks, are funded. Partial fiscal backing does affect the transmission of fiscal transfer and supply shocks to output and inflation, but not so much that of monetary policy or demand shocks. Finally, the drivers of inflation are mostly of a monetary nature, but there are episodes like the 1970s when fiscal-led inflation is highly relevant. Most of the post-pandemic rise and fall in inflation is explained by supply shocks. Expansionary fiscal policy contributed to higher inflation in 2021, mostly offsetting the disinflationary effects of negative demand developments following the outbreak of the pandemic.

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1. Introduction

As forcefully argued by Leeper (1991), the fiscal-monetary policy regime is crucial for the determination of inflation. Standard New Keynesian models such as Smets and Wouters (2007) assume a monetary-led regime. In such a regime monetary policy controls inflation by adjusting the nominal interest rate more than one for one in response to deviations of inflation from the inflation target (adhering to the so-called Taylor principle). Fiscal policy is passive in the sense that it adjusts primary surpluses to ensure debt sustainability and thereby backs up monetary policy by taking care of the fiscal implications of monetary policy actions, for example, for the government interest rate burden. In contrast, the Fiscal Theory of the Price Level (FTPL) (Leeper, 1991; Sims, 1994, Woodford, 2001, Cochrane, 2001) proposes an alternative fiscal-led regime. In this regime fiscal policy controls inflation. Unfunded changes in primary deficits give rise to variations in inflation that stabilise the government debt ratio. Monetary policy is passive as it accommodates the changes in inflation by allowing real policy rates to fall. [2]

Monetary and fiscal-led equilibria in New Keynesian models are extreme fiscal-monetary policy regimes. In this paper we investigate intermediate regimes where fiscal policy generally commits to serve current debt by running future surpluses, but it may not take the full burden of fiscal adjustment, whereas monetary policy is generally geared towards stabilising inflation, but it may have to face the inflationary consequences of partially unfunded government debt. Cochrane (2022) describes this as a regime of partial fiscal backing and discusses how this may be interpreted as the central bank following a stochastic inflation target, whereby the time-varying inflation target serves to stabilise the unbacked portion of the government debt.

The objective of the paper is to develop and estimate a model for the US economy which allows for such an intermediate monetary/fiscal policy regime. We capture the degree of fiscal backing by a regime parameter λ. When λ is 1, the economy is in a monetary-led regime and there is full fiscal backing; when λ is zero, the economy is in a fiscal-led regime, changes in government debt are unfunded and inflation is driven by the need to stabilise debt. An intermediate value of λ between zero and one captures the degree to which the fiscal implications of various shocks are funded. By allowing for such intermediate regimes, we move away from the extreme regime switching assumption in Bianchi and Ilut (2017) and Bianchi and Melosi (2020) and closer to the approaches of Cochrane (2022), Bianchi, Faccini and Melosi (BFM, 2023) and Barro and Bianchi (2023) which entertain different degrees of partial fiscal backing. Our analysis also differs from the seminal work of BFM (2023) in that we analyse the impact of intermediate regimes on the effects of different types of shocks, not just fiscal transfer shocks. All supply and demand shocks have potential fiscal implications, and the degree of fiscal backing may therefore affect how those shocks transmit to inflation. In most of the paper, we assume that the regime parameter is constant over time and across shocks. However, straightforward extensions can be considered in which the regime parameter is changing over time and differs across shocks.

In the remainder of the paper, we first present our methodology for characterising intermediate monetary/fiscal policy regimes. This is an extension of the methodology developed by Bianchi and Melosi (2022) and BFM (2023). We show the implications of partial fiscal backing in two simple models: a Fisherian model and a New Keynesian model. This allows us to highlight how the

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[2] We will generally use the terminology of Bianchi, Faccini and Melosi (2023) to distinguish between the two regimes: monetary-led versus fiscal-led. Alternative descriptions are a regime of monetary or fiscal dominance or a regime of active monetary policy/passive fiscal policy (AM/PF) versus passive monetary policy/active fiscal policy (PM/AF) as in Leeper (1991).

transmission of various shocks to the economy and inflation depends on the degree of fiscal backing. One insight is that all shocks that have fiscal implications may give rise to changes in fiscal-led inflation.

Section 3 then provides an empirical application. We estimate an extended version of the Smets and Wouters (2007) model for the US economy over the period 1965 till 2019. This includes an estimate of the policy regime parameter λ. This estimated model is used to answer three main questions. First, what has been the average degree of fiscal backing in the US economy? Second, how does partial fiscal backing affect the transmission of various business cycle shocks to economic activity and inflation? And third, what are the most important drivers of inflation and are they monetary or fiscal? We find that the estimated λ is around 0.8, meaning that the fiscal/monetary policy regime is closer to a monetary-led regime. We estimate that on average 80 percent of the fiscal implications of business cycle shocks, including fiscal shocks, are funded. Partial fiscal backing nevertheless affects the transmission of various business cycle shocks to output and inflation. This is particularly the case for fiscal transfer and supply shocks, the inflationary effects of which are enhanced. Finally, the drivers of inflation are mostly of a monetary nature, although there are episodes like the 1970s or 2020s when fiscal-led inflation is also relevant.

In Section 4, we then use the estimated model to interpret the post-pandemic inflation surge since 2020. We find that fiscal inflation did contribute significantly to the surge in inflation. Expansionary fiscal policy contributed to higher inflation mostly in 2021, offsetting the disinflationary effects of negative demand developments following the outbreak of the pandemic. The inflationary impact of negative supply shocks is enhanced by the partial fiscal backing and explains most of the rise and fall in inflation in 2022 and 2023.

Finally, in Section 5, we investigate the robustness of our results when allowing for shock and time-specific degrees of fiscal backing.

Related literature

The paper contributes to various strands of the literature on monetary and fiscal policy interaction. First, it builds on the Fiscal Theory of the Price Level (FTPL) pioneered by Leeper (1992), Sims (1994), Woodford (2001) and Cochrane (2001) and more recently extensively discussed and summarized in Leeper and Leith (2016) and Cochrane (2023). As discussed above, most of that literature discusses the fiscal/monetary policy regime in terms of two stable equilibria: In Leeper's (1992) terminology: an active monetary policy, passive fiscal policy regime (AM/PF) versus a passive monetary policy, active fiscal policy regime (PM/AF). Chung et al (2007) analyse the impact of switches in regime on the propagation of fiscal shocks. Bianchi and Ilut (2017) and Bianchi and Melosi (2020) adopt a regime-switching model to estimate the probability of being in one or the other regime. For the US economy they find that the probability of being in the fiscal dominance regime was high in the 1960s and 1970s and again following the great recession of 2008.[3]

Our paper is closer to the seminal work of Bianchi and Melosi (2022) and BFM (2023) that allows for mixed regimes in which both funded and unfunded fiscal transfer shocks can affect the economy. BFM (2023) show that unfunded fiscal transfer shocks can explain a lot of the persistent inflation in the United States. A closely related paper is Balke and Zarazaga (2024). They introduce both funded and unfunded fiscal shocks in a Smets-Wouters model with a passive monetary policy reaction function and find that unfunded fiscal shocks contribute roughly one-third of the 2021-2022 post-

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[3] See also Hinterlang and Hollmayer (2022) for a classification of monetary and fiscal-led regimes using machine learning techniques.

Covid increase in inflation, and that they played yet a more significant role during the 1970s and 1980s, when their contribution to the rise and fall of inflation was roughly 50%. Relative to this work we allow all shocks to be partially fiscal funded and study the empirical implications of partial fiscal backing for the propagation of those shocks (also non-fiscal shocks) to economic activity and inflation. Our paper is also related to Cochrane (2022), which assumes that fiscal authorities do respond to deficits by engineering future surpluses, but not sufficiently to fully fund the ensuing government debt. Under these assumptions, Cochrane (2022) analyses the effect of fiscal and monetary policy shocks in a fiscal-led equilibrium.

The implications of different fiscal policy regimes for monetary policy have also been studied in standard New Keynesian frameworks. Most notably, Benigno and Woodford (2006) analyse the optimal monetary policy response to unfunded fiscal shocks in the usual linear-quadratic framework of a standard New Keynesian model. They show that it is optimal for the central bank to internalise the unfunded nature of the fiscal spending by allowing the temporary inflation needed to satisfy the intertemporal government budget constraint. Nonetheless, optimal monetary policy can still be implemented through a form of flexible inflation targeting and it remains critical that inflation expectations (beyond some very short horizon) remain anchored in response to such shocks. Similarly, Harrison (2022) and Kumhof et al (2010) respectively analyse optimal time-consistent monetary policy and simple instrument rules in an economy with unfunded fiscal policy. Our paper provides a positive analysis of the extent to which the central bank accommodates unfunded government debt developments and its implications for inflation.

Our empirical results on the impact of partial fiscal backing on the transmission of fiscal shocks speak to the large literature on fiscal multipliers and their dependence on the monetary policy regime. This literature includes the model-based analysis of Christiano et al (2017) and Woodford (2011) as well as the empirical work of Ramey and Zubairy (2018), Leeper et al (2017) and Corsetti et al (2012). Both theoretically in the context of New Keynesian DSGE models as well as empirically this literature shows that government spending multipliers on economic activity depend on the monetary policy reaction function. Christiano et al (2017) show that those multipliers can be much larger than one if the monetary authority commits to keep interest rates constant. Our empirical work is closely related to Leeper et al (2017). They estimate a modified Smets-Wouters model with a set of different tax and transfer policies under two different regimes (monetary-led and fiscal-led) to investigate the multipliers of government spending shocks. They find that the posterior odds of both regimes are similar, that the short-run government spending multipliers are comparable (but with different transmission mechanisms) and that the long-run multipliers are much higher in the fiscal-led regime compared to the monetary-led regime. A recent paper that empirically investigates the dependence of the economic effects of government spending shocks on the monetary policy reaction function is Hack et al (2023). It shows that the estimated effect of an expansionary government spending shock is highly dependent on the hawkishness of the FOMC. When the FOMC is more dovish, higher government spending leads to a significant GDP expansion, a fall in the federal funds rate and a rise in inflation expectations. Conversely, when the FOMC is more hawkish, increased spending rather leads to a decline in GDP, a rise in the Federal Funds Rate, effectively preventing a rise in inflation expectations. With a hawkish FOMC, the standard fiscal spending multiplier is insignificant, with estimates at or below 0. In contrast, under a dovish FOMC, the multiplier is highly statistically significant, ranging between 2 and 3. Our paper supports such empirical results in the context of an estimated, medium-scale New Keynesian DSGE model with partial fiscal backing.

Several recent empirical papers highlight that the fiscal/monetary policy regime matters for the inflationary effects of fiscal shocks. Banerjee et al (2022) show that the inflationary effect of fiscal deficits depends on the prevailing fiscal-monetary policy regime. Under a fiscal-led regime, the average effect on inflation of higher deficits is found to be up to five times larger than under a monetary-led regime. Based on forecasts from their model, the high inflation experienced by many countries during the recovery from the Covid-19 pandemic appears more consistent with a fiscal-led regime than a monetary-led one. Barro and Bianchi (2023) focus on the inflationary implications of the fiscal expansion following the Covid-19 shock. Based on the FTPL, they derive a simple relationship between the cumulative fiscal expansion during the Covid-19 period and inflation and test it across the OECD countries. Their key finding is that about 40% of the cumulative fiscal expansion is unfunded giving rise to a highly significant relationship with inflation. To find this result it is crucial to modify the cumulative fiscal expansion with the inverse of the nominal government debt to GDP ratio and a measure of the average maturity of government debt as highlighted by the FTPL.[4]

Finally, there is also a related literature on how the degree of fiscal backing affects the transmission of monetary policy shocks. In a standard New Keynesian model without fiscal backing, Caramp and Silva (2022) show that a contractionary monetary policy reduces inflation only if followed by contractionary fiscal policy. The slope of the Phillips curve determines the importance of monetary-fiscal coordination for the effectiveness of monetary policy, i.e. more sticky prices imply less need for fiscal backing. Similarly, when the debt has a long maturity than there is less need for fiscal backing and the effectiveness of monetary policy will also be larger. Caramp and Feilich (2022) find that these findings are consistent with US data.[5]

2. Partial fiscal backing and inflation in a simple Fisherian and New Keynesian model

In this section we illustrate our methodology based on BM (2022) and BFM (2023) using a simple Fisherian and New Keynesian model. This facilitates building the intuition for the impact of different degrees of fiscal backing on the transmission mechanism of various business cycle shocks to the economy and inflation.

The main novelty of our approach is to allow for intermediate regimes between what Bianchi and Melosi (2022) call a monetary-led and a fiscal-led regime.[6] In such an intermediate regime, fiscal policy generally commits to serve current debt by running future surpluses, but it may not take the full burden of fiscal adjustment. Cochrane (2022) describes this as a regime of partial fiscal backing

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[4] On the inflationary effects of government debt surprises, see also Brandao-Marquez et al (2023) and Grigoli and Sandri (2023).

[5] See also Kloosterman, Bonam and Vanderveer (2022). They estimate the effect of monetary policy shocks across contractionary and expansionary fiscal regimes in the euro area. An expansionary monetary policy shock leads to an increase in inflation and output growth, but only when it occurs in the expansionary fiscal regime. In a contractionary fiscal regime, the responses to a monetary easing are insignificant or even negative. Similarly, a monetary tightening only reduces inflation and output in the contractionary fiscal regime. They also show that the variable that reflects most this behaviour is consumption corroborating the importance of the wealth effect. Afonso et al (2023) study the effect of monetary surprises on real output and the price level, conditioned on different fiscal sustainability regimes in the period 2001Q4-2021Q4. The results show that in a Ricardian regime, output and prices respond to monetary tightening by contracting, while in a non-Ricardian regime the effect on output and price levels is negligible (or even positive).

[6] These regimes are identical to the “active” monetary policy and “passive” fiscal policy and “passive” monetary policy and “active” fiscal policy regimes described in Leeper (1991).

and discusses how this may be interpreted as the central bank following a stochastic inflation target, whereby the time-varying inflation target serves to stabilise the unbacked portion of the government debt. Cochrane (2022) implements this idea in a fiscal-led equilibrium. We follow BFM (2023), which starts from the monetary-led regime, but allows for some fiscal shocks to be unfunded meaning that the monetary/fiscal policy reaction function to those shocks is consistent with a fiscal-led regime.

We extend the BFM (2023) methodology in two ways. First, while BFM (2023) allows for both extremes, totally funded and totally unfunded fiscal shocks, we allow the fiscal shock to be partially funded in the spirit of Cochrane (2022). This means that only a fraction of the fiscal shock is unfunded. The degree of fiscal backing will then determine to what extent the monetary authorities need to deviate from their standard reaction function, as characterised by a time-varying inflation target which depends on the portion of unfunded debt. Second, we extend the idea of partial fiscal backing to all business cycle shocks (not just fiscal policy shocks), as all those shocks have potential fiscal implications which may be backed or not. The implications of lack of fiscal backing for a monetary policy shock have been investigated by Sims (2011) and Cochrane (2017). But other business cycle shocks such as negative supply shocks also have fiscal implications that may be partially unbacked with implications for the persistence of the inflation response.

The main objective of the paper is to empirically determine the degree of fiscal backing in response to various business cycle shocks, its impact on the transmission process of these shocks and the implications for the source of business cycles and inflation developments. The simple Fisherian and New Keynesian models analysed in this section are meant to illustrate the methodology and how partial fiscal backing changes the transmission mechanism of shocks to the economy. As in BFM (2023), we first illustrate the impact of the intermediate regime on fiscal shocks using a simple Fisherian model. Then we analyse the impact of other shocks using a standard forward-looking New Keynesian model. Section 3 will then implement this methodology in an estimated version of the medium-scale DSGE model of Smets and Wouters (2007).

2.1. A Fisherian model with partial fiscal backing

The Fisherian model can be derived from a simple endowment economy with flexible prices and one-period nominal government debt. Its linearised version is characterised by the following four equations (Leeper, 1991 and BFM, 2023):

(1) $R_t = E_t \pi_{t+1}$

(2) $b_t = \beta^{-1} b_{t-1} + b\left(R_t - \beta^{-1}\pi_t\right) - \tau_t$

(3) $R_t = \psi \pi_t$

(4) $\tau_t = \delta_b b_{t-1} - \varepsilon_t^{\tau}$

where R_t is the short-term nominal interest rate at time t, π_t is the inflation rate, b_t is the government debt over GDP ratio, β is the discount rate, τ_t is the primary surplus to GDP ratio, and ε_t^{τ} is a government transfer shock.

Equation (1) is the one-to-one Fisher relationship between the nominal interest rate and expected inflation. Equation (2) is the linearised government budget constraint which states that current debt is a function of lagged government debt, the real interest rate and the primary surplus. Equations (3) and (4) are the monetary and fiscal policy reaction functions. Equation (3) says that the nominal interest rate set by the central bank responds to inflation. Equation (4) states that the primary surplus is set by the fiscal authorities as a function of past government debt and a transfer shock.

Combining equations (1) and (3) and (2) and (4) gives a system of two differential equations in π_t and b_t:

(5) $E_t \pi_{t+1} = \psi \pi_t$
(6) $b_t = (\beta^{-1} - \delta_b) b_{t-1} - b(\beta^{-1} - \psi)\pi_t + \varepsilon_t^{\tau}$

Leeper (1991) and BFM (2023) show that there are two possible stable equilibria depending on the configuration of the monetary and fiscal reaction coefficients, ψ and δ_b.

The monetary-led regime corresponds to Leeper (1991)'s regime with an active monetary policy ($\psi > 1$) and a passive fiscal policy ($\delta_b > \beta^{-1} - 1$) (AM/PF). In this regime, the so-called Taylor principle holds, and the central bank increases nominal interest rates more than one-for-one to inflation, whereas fiscal policy takes care of the higher interest payments on government debt by increasing the primary surplus in response to increases in past government debt. In this equilibrium an unexpected increase in lump sum transfers has no impact on inflation or the economy because Ricardian equivalence holds. Agents in the economy expect the current increase in transfers to be offset by future increases in taxes as they adjust to the higher debt. In Figure 1 the impulse response under the monetary-led regime is the line which corresponds to $\lambda = 1$.

The alternative regime, the fiscal-led regime, corresponds to Leeper (1991)'s regime of a passive monetary policy ($\psi \leq 1$) and an active fiscal policy ($\delta_b \leq \beta^{-1} - 1$) (PM/AF). In this regime, fiscal policy is unfunded in the sense that primary surpluses do not respond sufficiently to changes in government debt to ensure sustainability. Instead, inflation adjusts to devalue the nominal debt and to ensure the government intertemporal budget constraint continues to hold in response to exogenous changes in fiscal policy. This is made possible by a passive monetary policy which does not raise real interest rates in response to inflation. This regime corresponds to the equilibrium emphasised in the FTPL. As shown in Figure 1 with the line corresponding to $\lambda = 0$, in this equilibrium a positive transfer shock gives rise to a jump in inflation, which keeps the value of government debt constant. As a result, there is no need for future primary surpluses to ensure government debt sustainability.

An important contribution of BFM23 is to show that one can define a mixed regime where some fiscal shocks are funded, whereas others are unfunded. To allow for unfunded fiscal shocks in a regime where all other shocks propagate in a monetary-led regime, they propose to modify the policy reaction functions as follows:

(7) $\tau_t = \delta_b^M (b_{t-1} - b_{t-1}^F) + \delta_b^F b_{t-1}^F - \varepsilon_t^{\tau M} - \varepsilon_t^{\tau F}$
(8) $R_t = \psi^M (\pi_t - \pi_t^F) + \psi^F \pi_t^F$

where b_t^F is unfunded government debt and π_t^F is fiscal-led inflation which finances the unfunded government debt. $\varepsilon_t^{\tau M}$ and $\varepsilon_t^{\tau F}$ are the funded and unfunded fiscal transfer shocks and it is assumed that $\psi > 1$ and $\delta_b > \beta^{-1} - 1$). As suggested by equation (8), fiscal-led inflation, π_t^F, can be viewed as a time-varying inflation target necessary to finance the unfunded debt.

Unfunded debt and fiscal-led inflation are determined in a shadow economy which operates under a fiscal-led regime and only features the unfunded shocks, $\varepsilon_t^{\tau F}$. More concretely, the unfunded debt and corresponding fiscal-led inflation are determined in the following fiscal-led shadow economy:

(9) $E_t \pi_{t+1}^F = \psi^F \pi_t^F$

(10) $b_t^F = \left(\beta^{-1} - \delta_b^F\right) b_{t-1}^F - b(\beta^{-1} - \psi^F)\pi_t^F + \varepsilon_t^{\tau F}$

where it is assumed that $\psi^F \leq 1$ and $\delta_b^F \leq \beta^{-1} - 1$).

BFM23 assume that the fiscal transfer shocks are either totally funded or totally unfunded and are uncorrelated. One can, however, also define intermediate regimes where a fiscal shock may be partly funded. In the Fisherian model developed above this can be implemented by defining $\varepsilon_t^{\tau M} = \lambda \varepsilon_t^{\tau}$ and $\varepsilon_t^{\tau F} = (1 - \lambda)\varepsilon_t^{\tau}$, where the parameter λ captures the degree of fiscal funding. If $\lambda = 1$, we are back to the monetary-led regime discussed above. The fiscal shock is fully funded and will have no impact on inflation. If instead $\lambda = 0$, there is no fiscal backing and we are in the fiscal-led regime where inflation will adjust to ensure debt sustainability. If λ takes an intermediate value, there is partial fiscal funding. A lower λ means a larger share of unfunded fiscal debt and more fiscal-led inflation.

Figure 1 shows the impulse responses to a positive fiscal transfer shock for different degrees of fiscal funding. The lower the fiscal funding, the higher the inflation response, the smaller the response of the debt ratio and the smaller the response of future primary surpluses. In this model with one-period nominal government debt, the value of nominal debt can only be affected by the instantaneous surprise in inflation. In the extreme regime of no fiscal backing (fiscal-led regime), the inflation rate jumps up to keep the market-value of debt unchanged.

As shown by BFM (2023), the monetary policy reaction coefficient to inflation in the fiscal-led shadow economy determines the persistence of inflation through the Fisherian effect. As can be seen from Figure A1 in the appendix, when the nominal interest responds to inflation (e.g. $\psi^F = 0.99$), the effect of the fiscal expansion on inflation will be more persistent. This will also affect the price of government bonds and lead to a proportional increase in the nominal market value of debt. There is, however, no impact on the expected path of primary surpluses and in this model with one-period nominal government debt the impact effect on inflation will be the same.

Insert **Figure 1**

2.2. A New Keynesian model with partial fiscal backing

The previous section showed how one can use the BFM23 methodology to analyse fiscal shocks in monetary/fiscal policy regimes with partial fiscal backing. This methodology can be generalised to all shocks in the economy that have fiscal implications. To illustrate this, in this section a standard forward-looking New Keynesian model with sticky prices is used. Following Woodford (2001) and Cochrane (2001) the model also features nominal long-term government debt with a coupon that is decaying at a constant rate. As shown by Cochrane (2001), this is important for persistent inflation to have an impact on the valuation of government bonds. It will allow monetary policy to smooth out fiscal inflation and its effects on output.

The linearised New Keynesian model is described by the following eight equations:

Euler/IS equation:

(11) $y_t = E_t y_{t+1} - [R_t - E_t \pi_{t+1}] + \varepsilon_t^d$

New Keynesian Phillips curve:

(12) $\pi_t = \kappa(y_t - y_t^*) + \beta E_t \pi_{t+1}$

Output target:

(13) $y_t^* = \varepsilon_t^a$

No arbitrage condition:

(14) $R_t = E_t R_{t,t+1}^b$

Return on long-term bond:

(15) $R_{t-1,t}^b = \frac{\rho_M}{R} P_t^b - P_{t-1}^b$

Government budget constraint:

(16) $b_t = \beta^{-1} b_{t-1} + b\beta^{-1}\left(R_{t-1,t}^b - y_t + y_{t-1} - \pi_t\right) - \tau_t$

Monetary policy rule:

(17) $R_t = \rho_R R_{t-1} + (1-\rho_R)\left[\psi_\pi(\pi_t - \pi_t^F) + \psi_\pi^F \pi_t^F + \psi_y(y_t - y_t^*)\right] + \varepsilon_t^{mp}$

Fiscal policy rule:

(18) $\tau_t = \rho_\tau \tau_{t-1} + (1-\rho_\tau)\left[\delta_b(b_{t-1} - b_{t-1}^F) + \delta_b^F b_{t-1}^F + \delta_y y_t\right] + \delta_{dy}(y_t - y_{t-1}) + \varepsilon_t^\tau$

where y_t and y_t^* are respectively output and potential output (or the output target), $R_{t-1,t}^b$ is the ex-post return on the long-term government bond, P_t^b is the price of the bond. Equation (15) defines the ex-post return on the long-term bond (Cochrane, 2001 and 2023). Equation (14) is a no-arbitrage condition that the expected return on holding the long-term bond equals the interest rate on the one-period bond.

The economy is driven by four exogenous and independent processes. Supply, ε_t^a , and demand, ε_t^d, disturbances follow an autoregressive process of order one, whereas the monetary policy and fiscal transfer shocks, ε_t^{mp} and ε_t^τ, are iid processes.

The monetary and fiscal policy rules (17) and (18) again capture the fact that the joint fiscal and monetary policy response to the various shocks is only partially funded. As in the simple Fisherian model, b_t^F is non-funded debt, i.e. the part of debt which is not expected to be backed by future fiscal surpluses, and π_t^F is fiscal-led inflation, i.e. the part of inflation that ensures the sustainability of the unfunded debt and that can be described as a time-varying fiscal inflation target. The distinction between funded and unfunded debt and monetary-led and fiscal-led inflation is implemented by imposing that ψ_π is greater than one (i.e. it satisfies the Taylor principle) and δ_b is sufficiently greater than zero implying that future surpluses back up an increase in funded debt. In the calibration below we will assume that ψ_π^F and δ_b^F are equal to zero capturing the fiscal-led policy regime.[7] Also note that the primary surplus is assumed to be procyclical. It responds positively to the level and changes in economic activity through increased government revenues and reduced transfers giving rise to partial self-financing to the extent that an expansionary fiscal shock stimulates output.

As discussed in the previous section, unfunded debt and fiscal-led inflation are determined in a fiscal-led shadow economy that keeps track of both variables. This shadow economy is identical to

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[7] These reaction coefficients could be positive, but need to satisfy adjusted conditions for a unique equilibrium. Below we will show the sensitivity of the results to the monetary policy reaction coefficient to inflation in the fiscal-led regime.

equations (11) to (16) where all endogenous variables carry a subscript F and are associated with the fiscal-led regime and the shock processes are preceded by a fraction (1-λ) which as before captures the degree of fiscal backing and can be shock-specific. The shadow economy also contains the following monetary and fiscal policy reaction functions:

$$(19) \qquad R_t^F = \rho_R R_{t-1}^F + (1-\rho_R)\left[\psi_\pi^F \pi_t^F + \psi_y \; (y_t^F - y_t^{*F})\right] + (1-\lambda_{mp})\varepsilon_t^{mp}$$

$$(20) \qquad \tau_t^F = \rho_\tau \tau_{t-1}^F + (1-\rho_\tau)\left[\delta_b^F b_{t-1}^F + \delta_y y_t^F\right] + \delta_{dy}(y_t^F - y_{t-1}^F) + (1-\lambda_\tau)\varepsilon_t^\tau$$

In BFM23 only the unfunded fiscal shock enters the shadow economy. As a result, unfunded debt and fiscal-led inflation is only driven by this shock. In contrast, we assume that a fraction $1-\lambda$ of each shock (both structural and policy shocks) affects the shadow economy. The parameter λ can be shock dependent. In other words, in our set-up all shocks can drive fiscal-led inflation.

To show the effects of partial backing on the transmission mechanism of the various shocks, we calibrate the economy using the estimated structural parameters of Bianchi and Melosi (2022) as listed in Table A1 of the appendix. The average maturity of government debt is calibrated to be equal to six years in line with the evidence for the US in BFM (2023). We assume that the AR(1) parameters in the supply and demand shock processes and the smoothing parameter in the monetary and fiscal policy reaction functions (ρ_R and ρ_τ) are equal to 0.9. Finally, we assume that in the fiscal-led shadow economy there is no fiscal policy response to debt ($\delta_b^F = 0$) and no monetary policy response to inflation ($\psi_\pi^F = 0$), and that the persistence of the policy rules and the response to the output gap and output in the monetary and fiscal policy reaction functions are the same in the fiscal-led shadow economy as in the actual economy.

Figures 2 to 5 show how the impulse responses to the four shocks vary with different degrees of fiscal backing. We plot the impulse responses for five values of λ. When λ is equal to one, we are in the conventional monetary-led regime and the impact of the shocks on the economy are quite standard. When λ is equal to zero, we are in the fiscal-led regime. Fiscal policy is active and determines inflation. With long-term nominal debt, monetary policy only manages to distribute inflation over time. Values of λ in between zero and one describe intermediate regimes of partial fiscal backing.

We first discuss the fiscal transfer shock (Figure 2). With full fiscal backing an expansionary fiscal transfer shock has no effect on inflation, output and the short-term nominal and real interest rate. Ricardian equivalence holds. Households understand that in this regime the current increase in lump sum transfers will be offset by future taxes. Government debt initially rises due to the accumulation of primary deficits but is eventually paid back through the accumulation of future primary surpluses.[8] With partial fiscal backing, a part of the debt is unfunded and contributes to a pronounced and persistent increase in inflation, which is accommodated by the central bank. In this case, the observed inflation response is identical to an increase in fiscal-led inflation, i.e. the time-varying inflation target that accommodates the rise in unfunded debt. The rise in inflation leads to an immediate drop in the market value of debt reducing the need for future fiscal surpluses. The associated fall in the ex-ante real rate stimulates economic activity, which in turn reduces the primary deficits and the accumulation of government debt. Part of the fiscal stimulus becomes self-financing. In sum, under partial fiscal backing, the fiscal multiplier rises. The size of these effects is inversely related to the degree of fiscal backing and the largest when there is no fiscal backing, i.e. in

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[8] In a more realistic model with finite lives or where some households face credit constraints, a rise in lump sum transfers would have a positive impact on output and inflation.

the fiscal-led regime when $\lambda = 0$. An alternative interpretation is that with partial fiscal backing, Ricardian equivalence breaks down as part of the rise in debt is seen as a rise in net wealth. As a result, economic activity rises, pushing up inflation and contributing to a fall in the value of government debt.

Insert **Figure 2**

Figure 3 illustrates how the responses to a transfer shock under partial fiscal backing are affected by the degree of price stickiness. Higher price stickiness (a flatter Phillips curve) leads to a lower, but somewhat more persistent inflation and output response of the transfer shock. The impact on primary balance and government debt are limited.

Insert **Figure 3**

As discussed in section 2.1, another important parameter determining the persistence of the inflation response under partial fiscal backing is the reaction coefficient of the nominal interest rate to inflation in the fiscal-led shadow economy. In the baseline calibration we assume that the interest rate does not react to inflation ($\psi_\pi^F = 0.0$). Figure 4 illustrates the impact of increasing this reaction coefficient to 0.4 and 0.8. As in the Fisherian model, the main impact is to increase the persistence of the response of inflation, the nominal interest rate and the nominal value of debt. However, in this case it also reduces the response of output as the real rate drops by less. As inflation is spread out over the maturity of the bond, the initial impact on inflation is less and so is the impact on output.[9]

Insert **Figure 4**

Finally, figure A2 in the appendix shows the impact of varying the response of the primary balance to output and output growth in the fiscal policy reaction function. A zero response of the primary balance ratio to economic activity leads to a larger output and inflation response to the expansionary transfer shock, a bigger drop in the real rate and a lower path for government debt ratio. The absence of automatic fiscal stabilisers increases the impact of the fiscal expansion on the primary deficit and thereby increases the need for fiscal inflation to stabilise the debt.

As discussed before, in this model all shocks with fiscal implications will give rise to fiscal inflation. Next, we investigate the impact of a monetary policy shock (Figure 5). In the monetary-led regime ($\lambda = 1$), a monetary policy tightening leads to a rise in the real interest rate as prices are sticky and a fall in output and inflation. On the fiscal side, the rise in the real rate and the persistent fall in inflation contribute to a rise in the value of government debt and the fall in activity translates into a primary deficit, also contributing to a rise government debt ratio. Several papers have analysed the impact of the FTPL on the transmission process of monetary policy shocks and emphasised the "stepping on a rake" effect (Sims, 2011, Cochrane, 2017, Caramp and Silva, 2022). In the FTPL equilibrium ($\lambda = 0$) the incipient rise in debt is unbacked and will give rise to higher current and

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[9] Bianchi et al (2023) also show the importance of allowing for long-term debt and a positive reaction function coefficient of the short-term rate to inflation for creating a persistent response of inflation. In a model with nominal rigidities, the latter will determine the split between adjustments in the real growth rate due to the fall in the real rate and adjustments in inflation. With a larger, but less than zero, reaction coefficient to inflation, inflation will be larger (also in line with the Fisher effect) and the growth adjustment lower (and vice versa).

expected inflation, putting downward pressure on the value of debt. With partial fiscal backing, the inflationary impact will be proportional to the unfunded part of the rise in government debt. Overall, this undermines any attempt of monetary policy to bring down inflation. The fiscal-led inflation and its negative impact on the value of the government debt allows for smaller futures surpluses and somewhat higher output.

Insert **Figure 5**

Partial fiscal backing also enhances the inflationary effects of a negative supply shock. As shown in Figure 6, in the monetary-led regime ($\lambda = 0$), a negative supply shock leads to a large fall in output and a moderate rise in inflation. Monetary policy responds by raising nominal and real interest rates to rein in inflation. The fall in output and the resulting increase in the government deficit leads to a persistent rise in government debt, in spite of the fact that rising interest rates reduce the value of debt. This in turn leads to a tightening of fiscal policy over time. Under partial fiscal backing, government debt rises much less or may even fall as a part of this debt is inflated away reducing the value of debt. Real interest rates initially fall and stimulate demand and output, which reduces the primary deficit and the rise in government debt. With partial fiscal backing, government debt is considered to be net wealth and stimulates demand and inflation. In summary, partial fiscal backing alleviates fiscal sustainability associated with a fall in economic activity due to negative supply developments, but at the cost of moving the output inflation tradeoff towards higher inflation.

Insert **Figure 6**

Finally, Figure 7 illustrates the effects of a demand shock under different degrees of fiscal backing. In the monetary-led regime, the positive demand shock leads to a rise in output and inflation, which is counteracted by a tightening of monetary policy and in the short run also of fiscal policy. The government debt ratio falls as higher inflation reduces the value of the debt, higher output and inflation increase the denominator and initial primary balances go into surplus. In response, primary surpluses subsequently fall into deficit to bring the debt back to its steady state equilibrium. In this case, partial fiscal backing strengthens the transmission on inflation and output. These effects are similar to those when monetary policy is restricted to respond under the effective lower bound. Overall, the transmission of demand shocks are less affected by partial fiscal backing than those of supply shocks as the positive fiscal implications of higher nominal output are offset by the negative fiscal implications of rising real rates.

Insert **Figure 7**

3. Estimating the Smets-Wouters (2007) model with partial fiscal backing

In this section, we extend the Smets-Wouters (2007) model with a fiscal block to estimate the degree of fiscal backing in the US economy since the 1960s and investigate the implications for the inflationary effects of business cycle shocks and the sources of business cycles.

3.1. Extended Smets-Wouters model

We extend the Smets-Wouters (2007) model in three directions. First, we explicitly introduce a fiscal policy block. This block includes the intertemporal government budget constraint describing the evolution of government debt. As in BFM23 and in section 2.2, we use Woodford's (2001) portfolio of bonds with exponentially declining coupons to capture the average maturity of the US government debt. The resulting government budget constraint is given by:

$$b_t = \beta^{-1} b_{t-1} + b\beta^{-1}\left(R^b_{t-1,t} - \pi_t - y_t + y_{t-1}\right) - \tau_t + tra_t + g_t \tag{21}$$

where tra_t are government transfers, g_t is government spending, τ_t are government revenues and $pb_t = \tau_t + tra_t + g_t$ is the primary balance over steady-state GDP. As before, the realised return on the long-term government bond is given by equation (15) above and equals in expectation the short-term interest rate through an arbitrage equation as in (14).

Fiscal policy consists of three reaction functions:

$$\tau_t = \rho_\tau \tau_{t-1} + (1-\rho_\tau)\left[\delta_b^\tau (b_{t-1} - b^F_{t-1}) + \delta_y (y_{t-1})\right] + \delta_{dy}(y_t - y_{t-1}) + \varepsilon_t^\tau \tag{22}$$

$$tra_t = \rho_{tra} tra_{t-1} + (1-\rho_{tra})[\delta_b^{tra}(b_{t-1} - b^F_{t-1})] - \delta_{dh}(h_t - h_{t-1}) + \varepsilon_t^{tra} \tag{23}$$

$$g_t = \rho_g g_{t-1} + \left(1-\rho_g\right)\left[\delta_b^g (b_{t-1} - b^F_{t-1})\right] + \varepsilon_t^g \tag{24}$$

The degree of persistence and the responsiveness to changes in government debt in the three fiscal policy reaction functions are instrument-specific and will be estimated in Section 3.2. In addition, we assume that government revenues (taxes) increase as the economy grows both in the short and long run, whereas government transfers respond negatively to changes in hours worked. This captures the fact that government revenues are procyclical and transfers like unemployment benefits are countercyclical.

Second, to take into account the zero lower bound periods after the Global Financial Crisis, we extend the dataset with a 1-year short-term interest rate and introduce an additional monetary policy shock that captures the impact of forward guidance. The monetary policy reaction function is modified as follows:

$$\begin{aligned} R_t = \rho_R R_{t-1} + (1-\rho_R)\left[\psi_\pi(\pi_t - \pi_t^F) + \psi_\pi^F \pi_t^F + \psi_y\left((y_t - y_t^*) - (y_t^F - y_t^{F*})\right)\right] + \\ \psi_{dy}\left(\Delta(y_t - y_t^*) - \Delta(y_t^F - y_t^{F*})\right) + \varepsilon_t^{mp} \end{aligned} \tag{25}$$

As in Section 2 and following BFM (2023), we introduce an implicit time-varying inflation target as well as an associated output target, which captures the inflation that is necessary to cover the unfunded government debt.

Third, we append the Smets-Wouters model with a shadow economy like in the simple examples of Section 2, which keeps track of the unfunded government debt, b_t^F, and the associated fiscal inflation, π_t^F, and output gap, $(y_t^F - y_t^{F*})$. This shadow economy replicates all the equations of the Smets-Wouters model where the endogenous variables are superscripted with F, associated with the fiscal-led regime, and are affected by a fraction (1- λ) of the structural shocks. (1- λ) is assumed to be the same for all shocks and captures the weight on the fiscal-led policy regime. The monetary policy reaction function in the fiscal-led shadow economy is given by:

$$R_t^F = \rho_R R_{t-1}^F + (1-\rho_R)\psi_\pi^F \pi_t^F + (1-\lambda)\varepsilon_t^{mp} \tag{26}$$

We assume that the degree of interest rate smoothing is the same as in (25). The reaction coefficient to inflation is less than one capturing the fiscal-led regime and there is no reaction to current or lagged output gaps in the shadow economy.[10] The fiscal policy reaction functions in the shadow economy feature the same degree of persistence, but a zero response to the debt variable. Finally, like all the other shocks in the shadow economy, each of the fiscal shocks is preceded by the parameter (1- λ), capturing the degree to which the fiscal shocks are unfunded. The full set of equations is given in the appendix (to be completed).

3.2. Estimation of the extended Smets-Wouters (2007) model with partial fiscal backing

We estimate the extended Smets-Wouters model using the seven data series used in Smets and Wouters (2007) plus the one-year interest rate and four fiscal variables: the market value of US government debt, the total government primary balance, social security transfers and government spending.[11] The sample period is 1965Q1 till 2019Q4. The data appendix gives the precise data definitions and sources. We do not include the pandemic crisis period to avoid that the unusual pandemic-related shocks unduly affect the whole-sample estimates. However, in section 4 we do investigate how the estimated model interprets the post-pandemic inflation period.

The left-hand panel of Table 1 shows the estimates of the structural parameters and the parameters driving the shock processes and compares those estimates with two alternative models. The middle column of Table 1 is the model with $\lambda = 1$, i.e. the model estimated under the assumption of a monetary-led regime. Apart from the addition of the fiscal block as observables, this corresponds most closely to the original Smets-Wouters (2007) model. The right-hand column of Table 1 shows the estimates of the same model with $\lambda = 0$, i.e. the estimated model under the fiscal-led regime. Note that in those cases the reaction coefficients in the fiscal and monetary policy functions in the regime with zero weight are for obvious reasons not identified.

A few findings are worth highlighting. First, as shown in Table 1 the mode of the estimated λ equals 0.83. In other words, the data prefers an intermediate monetary/fiscal policy regime where 83% of the fiscal implications of the various shocks are funded. This intermediate regime is preferred over the monetary-led regime, which has a log likelihood that is about 8 points lower. It is also preferred over the fiscal-led regime (the FTPL equilibrium) which has a likelihood which is 95 points lower. So, the data prefer a fiscal/monetary policy regime that is closer to the monetary-led than to the fiscal-led regime.

Second, the estimates of the structural parameters in the model with partial fiscal backing are generally similar to those of the model estimated in a monetary-led regime and in Smets and Wouters (2007). One exception is the degree of price and wage stickiness which rises as the degree of fiscal backing falls. The degree of price/wage stickiness is estimated to be 0.79/0.63 in the intermediate regime compared to 0.72/0.53 in the monetary-led regime. One interpretation is that when inflation expectations are directly affected by unfunded government debt, price stickiness needs to be larger to avoid that the immediate inflationary effects become too large. It is noteworthy that when the model is estimates under the assumption of a fiscal-led regime (right-hand-side column of Table 1), also the real rigidities are estimated to be much larger. For example, the degree of habit formation in the consumption function is 0.83 compared to 0.62 in the

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[10] When we allow for a response to the output gap, we find that the estimated reaction coefficient is not significantly different from zero.

[11] The Bayesian estimation is done using the Dynare package. See Adjemian et al (2022).

intermediate regime. Similarly, the investment cost parameter is 7.5 in the fiscal-led regime compared to 4.0 in the intermediate regime.

An important new parameter is the estimated average maturity of US government debt. The estimated parameter is 0.9, which corresponds to an average maturity of about 3 years, which is lower than the current average maturity of outstanding US federal debt of 6 years. This may be due to a lower average maturity in the early part of the sample as well as to the impact of quantitative easing which shortened the maturity of government debt in the hands of the private sector.

Another important set of parameters for the size of possible fiscal inflation effects is the persistence of the fiscal and other shocks. The transfer shock is estimated to have the highest persistence at 0.99, but also the government spending and tax shocks are estimated to have a high degree of persistence (0.93 and 0.92 respectively). This is consistent with the estimates of high persistence in BFM(2023). Amongst the other shocks, the supply shocks - productivity, price and wage mark-up shocks - are the most persistent at 0.97, 0.95 and 0.97 respectively.

Turning to the estimates of the monetary and fiscal reaction function parameters. The monetary policy response parameters in the monetary-led regime are quite standard and similar to those in the estimated monetary-led model. The monetary policy reaction coefficient to inflation in the fiscal-led regime is quite small at 0.20 and estimated with relatively large uncertainty (a 90% posterior interval of 0.07-0.83). With respect to the fiscal instruments, fiscal transfers are estimated to be most responsive to the government debt ratio (0.07), while both government spending and tax revenues respond less (0.02 and 0.01). Government revenues are estimated to be procyclical, whereas transfers are countercyclical.

Insert **Table 1**

3.2. Partial fiscal backing and the propagation of fiscal policy, monetary policy and business cycle shocks

In this section, we discuss the contribution of fiscal inflation to the effects of the fiscal and monetary policy shocks as well as of the various demand and supply shocks in the estimated Smets-Wouters model. As before, we first focus on the fiscal policy shocks.

Fiscal policy shocks

The qualitative impact of a positive public transfer shock in the estimated Smets-Wouters (2007) model is very similar to the one in the simple New Keynesian model (Figure 8). In a model with full fiscal backing, a rise in transfers would have no impact on real GDP, inflation, and interest rates, because in this case Ricardian equivalence holds in our representative agent model. Households realise that the current rise in income will be offset by future taxes or primary surpluses. With partial fiscal funding the expansionary and very persistent transfer shock does have a persistent positive effect on economic activity and inflation. The actual inflation response is equal to the response of fiscal-led inflation and contributes to a persistent fall in the value of government debt. In the estimated model, this reduction in government debt initially more than offsets the rise in debt under the monetary regime. Following a sharp, one-off rise in the deficit due to the temporary part of the transfer programme, the deficit turns into a surplus further contributing to the fall in the debt ratio. With partial fiscal backing the increase in transfers becomes partially self-financing because the boost of the economy increases tax revenues. These findings are similar to the estimates of BFM23 and reminiscent of the results of self-financing government transfers in Angeletos et al (2023).

An expansionary government spending shock has very similar effects. In contrast to the rise in lump-sum transfers an expansionary government spending shock has positive effects on output and inflation and leads to a tightening of monetary policy, a persistent government deficit and rising debt. As the degree of fiscal funding falls (smaller lambda), the effects on output and inflation are boosted, the primary deficit is less persistent and the rise in debt more delayed. Overall, these effects are however smaller than in the case of the transfer shocks because the persistence of the government spending shock is smaller. Finally, a rise in non-distortionary taxes has very similar effects on the economy as a change in transfers. Differences arise because the shock process is less persistent and the estimated feedback through the other components differs.

Insert **Figure 8**

Monetary policy shocks

Partial fiscal backing of a monetary policy tightening leads to the "stepping on a rake" phenomenon highlighted by Sims (2001) and Cochrane (2017) also in the estimated SW model. Because of sticky nominal prices and wages a policy tightening has a negative impact on economic activity and inflation, but partial fiscal backing leads to a rise in inflation down the road. Monetary policy is therefore less "effective" in bringing down in inflation when there is only limited fiscal backing. The estimated fiscal inflation effect is, however, relatively small, so that with an estimated lambda of 0.8 the effectiveness of monetary policy to bring inflation down is not impaired. This may be partly due to the relatively low estimated degree of persistence in the monetary policy rule (0.75) compared to the one assumed in the NK model (0.9).

Insert **Figure 9**

Supply shocks

Under partial fiscal backing fiscal inflation also enhances the inflationary effects of negative supply shocks, while the negative effects on output are reduced. The higher inflation contributes to a rise in nominal long-term interest rates and a fall in the value of government debt, whereas the smaller negative impact on output contributes to a smaller fall in the primary surplus. As a result, with partial fiscal backing the rise in government debt following a persistent negative productivity shock is less than under a monetary-led regime.

These effects are qualitatively similar for both negative productivity (Figure 10) and price mark-up shocks (Figure 11). The contribution of fiscal inflation in response to a price mark-up shock is, however, proportionally less, partially because the relatively larger increase in inflation due to the shock leads to an automatic fall in the value of government debt. Overall, partial fiscal backing changes the trade-off between output and inflation stabilisation towards the former. Similar considerations hold in response to wage mark-up shocks (not shown). However, in this case the boost to inflation and output may turn the negative impact on output in the monetary regime temporarily into a positive effect.

Insert **Figure 10**

Insert **Figure 11**

Demand shocks

The most important demand shock driving output fluctuations is the risk premium shock, which is estimated to be quite persistent. As with the monetary policy shock, the impact of partial fiscal backing on the effects of demand shocks is relatively small. A persistent rise in the risk premium leads to a fall in economic activity, inflation and real interest rates, puts pressure on government finances and leads to a rise in government debt by generating a government budget deficit in response to the recession and increasing the value of existing government debt through lower inflation and interest rates. Fiscal-led inflation and unfunded debt are small in this case.

Insert **Figure 12**: Impulse response to a risk premium shock in estimated SW model

In sum, we find that the empirical importance of fiscal inflation in the impulse responses is largest for the fiscal shocks (in particular the transfer shock), significant for the supply shocks, but less important for the demand shocks, including the monetary policy shock.

3.3. What drives inflation and business cycles?

Using the estimated Smets-Wouters model with partial fiscal backing, we now analyse the drivers of business cycle fluctuations in output and inflation. To simplify the analysis, we bunch the shocks together in four categories. Demand shocks include the risk premium, investment-specific technology and net export shocks. Supply shocks include the total factor productivity and price and wage-mark-up shocks. Fiscal policy shocks include the transfer, government spending and tax shocks and, finally, monetary policy shocks include the interest rate and forward guidance shocks.

Table 2 provides the variance decomposition with respect to these shocks for three horizons: one year, 2.5 years and 10 years. The big picture is not very different from Smets-Wouters (2007). Business cycle fluctuations in output are mostly driven by demand shocks. They explain between 60 and 70% of fluctuations in GDP at the one- and two-and-a-half-year horizon. The other shocks split the remainder explaining about 10% of those fluctuations. At the 10-year horizon, the role of demand shocks drops to less than 35%. Supply shocks have a more important effect on economic activity at this horizon, explaining 60%. Monetary and fiscal policy shocks do not significantly contribute to output fluctuations in the long run.

Inflation is instead mostly driven by supply shocks both in the short and the longer run: 80% or more over all horizons. The biggest contribution comes from price mark-up shocks that affect prices immediately. The risk premium shock has a significant, but much smaller impact on inflation. Somewhat surprisingly, the fiscal shocks do not contribute a lot to inflation at any horizon, although they do contribute around a quarter of the variation in fiscal inflation. Fiscal-led inflation is mostly driven by supply shocks, followed by fiscal policy shocks and to a lesser extent demand shocks.

Interest rates are mostly driven by demand shocks, as the central bank responds to recessions or booms by adjusting its monetary policy stance, while it generally looks through supply shocks. As the estimated persistence of the demand shocks is quite high, they also drive interest rates beyond the business cycle frequency and pick up the persistent downward trend in interest rates since the 1980s and after the Global Financial Crisis. In addition, there is a role for monetary policy shocks, driving interest rates in the short run. Qualitatively similar conclusions can be drawn for the ex-ante real interest rate.

New relative to Smets and Wouters (2007) is the account of the fiscal variables. Business cycle fluctuations of the primary balance are about equally driven by demand and fiscal policy shocks. This translates in an important role for demand shocks in driving changes in the public debt ratio. Monetary policy and price mark-up shocks have a less significant impact, although supply shocks are an important driver in the long run, also for the debt ratio, as government revenues increase with output. In line with the drivers of fiscal inflation and the discussion of the impulse responses in the previous section, unfunded government debt is mostly driven by supply and fiscal policy shocks and to a lesser extent, by demand shocks.

Insert **Table 2**

Overall, these conclusions about the drivers of the business cycle are also visible in the historical decompositions of the various endogenous variables (See Figure A3 in the appendix). More relevant for this paper is to what extent fiscal-led inflation and unfunded primary balances have contributed to the evolution of inflation and the fiscal balance. Figure 13 shows the decomposition of inflation into its monetary-led and fiscal-led component and the decomposition of the primary surplus in its funded and unfunded part. In line with the relatively high estimated degree of fiscal backing, we find that most of the inflation developments since the 1960s are monetary-led. Fiscal inflation did contribute to the inflation peaks of the 1970s. It contributed about one third of the inflation burst of the first half of the 1970s. Since then, the contribution has been limited, although it gradually became positive since the Global Financial crisis, thereby counteracting the low inflation period since then. The lower panel of figure 13 suggests that the fiscal inflation of the 1960s and 1970s created quite a bit of fiscal space with a maximum of almost 4 percent of GDP in 1974. This significantly contributed to the fall in the market-value of government debt during that period. The fiscal space created by the more recent fiscal inflation is smaller and between 1 and 2 percent of GDP.

Insert **Figure 13**

Figure 14 decomposes the sources of fiscal inflation and the unfunded fiscal balance with respect to various groups of shocks. The role of fiscal policy shocks is clear in the 1970s and also more recently, but according to this analysis it is not the only source of fiscal-led inflation. In the 1970s the various negative supply shocks also contributed to fiscal inflation.

Insert **Figure 14**

4. Explaining the post-pandemic inflation surge

This section uses the estimated SW model with partial fiscal backing to analyse the sources behind the inflation surge of the 2020s.

To account for the special nature of the pandemic-related recession, we consider three specific covid-19 related shocks in Q2 and Q3 of 2020.[12] First, a temporary productivity shock that enters the marginal cost, the production function and the real wage to capture the fact that the lock-down measures primarily lead to the closure of less productive sectors with corresponding lower wages. The standard deviation of this shock in 20Q2 and Q3 was 6% and 2% respectively. Second, a temporary forced savings shock that reduced the demand for consumption and investment. It enters in the first-order conditions for consumption and investment, including in the lag and lead terms. The standard deviation of this demand shock in 20Q2 and Q3 was respectively 10% and 3.3%. And, finally, a temporary shock to exogenous net export demand of 2.5% and 0.8% respectively. These three shocks serve to remove the extreme outliers in the business cycle behaviour caused by the pandemic and the associated containment measures in the second and third quarter of 2000. Apart

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[12] The main difference of the Covid shock from the usual shocks in our estimated model is that the Covid episode is best captured by a collection of temporary shocks. Our approach is based on an informal investigation of the one-off errors in the second and third quarter of 2002. For a more formal methodology for accounting for unusual shocks in estimated DSGE models see Ferroni et al (forthcoming).

from these temporary shocks, the estimated model uses the standard shocks to explain the developments since 2020.

Insert **Figure 16**.

Figure 16 depicts the historical shock decomposition of inflation, output, the short-term policy rate and the primary balance (and their decomposition in the monetary/funded and fiscal-led/unfunded component) since 2020. A few observations are worth mentioning. First, most of the rise and fall in inflation in this period is due to negative supply shocks, in particular price mark-up shocks. These shocks capture the various supply-chain distortions as well as the increase in energy prices and their upward impact on consumer prices. Second, the easing of fiscal policy on top of the direct impact from the pandemic-related shocks has positively contributed to both output and inflation with a peak in 2021Q2. This has substantially offset the negative effects of demand shocks on output and inflation in that period. Without fiscal stimulus the pandemic-related recession would have been deeper and more persistent and given rise to deflation in 2021. The important role of the unfunded fiscal component can also be seen from the decomposition of inflation and output in its monetary and fiscal-led component. In a purely monetary-led regime (shown in the second column of Figure 16), the negative supply shocks would have lifted inflation out of the deflation zone and peak inflation in the third quarter of 2022 would have been only 2 percentage points above target. At the same time, the recession would have been deeper and more persistent. The third column of Figure 16 shows that fiscal-led inflation and economic expansion allowed to offset the deflationary effects of negative demand shocks during this period and created a fiscal space of the order of 4% of GDP. Most of the fiscal inflation is due to expansionary fiscal policy, but also the cost-push shocks contributed to fiscal inflation in 2022. Finally, monetary policy shocks had a tightening impact in 2021 as nominal interest rates were constrained by the effective lower bound. This mildly contributed to deepening the recession and a limited negative impact on inflation.

5. Robustness analysis

This section provides robustness analysis by estimating alternative model specifications. We first let the degree of fiscal backing depend on the shock hitting the economy. Next, we allow for time variation in the degree of fiscal backing by estimating regime-switching models and allowing for independent funded and unfunded shocks. Finally, we consider alternative versions of the Smets-Wouters model that feature non-Ricardian effects of public transfer shocks.

Shock-specific degree of fiscal backing

In the baseline model of Section 4 we assumed that the degree of fiscal backing is the same for all shocks. In this section we allow for shock-specific $\lambda's$. We first differentiate the degree of fiscal backing in response to fiscal shocks from that in response to other shocks. The estimation results are reported in the second column of Table 3. The estimated degree of fiscal backing in response to fiscal shocks increases to 0.88, while the degree of fiscal backing following non-fiscal shocks remains similar to the one in the baseline model (0.82). The other estimation results and their implications for the propagation of various shocks are very similar to the baseline model (first column of Table 3). This is also reflected in a very similar log likelihood of the model. These estimation results contrast, however, with the assumption in BFM (2023) that λ is zero in response to fiscal transfer shocks (no fiscal funding) and one in response to all other shocks (full fiscal backing).

We also allow for specific λ's for each shock individually with a prior Normal distribution of N(0.83, 0.1). The estimation results are reported in the third column of Table 3. We find the highest degree of fiscal backing for two demand shocks: the risk premium shock and the investment-specific technology shock. In line with the previous result discussed in this section, the degree of fiscal backing of the fiscal shocks is generally also somewhat higher than in the baseline model, but not for the fiscal transfer shock. The supply shocks and the fiscal transfer shock have the lowest degree of fiscal backing. The log likelihood of the model increases by five points, but overall this analysis provides only limited evidence of systematic differences in fiscal backing across various shocks.

Time-specific degree of fiscal backing

In the baseline model of section 3 we assume that the degree of fiscal backing is constant over time. This stands in sharp contrast to Bianchi and Ilut (2017) and Bianchi and Melosi (2017) which assume that over time the fiscal/monetary policy regime switches between the two extremes of a fully monetary (λ=1) and fully fiscal-led ($\lambda = 0$) regime. In this section we compare our model with such a regime-switching model, as well as with a second, less extreme regime-switching model that considers two regimes with intermediate fiscal backing of $\lambda = 0.75$ and $\lambda = 0.90$ respectively. The estimation results are shown in Table 4.[13] The marginal log likelihood of the second model is very similar to the baseline model. The estimated regime transition probability matrix is [0.85 0.15 ; 0.11 0.89]. The marginal likelihood of the extreme switching model is slightly worse than the baseline model. In this case the estimated regime transition probability matrix is [0.89 0.11 ; 0.05 0.95]. Figure A4 shows the time-varying regime probability of the two models. Overall, there is only weak evidence of time variation in the degree of fiscal backing. There is some evidence of less fiscal backing in the 1970s, after the Global Financial Crisis and more generally after recessions.

This is also confirmed by sub-sample analysis. Table A2 in the appendix reports the Bayesian estimation results for two subperiods 1965:Q1-1979Q4 and 1985:Q1-2019Q4. First, we do not find a significant difference in the degree of fiscal backing across those two periods. Second, some of the structural parameters differ across those two subperiods in line with previous results reported in Smets and Wouters (2007). For example, the reaction coefficient to inflation and the estimated degree of price stickiness are higher in the most recent subsample. Third, the average maturity of government debt is estimated to be much smaller in the first period compared to the second period. At the same time, the reaction coefficient to inflation in the fiscal-led regime is estimated to be higher contributing to the persistence of the inflation process in the first period.

Uncorrelated funded and unfunded shocks

In the baseline model the assumption has so far been that each of the shocks are partially backed, implying that the funded and unfunded part of each shock are perfectly correlated. However, one can also follow the lead of BFM23 and assume that each shock has an uncorrelated funded and unfunded component. The middle column of Table A3 in the appendix presents the estimation results when making that assumption.

To make the results comparable with those of the baseline model, we assume that the ratio of the standard deviation of the unfunded shock over the funded shock is a function of λ and equal to $(1 -$

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[13] These models were estimated using the RISE toolbox (https://github.com/jmaih/RISE_toolbox). See Maih (2015).

$\lambda)/\lambda$ for all shocks. But the funded and unfunded shocks are assumed to be independent. To make the estimated standard deviation of the shocks comparable across the two models, we also impose that the variance of the sum of the two shocks is equal to the variance of the unique shock.[14]

Making these assumptions and assuming that the relative variance is the same across shocks, we find that the log likelihood of the independent shock model is a bit higher (see middle column of Table A3). λ is estimated to be 0.75, meaning that the variance of the funded shocks is three times as high as the variance of the unfunded shocks. However, we also find that in sample the funded and unfunded components of each shock are often very highly correlated. This correlation is 0.99 for the government spending shock, 0.77 for the transfer shock, and 0.95 for the revenue shock. The other shocks also turn out to be highly correlated: productivity (0.87), price mark-up (0.72), wage mark-up (0.84), risk premium (0.60), monetary policy (0.89), anticipated monetary policy (0.98) and investment shocks (0.85). It is therefore not surprising that the estimated parameters are very similar to those in the baseline model, as can be seen in Table A3. Some of the more notable differences are that the estimated degree of price stickiness is less and that there is a lower (higher) reaction coefficient to inflation in the monetary(fiscal)-led regime. Panel b of Table 2 contains the variance decomposition of this model.

In the right column of Table A3, we also allow for a shock-specific relative variance of the funded and unfunded components. Differences in the importance of the unfunded component across shocks are very similar to the differences in estimated $\lambda's$ across shocks in the model of Table 3. Supply shocks and the public transfer shock have a relatively large unfunded component; demand and monetary policy shocks have a relatively low unfunded component.

By way of summary, Figure 17 plots the estimates of fiscal inflation in various alternative models estimated in this section. Overall, we find that the estimated fiscal inflation is highly correlated across models and quite similar to that in the baseline model. The model with uncorrelated funded and unfunded shocks shows the largest variation in fiscal inflation.

5.4. Non-Ricardian models

In this section we briefly report on estimates of the degree of fiscal backing in versions of the Smets-Wouters model that allow for public transfer policies to have real and inflationary effects in the monetary-led regime. The first model builds on Galí, López-Salido and Vallés (2007). It is an extension of the Smets-Wouters model in which a fraction of households is liquidity constrained and transfers are targeted. In this model an expansionary transfer shock has positive income effect on private consumption and stimulates aggregate demand and inflation. A second model builds on Leeper et al (2017) and allows for complementarity between private and public consumption in household preferences. In this model, an increase in public consumption crowds in private consumption, amplifying aggregate demand and inflation effects. We find that introducing these non-Ricardian features do not materially change the estimated λ. As in the baseline model, due to imperfect fiscal backing the impact of all shocks on aggregate demand and inflation is stronger and

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[14] This requires a rescaling of the estimated standard deviation 'csig' for each of the two innovations as follows: crsig = csig/(((1- λ)^2+(λ)^2)^0.5). The variance of the sum of the two innovations (λ *crsig*eps+(1-λ)*crsig*eps_)^2 is than equal to csig^2 (the variance of the unique innovation in the shadow model).

more persistent. This feature is difficult to capture by the non-Ricardian transmission mechanism in a fully monetary-led regime.

6. Conclusions and further research

This paper estimates the degree of fiscal backing in the US economy since the 1960s and analyses how the transmission of business cycle shocks to the economy and inflation changes with different degrees of fiscal backing. We highlight three findings. The degree of fiscal backing is generally large and estimated to be 0.83 over the full sample. It suggests that for many purposes estimating a model under the monetary-led regime is a good approximation. However, partial fiscal backing does significantly affect the estimated effect on output and inflation of fiscal transfer shocks and supply shocks. The resulting fiscal inflation was mostly visible in the 1960s and 1970s and has more recently contributed to the post-pandemic surge in inflation. These results are overall robust if we allow for variation in the degree of fiscal backing across shocks and over time.

Several further extensions are worth pursuing. First, it would be interesting to test more formally changes in fiscal backing over time and across shocks. Second, the degree of fiscal backing is assumed to be symmetric across shocks that have a positive and negative effect on fiscal sustainability. Political economy reasons suggest that the degree of fiscal backing may be lower if shocks have a negative effect on debt sustainability. Third, in our model transfer shocks have no effect on output and inflation in the monetary-led regime due to the assumption of infinitely-lived forward-looking agents, the lump-sum nature of the transfers and the corresponding Ricardian equivalence. In an extension it could be interesting to test more formally the assumption of partial fiscal backing against other ways of increasing the fiscal multiplier such as introducing heterogenous credit-constrained or finitely-lived households.

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Table 1: Bayesian estimation of extended Smets-Wouters (2007) model

		Baseline model		λ=1 Monetary-led model		λ = 0 Fiscal-led model	
		Log marg.lik. = -2757.72		Log marg.lik. = -2765.55		Log marg.lik. = -2842.09	
	prior distribution	posterior distribution		posterior distribution		posterior distribution	
		mode	HPD interval	mode	HPD interval	mode	HPD interval
σ_c	N (1.500 , 0.3750)	1.10	[1.03 , 1.40]	1.19	[1.05 , 1.31]	1.22	[1.11 , 1.31]
h	B (0.700 , 0.1000)	0.62	[0.52 , 0.69]	0.64	[0.57 , 0.71]	0.81	[0.79 , 0.86]
σ_l	N (2.000 , 0.7500)	0.03	[0.03 , 0.37]	0.03	[0.07 , 0.23]	0.03	[0.04 , 0.32]
ξ_w	B (0.500 , 0.1000)	0.63	[0.51 , 0.74]	0.53	[0.44 , 0.67]	0.73	[0.67 , 0.81]
ξ_p	B (0.500 , 0.1000)	0.79	[0.74 , 0.85]	0.72	[0.67 , 0.85]	0.87	[0.84 , 0.9]
ι_w	B (0.500 , 0.1500)	0.54	[0.29 , 0.74]	0.54	[0.3 , 0.75]	0.49	[0.27 , 0.7]
ι_p	B (0.500 , 0.1500)	0.24	[0.11 , 0.36]	0.18	[0.09 , 0.3]	0.28	[0.13 , 0.4]
φ	N (4.000 , 1.0000)	3.83	[2.91 , 5.27]	3.96	[3.21 , 5.34]	7.23	[6.45 , 8.63]
ψ	B (0.500 , 0.1500)	0.6	[0.53 , 0.77]	0.75	[0.64 , 0.86]	0.47	[0.35 , 0.6]
Φ	N (1.250 , 0.2500)	1.74	[1.62 , 1.98]	1.75	[1.59 , 1.95]	1.86	[1.68 , 2.1]
α	N (0.300 , 0.0500)	0.27	[0.24 , 0.32]	0.29	[0.25 , 0.32]	0.28	[0.24 , 0.31]
r_π	N (1.500 , 0.2500)	1.76	[1.51 , 1.98]	1.84	[1.58 , 2.08]	1.5	[1.1 , 1.88]
r_ρ	B (0.750 , 0.1000)	0.72	[0.72 , 0.83]	0.8	[0.78 , 0.85]	0.8	[0.77 , 0.84]
r_y	B (0.125 , 0.0625)	0.02	[0.01 , 0.03]	0.03	[0.02 , 0.06]	0.09	[0.02 , 0.21]
$r_{\Delta y}$	B (0.125 , 0.0625)	0.23	[0.20 , 0.32]	0.23	[0.19 , 0.28]	0.1	[0.03 , 0.22]
r_{π_F}	N (0.500 , 0.2000)	0.22	[0.07 , 0.83]	0.5	[0.13 , 0.87]	0.81	[0.58 , 0.89]
l-cte	N (0.000 , 2.0000)	-0.11	[-2.61 , 2.04]	1.27	[-1.4 , 3.2]	-1.45	[-3.47 , 0.72]
γ-cte	N (0.430 , 0.0250)	0.38	[0.34 , 0.40]	0.38	[0.33 , 0.4]	0.4	[0.38 , 0.42]
β^{-1}-1	G (0.250 , 0.1000)	0.09	[0.05 , 0.17]	0.1	[0.05 , 0.17]	0.1	[0.05 , 0.19]
$y1$-cte	U (1.000 , 0.5774)	1.01	[0.94 , 1.15]	1.01	[0.9 , 1.1]	1.06	[0.99 , 1.18]
ω_{y1}	B (0.500 , 0.2000)	0.87	[0.60 , 0.97]	0.86	[0.63 , 0.97]	0.17	[0.04 , 0.46]
δ_y	N (0.280 , 0.1250)	0.49	[0.33 , 0.60]	0.44	[0.18 , 0.59]	0.5	[0.42 , 0.62]
$\delta_{\Delta y}$	N (0.280 , 0.1250)	0.39	[0.30 , 0.45]	0.35	[0.29 , 0.43]	0.39	[0.31 , 0.46]
$\delta_{\Delta h}$	N (0.250 , 0.1250)	0.18	[0.13 , 0.21]	0.14	[0.09 , 0.17]	0.19	[0.14 , 0.23]
δ_g	B (0.250 , 0.1250)	0.03	[0.02 , 0.04]	0.01	[0,00 , 0.05]	0.2	[0.05 , 0.44]
δ_{tra}	B (0.250 , 0.1250)	0.07	[0.00 , 0.27]	0.05	[0.03 , 0.16]	0.19	[0.05 , 0.44]
δ_{tax}	B (0.250 , 0.1250)	0.01	[0.00 , 0.03]	0.01	[0,00 , 0.03]	0.19	[0.05 , 0.44]
ρ_M	U (0.500 , 0.2887)	0.90	[0.83 , 0.94]	0.86	[0.74 , 0.91]	0.84	[0.65 , 0.92]
λ	U (0.500 , 0.2887)	0.83	[0.77 , 0.91]	1.00		0.00	
σ_a	IG (0.100 , 2.0000)	0.43	[0.39 , 0.47]	0.41	[0.38 , 0.46]	0.44	[0.41 , 0.48]
σ_b	IG (1.000 , 2.0000)	0.85	[0.55 , 1.35]	1.13	[0.79 , 1.48]	2.78	[2.12 , 3.85]
σ_I	IG (0.100 , 2.0000)	0.28	[0.26 , 0.38]	0.33	[0.28 , 0.38]	0.27	[0.24 , 0.34]
σ_r	IG (0.100 , 2.0000)	0.22	[0.20 , 0.25]	0.23	[0.21 , 0.25]	0.23	[0.22 , 0.26]
σ_{y1}	IG (0.100 , 2.0000)	0.14	[0.13 , 0.16]	0.15	[0.14 , 0.17]	0.13	[0.11 , 0.15]
σ_p	IG (0.100 , 2.0000)	0.13	[0.11 , 0.15]	0.13	[0.11 , 0.15]	0.14	[0.11 , 0.15]
σ_w	IG (0.100 , 2.0000)	0.37	[0.33 , 0.41]	0.4	[0.35 , 0.44]	0.34	[0.31 , 0.37]
σ_{ne}	IG (0.100 , 2.0000)	0.40	[0.37 , 0.44]	0.39	[0.37 , 0.44]	0.4	[0.37 , 0.44]
σ_g	IG (0.100 , 2.0000)	0.15	[0.14 , 0.17]	0.16	[0.15 , 0.18]	0.17	[0.15 , 0.18]
σ_{tra}	IG (0.100 , 2.0000)	0.28	[0.26 , 0.31]	0.27	[0.25 , 0.3]	0.29	[0.27 , 0.32]
σ_{tax}	IG (0.100 , 2.0000)	0.52	[0.49 , 0.57]	0.53	[0.49 , 0.58]	0.52	[0.49 , 0.57]
σ_{debt}	IG (1.000 , 2.0000)	5.65	[5.30 , 6.20]	5.71	[5.32 , 6.24]	5.81	[5.43 , 6.34]
ρ_a	B (0.500 , 0.1750)	0.97	[0.96 , 0.98]	0.98	[0.96 , 0.99]	0.98	[0.96 , 0.99]
ρ_b	B (0.500 , 0.1750)	0.93	[0.85 , 0.94]	0.92	[0.86 , 0.94]	0.86	[0.75 , 0.91]
ρ_I	B (0.500 , 0.1750)	0.87	[0.78 , 0.91]	0.8	[0.74 , 0.88]	0.79	[0.71 , 0.84]
ρ_r	B (0.500 , 0.1750)	0.18	[0.09 , 0.24]	0.19	[0.1 , 0.25]	0.09	[0.04 , 0.15]
ρ_{y1}	B (0.500 , 0.1750)	0.76	[0.70 , 0.83]	0.79	[0.73 , 0.86]	0.83	[0.77 , 0.89]
ρ_p	B (0.500 , 0.1750)	0.96	[0.90 , 0.97]	0.99	[0.9 , 1,00]	0.91	[0.82 , 0.92]
ρ_w	B (0.500 , 0.1750)	0.98	[0.96 , 0.99]	0.98	[0.97 , 0.99]	0.98	[0.96 , 0.99]
ρ_{ne}	B (0.500 , 0.1750)	0.24	[0.16 , 0.33]	0.23	[0.15 , 0.32]	0.27	[0.19 , 0.35]
ρ_g	B (0.500 , 0.1750)	0.93	[0.92 , 0.99]	0.99	[0.97 , 1,00]	0.99	[0.98 , 0.99]
ρ_{tra}	B (0.500 , 0.1750)	1.00	[0.99 , 1.00]	0.99	[0.98 , 1,00]	0.99	[0.98 , 0.99]
ρ_{tax}	B (0.500 , 0.1750)	0.92	[0.89 , 0.96]	0.94	[0.93 , 1,00]	0.93	[0.9 , 0.95]
μ_b	B (0.500 , 0.1750)	0.78	[0.59 , 0.84]	0.82	[0.67 , 0.87]	0.79	[0.63 , 0.86]
μ_p	B (0.500 , 0.1750)	0.89	[0.80 , 0.92]	0.9	[0.8 , 0.94]	0.87	[0.73 , 0.89]
μ_w	B (0.500 , 0.1750)	0.92	[0.86 , 0.97]	0.89	[0.83 , 0.96]	0.95	[0.92 , 0.97]
μ_{tra}	B (0.500 , 0.1750)	0.37	[0.23 , 0.48]	0.44	[0.27 , 0.5]	0.24	[0.14 , 0.33]
ζ_{ne}	B (0.500 , 0.1500)	0.01	[0.01 , 0.05]	0.04	[0.02 , 0.06]	0.04	[0.03 , 0.07]
ζ_{ne_d}	N (0.250 , 0.1250)	0.27	[0.22 , 0.39]	0.34	[0.26 , 0.41]	0.33	[0.24 , 0.4]
ζ_{ne_s}	N (0.500 , 0.2500)	0.51	[0.38 , 0.62]	0.52	[0.38 , 0.63]	0.49	[0.36 , 0.6]

Fixed: π-cte=0.5, D/Y=2.4, G/Y=0.18,Tra/Y=0.10

Table 2: Variance decomposition evaluated at the posterior mode

a) Baseline model

Horizon = 4q/10q/10y	Supply shocks	Demand shocks	Mon.pol.shocks	Fis.pol.shocks
Output	0.08 0.15 0.60	0.68 0.66 0.33	0.12 0.07 0.03	0.13 0.11 0.04
Fiscal unfunded	0.33 0.30 0.30	0.18 0.18 0.17	0.01 0.01 0.01	0.48 0.52 0.53
Inflation	0.88 0.82 0.79	0.08 0.12 0.15	0.01 0.01 0.01	0.03 0.04 0.05
Fiscal unfunded	0.67 0.61 0.57	0.09 0.11 0.13	0.00 0.00 0.00	0.24 0.28 0.30
Nominal Interest rate	0.12 0.13 0.14	0.46 0.62 0.66	0.42 0.25 0.19	0.00 0.00 0.00
Real interest rate	0.21 0.19 0.17	0.18 0.35 0.43	0.58 0.43 0.36	0.03 0.03 0.04
Public debt ratio	0.08 0.04 0.43	0.77 0.73 0.39	0.08 0.10 0.05	0.07 0.13 0.13
Fiscal unfunded	0.46 0.43 0.33	0.14 0.15 0.14	0.01 0.00 0.00	0.39 0.42 0.53
Primary surplus ratio	0.02 0.10 0.43	0.40 0.53 0.37	0.07 0.06 0.04	0.51 0.31 0.17
Fiscal unfunded	0.40 0.37 0.37	0.20 0.20 0.19	0.02 0.01 0.01	0.38 0.43 0.43

b) Model with independent funded and unfunded shocks

Horizon= q/10q/10y	Supply shocks	Demand shocks	Mon.pol.shocks	Fis.pol.shocks	Of which Unfunded
Output	0.25 0.31 0.61	0.60 0.56 0.32	0.07 0.05 0.03	0.08 0.08 0.04	0.23 0.19 0.07
Fiscal unfunded	0.28 0.29 0.26	0.38 0.33 0.27	0.05 0.02 0.02	0.29 0.37 0.45	1.00 1.00 1.00
Inflation	0.87 0.80 0.73	0.09 0.13 0.19	0.01 0.01 0.01	0.04 0.05 0.07	0.32 0.38 0.41
Fiscal unfunded	0.87 0.83 0.76	0.02 0.03 0.06	0.00 0.00 0.00	0.11 0.14 0.17	1.00 1.00 1.00
Nominal Interest	0.14 0.15 0.16	0.49 0.63 0.68	0.37 0.22 0.15	0.00 0.01 0.01	0.12 0.11 0.11
Real interest rate	0.18 0.16 0.15	0.24 0.42 0.50	0.55 0.40 0.33	0.03 0.03 0.03	0.27 0.22 0.20
Public debt ratio	0.17 0.23 0.55	0.66 0.53 0.25	0.05 0.06 0.03	0.11 0.18 0.17	0.23 0.26 0.18
Fiscal unfunded	0.61 0.56 0.48	0.17 0.17 0.09	0.02 0.02 0.00	0.21 0.25 0.43	1.00 1.00 1.00
Primary surplus	0.11 0.25 0.42	0.31 0.38 0.32	0.04 0.04 0.03	0.53 0.33 0.23	0.15 0.18 0.14
Fiscal unfunded	0.27 0.33 0.33	0.35 0.35 0.32	0.04 0.02 0.02	0.33 0.30 0.33	1.00 1.00 1.00

Table 3: Bayesian estimation of alternative models with shock-dependent fiscal backing

		Baseline model		Fiscal shock specific λ_f		All shock specific λ_ι	
		Log marg.lik. = -2757.72		Log marg.lik. = -2758.02		Log marg.lik. =-2752.3	
	prior distribution	posterior distribution		posterior distribution		posterior distribution	
		mode	HPD interval	mode	HPD interval	mode	HPD interval
σ_c	N (1.500 , 0.3750)	1.10	[1.03 , 1.40]	1.1	[1.05 , 1.42]	1.09	[1.12 , 1.44]
h	B (0.700 , 0.1000)	0.62	[0.52 , 0.69]	0.61	[0.54 , 0.7]	0.58	[0.52 , 0.69]
σ_l	N (2.000 , 0.7500)	0.03	[0.03 , 0.37]	0.03	[0.08 , 0.33]	0.03	[0.03 , 0.36]
ξ_w	B (0.500 , 0.1000)	0.63	[0.51 , 0.74]	0.63	[0.52 , 0.76]	0.65	[0.58 , 0.77]
ξ_p	B (0.500 , 0.1000)	0.79	[0.74 , 0.85]	0.78	[0.74 , 0.84]	0.81	[0.85 , 0.91]
ι_w	B (0.500 , 0.1500)	0.54	[0.29 , 0.74]	0.54	[0.3 , 0.74]	0.51	[0.28 , 0.70]
ι_p	B (0.500 , 0.1500)	0.24	[0.11 , 0.36]	0.24	[0.11 , 0.35]	0.24	[0.13 , 0.42]
φ	N (4.000 , 1.0000)	3.83	[2.91 , 5.27]	3.82	[3.09 , 5.18]	3.99	[3.24 , 5.68]
ψ	B (0.500 , 0.1500)	0.6	[0.53 , 0.77]	0.6	[0.53 , 0.77]	0.55	[0.47 , 0.74]
Φ	N (1.250 , 0.2500)	1.74	[1.62 , 1.98]	1.74	[1.62 , 1.97]	1.71	[1.71 , 2.12]
α	N (0.300 , 0.0500)	0.27	[0.24 , 0.32]	0.27	[0.25 , 0.32]	0.26	[0.26 , 0.33]
r_π	N (1.500 , 0.2500)	1.76	[1.51 , 1.98]	1.8	[1.55 , 2.05]	1.89	[1.16 , 1.90]
r_ρ	B (0.750 , 0.1000)	0.72	[0.72 , 0.83]	0.71	[0.7 , 0.82]	0.74	[0.83 , 0.90]
r_y	B (0.125 , 0.0625)	0.02	[0.01 , 0.03]	0.02	[0.01 , 0.03]	0.02	[0.00 , 0.04]
$r_{\Delta y}$	B (0.125 , 0.0625)	0.23	[0.20 , 0.32]	0.23	[0.19 , 0.32]	0.25	[0.29 , 0.44]
r_{π_F}	N (0.500 , 0.2000)	0.22	[0.07 , 0.83]	0.22	[0.05 , 0.67]	0.28	[0.96 , 1.00]
l-cte	N (0.000 , 2.0000)	-0.11	[-2.61 , 2.04]	0.06	[-1.88 , 2.66]	-0.89	[-3.24 , 0.80]
γ-cte	N (0.430 , 0.0250)	0.38	[0.34 , 0.40]	0.38	[0.35 , 0.4]	0.39	[0.37 , 0.42]
β^{-1}-1	G (0.250 , 0.1000)	0.09	[0.05 , 0.17]	0.09	[0.04 , 0.18]	0.10	[0.05 , 0.18]
$y1$-cte	U (1.000 , 0.5774)	1.01	[0.94 , 1.15]	1.00	[0.95 , 1.15]	1.02	[0.98 , 1.17]
ω_{y1}	B (0.500 , 0.2000)	0.87	[0.60 , 0.97]	0.87	[0.59 , 0.97]	0.89	[0.55 , 0.98]
δ_y	N (0.280 , 0.1250)	0.49	[0.33 , 0.60]	0.47	[0.16 , 0.53]	0.45	[0.44 , 0.76]
$\delta_{\Delta y}$	N (0.280 , 0.1250)	0.39	[0.30 , 0.45]	0.39	[0.31 , 0.45]	0.38	[0.31 , 0.46]
$\delta_{\Delta h}$	N (0.250 , 0.1250)	0.18	[0.13 , 0.21]	0.18	[0.13 , 0.21]	0.19	[0.13 , 0.20]
δ_g	B (0.250 , 0.1250)	0.03	[0.02 , 0.04]	0.03	[0.02 , 0.04]	0.03	[0.04 , 0.12]
δ_{tra}	B (0.250 , 0.1250)	0.07	[0.00 , 0.27]	0.09	[0.00 , 0.24]	0.10	[0.06 , 0.32]
δ_{tax}	B (0.250 , 0.1250)	0.01	[0.00 , 0.03]	0.01	[0.00 , 0.04]	0.01	[0.01 , 0.18]
ρ_M	U (0.500 , 0.2887)	0.90	[0.83 , 0.94]	0.9	[0.84 , 0.94]	0.89	[0.61 , 0.94]
λ	U (0.500 , 0.2887)	0.83	[0.77 , 0.91]	0.82	[0.72 , 0.88]	-	
λ_f	U (0.500 , 0.2887)	-		0.88	[0.84 , 0.97]	-	
λ_a	U (0.500 , 0.2887)	-		-		0.72	[0.26 , 0.73]
λ_b	U (0.500 , 0.2887)	-		-		0.96	[0.85 , 1.00]
λ_l	U (0.500 , 0.2887)	-		-		1.00	[0.82 , 1.00]
λ_r	U (0.500 , 0.2887)	-		-		0.86	[0.59 , 0.89]
λ_{y1}	U (0.500 , 0.2887)	-		-		1.00	[0.51 , 1.00]
λ_p	U (0.500 , 0.2887)	-		-		0.85	[0.46 , 1.00]
λ_w	U (0.500 , 0.2887)	-		-		0.79	[0.00 , 0.55]
λ_{ne}	U (0.500 , 0.2887)	-		-		0.00	[0.00 , 0.48]
λ_g	U (0.500 , 0.2887)	-		-		1.00	[0.10 , 1.00]
λ_{tra}	U (0.500 , 0.2887)	-		-		0.82	[0.00 , 0.60]
λ_{tax}	U (0.500 , 0.2887)	-		-		0.99	[0.62 , 1.00]
σ_a	IG (0.100 , 2.0000)	0.43	[0.39 , 0.47]	0.43	[0.39 , 0.47]	0.44	[0.39 , 0.46]
σ_b	IG (1.000 , 2.0000)	0.85	[0.55 , 1.35]	0.83	[0.71 , 1.32]	0.73	[0.68 , 1.34]
σ_l	IG (0.100 , 2.0000)	0.28	[0.26 , 0.38]	0.28	[0.27 , 0.37]	0.26	[0.28 , 0.38]
σ_r	IG (0.100 , 2.0000)	0.22	[0.20 , 0.25]	0.22	[0.2 , 0.24]	0.21	[0.19 , 0.24]
σ_{y1}	IG (0.100 , 2.0000)	0.14	[0.13 , 0.16]	0.14	[0.13 , 0.16]	0.15	[0.13 , 0.16]
σ_p	IG (0.100 , 2.0000)	0.13	[0.11 , 0.15]	0.12	[0.11 , 0.15]	0.13	[0.12 , 0.16]
σ_w	IG (0.100 , 2.0000)	0.37	[0.33 , 0.41]	0.37	[0.33 , 0.41]	0.36	[0.33 , 0.40]
σ_{ne}	IG (0.100 , 2.0000)	0.40	[0.37 , 0.44]	0.4	[0.37 , 0.43]	0.40	[0.37 , 0.44]
σ_g	IG (0.100 , 2.0000)	0.15	[0.14 , 0.17]	0.15	[0.14 , 0.17]	0.15	[0.13 , 0.16]
σ_{tra}	IG (0.100 , 2.0000)	0.28	[0.26 , 0.31]	0.28	[0.26 , 0.31]	0.28	[0.25 , 0.30]
σ_{tax}	IG (0.100 , 2.0000)	0.52	[0.49 , 0.57]	0.52	[0.49 , 0.58]	0.52	[0.49 , 0.58]
σ_{debt}	IG (1.000 , 2.0000)	5.65	[5.30 , 6.20]	5.64	[5.28 , 6.18]	5.68	[5.32 , 6.25]
ρ_a	B (0.500 , 0.1750)	0.97	[0.96 , 0.98]	0.97	[0.96 , 0.98]	0.97	[0.95 , 0.98]
ρ_b	B (0.500 , 0.1750)	0.93	[0.85 , 0.94]	0.93	[0.88 , 0.95]	0.92	[0.81 , 0.94]
ρ_l	B (0.500 , 0.1750)	0.87	[0.78 , 0.91]	0.87	[0.77 , 0.9]	0.88	[0.73 , 0.88]
ρ_r	B (0.500 , 0.1750)	0.18	[0.09 , 0.24]	0.18	[0.09 , 0.23]	0.16	[0.03 , 0.14]
ρ_{y1}	B (0.500 , 0.1750)	0.76	[0.70 , 0.83]	0.75	[0.69 , 0.83]	0.75	[0.71 , 0.85]
ρ_p	B (0.500 , 0.1750)	0.96	[0.90 , 0.97]	0.96	[0.89 , 0.98]	0.97	[0.73 , 0.90]
ρ_w	B (0.500 , 0.1750)	0.98	[0.96 , 0.99]	0.98	[0.96 , 0.99]	0.97	[0.98 , 0.99]
ρ_{ne}	B (0.500 , 0.1750)	0.24	[0.16 , 0.33]	0.24	[0.16 , 0.33]	0.20	[0.17 , 0.34]
ρ_g	B (0.500 , 0.1750)	0.93	[0.92 , 0.99]	0.94	[0.92 , 0.97]	0.93	[0.92 , 0.96]
ρ_{tra}	B (0.500 , 0.1750)	1.00	[0.99 , 1.00]	1.00	[1.00 , 1.00]	1.00	[0.99 , 1.00]
ρ_{tax}	B (0.500 , 0.1750)	0.92	[0.89 , 0.96]	0.93	[0.91 , 0.98]	0.93	[0.92 , 0.99]
μ_b	B (0.500 , 0.1750)	0.78	[0.59 , 0.84]	0.78	[0.7 , 0.86]	0.75	[0.59 , 0.82]
μ_p	B (0.500 , 0.1750)	0.89	[0.80 , 0.92]	0.89	[0.78 , 0.93]	0.91	[0.59 , 0.87]
μ_w	B (0.500 , 0.1750)	0.92	[0.86 , 0.97]	0.92	[0.85 , 0.97]	0.92	[0.93 , 0.98]
μ_{tra}	B (0.500 , 0.1750)	0.37	[0.23 , 0.48]	0.36	[0.19 , 0.42]	0.41	[0.23 , 0.48]
ζ_{ne}	B (0.500 , 0.1500)	0.01	[0.01 , 0.05]	0.01	[0.01 , 0.04]	0.03	[0.02 , 0.07]
ζ_{ne_d}	N (0.250 , 0.1250)	0.27	[0.22 , 0.39]	0.26	[0.24 , 0.4]	0.22	[0.26 , 0.43]
ζ_{ne_s}	N (0.500 , 0.2500)	0.51	[0.38 , 0.62]	0.51	[0.39 , 0.62]	0.53	[0.37 , 0.61]

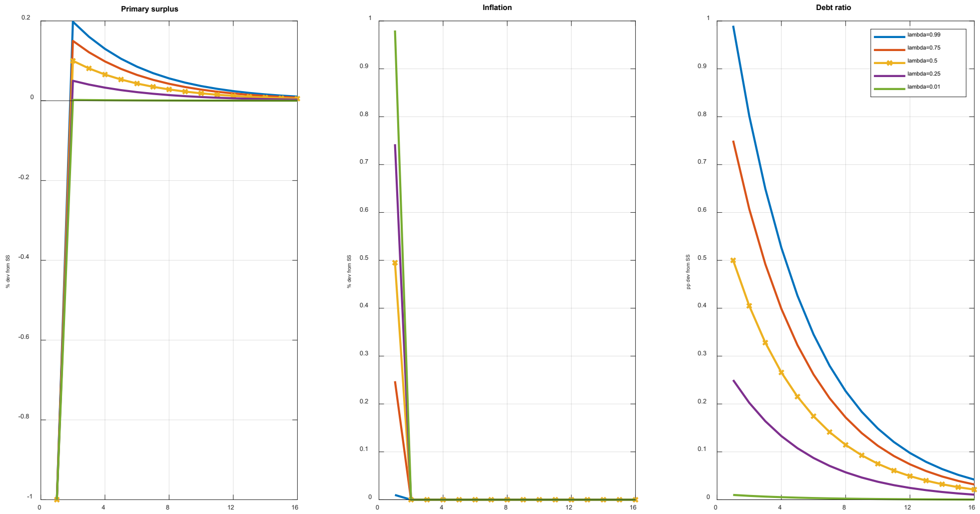
Fixed: π-cte=0.5, D/Y=2.4, G/Y=0.18,Tra/Y=0.10

Table 4: Bayesian estimation of alternative regime-switching models

		Baseline model		RS with λ=0,75 / λ=0,9		RS with λ=0 / λ=1	
		Log marg.lik. = -2757.72		Log marg.lik. = -2760,4		Log marg.lik. = -2762,8	
	prior distribution	posterior distribution		posterior distribution		posterior distribution	
		mode	HPD interval	mode	HPD interval	mode	HPD interval
σ_c	N (1.500 , 0.3750)	1.10	[1.03 , 1.40]	1.12	[1.02 , 1.24]	1.15	[1.06 , 1.24]
h	B (0.700 , 0.1000)	0.62	[0.52 , 0.69]	0.66	[0.60 , 0.72]	0.71	[0.64 , 0.76]
σ_l	N (2.000 , 0.7500)	0.03	[0.03 , 0.37]	0.36	[0.15 , 0.55]	0.30	[0.13 , 0.47]
ξ_w	B (0.500 , 0.1000)	0.63	[0.51 , 0.74]	0.70	[0.60 , 0.79]	0.76	[0.66 , 0.83]
ξ_p	B (0.500 , 0.1000)	0.79	[0.74 , 0.85]	0.80	[0.76 , 0.84]	0.87	[0.84 , 0.90]
ι_w	B (0.500 , 0.1500)	0.54	[0.29 , 0.74]	0.47	[0.32 , 0.64]	0.38	[0.21 , 0.57]
ι_p	B (0.500 , 0.1500)	0.24	[0.11 , 0.36]	0.27	[0.16 , 0.39]	0.27	[0.15 , 0.40]
φ	N (4.000 , 1.0000)	3.83	[2.91 , 5.27]	3.85	[3.10 , 5.03]	5.53	[4.70 , 6.71]
ψ	B (0.500 , 0.1500)	0.6	[0.53 , 0.77]	0.61	[0.48 , 0.74]	0.58	[0.47 , 0.69]
Φ	N (1.250 , 0.2500)	1.74	[1.62 , 1.98]	1.82	[1.69 , 1.96]	1.86	[1.70 , 2.05]
α	N (0.300 , 0.0500)	0.27	[0.24 , 0.32]	0.28	[0.25 , 0.32]	0.28	[0.24 , 0.32]
r_π	N (1.500 , 0.2500)	1.76	[1.51 , 1.98]	1.71	[1.47 , 1.99]	1.47	[1.23 , 1.72]
r_ρ	B (0.750 , 0.1000)	0.72	[0.72 , 0.83]	0.76	[0.71 , 0.80]	0.84	[0.81 , 0.86]
r_y	B (0.125 , 0.0625)	0.02	[0.01 , 0.03]	0.02	[0.01 , 0.03]	0.01	[0.00 , 0.02]
$r_{\Delta y}$	B (0.125 , 0.0625)	0.23	[0.20 , 0.32]	0.25	[0.20 , 0.31]	0.21	[0.17 , 0.26]
r_{π_F}	N (0.500 , 0.2000)	0.22	[0.07 , 0.83]	0.28	[0.12 , 0.48]	0.67	[0.47 , 0.78]
l-cte	N (0.000 , 2.0000)	-0.11	[-2.61 , 2.04]	-0.87	[-2.59 , 0.89]	-1.29	[-2.99 , 0.34]
γ-cte	N (0.430 , 0.0250)	0.38	[0.34 , 0.40]	0.38	[0.36 , 0.41]	0.41	[0.39 , 0.43]
β^{-1}-1	G (0.250 , 0.1000)	0.09	[0.05 , 0.17]	0.11	[0.06 , 0.20]	0.09	[0.04 , 0.16]
$y1$-cte	U (1.000 , 0.5774)	1.01	[0.94 , 1.15]	1.04	[0.96 , 1.13]	1.04	[0.96 , 1.13]
ω_{y1}	B (0.500 , 0.2000)	0.87	[0.60 , 0.97]	0.69	[0.48 , 0.88]	0.19	[0.05 , 0.46]
δ_y	N (0.280 , 0.1250)	0.49	[0.33 , 0.60]	0.43	[0.29 , 0.56]	0.60	[0.50 , 0.73]
$\delta_{\Delta y}$	N (0.280 , 0.1250)	0.39	[0.30 , 0.45]	0.39	[0.31 , 0.45]	0.38	[0.31 , 0.45]
$\delta_{\Delta h}$	N (0.250 , 0.1250)	0.18	[0.13 , 0.21]	0.17	[0.14 , 0.21]	0.16	[0.13 , 0.18]
δ_g	B (0.250 , 0.1250)	0.03	[0.02 , 0.04]	0.03	[0.02 , 0.04]	0.05	[0.05 , 0.07]
δ_{tra}	B (0.250 , 0.1250)	0.07	[0.00 , 0.27]	0.09	[0.01 , 0.25]	0.50	[0.36 , 0.64]
δ_{tax}	B (0.250 , 0.1250)	0.01	[0.00 , 0.03]	0.01	[0.00 , 0.03]	0.03	[0.01 , 0.05]
ρ_M	U (0.500 , 0.2887)	0.90	[0.83 , 0.94]	0.90	[0.84 , 0.94]	0.84	[0.24 , 0.92]
λ	U (0.500 , 0.2887)	0.83	[0.77 , 0.91]	Fixed 0,75 / 0,90		Fixed 0 / 1	
p(1→2)	U (0.500 , 0.2887)	-		0.20	[0,05 , 0,43]	0.11	[0.07 , 0.22]
p(2→1)	U (0.500 , 0.2887)			0.23	[0,02 , 0,32]	0.05	[0.03 , 0.09]
σ_a	IG (0.100 , 2.0000)	0.43	[0.39 , 0.47]	0.43	[0.39 , 0.47]	0.43	[0.40 , 0.47]
σ_b	IG (1.000 , 2.0000)	0.85	[0.55 , 1.35]	1.06	[0.80 , 1.47]	1.22	[0.88 , 1.61]
σ_l	IG (0.100 , 2.0000)	0.28	[0.26 , 0.38]	0.31	[0.27 , 0.36]	0.25	[0.22 , 0.30]
σ_r	IG (0.100 , 2.0000)	0.22	[0.20 , 0.25]	0.23	[0.20 , 0.25]	0.25	[0.23 , 0.28]
σ_{y1}	IG (0.100 , 2.0000)	0.14	[0.13 , 0.16]	0.14	[0.12 , 0.16]	0.13	[0.12 , 0.15]
σ_p	IG (0.100 , 2.0000)	0.13	[0.11 , 0.15]	0.13	[0.11 , 0.15]	0.13	[0.11 , 0.15]
σ_w	IG (0.100 , 2.0000)	0.37	[0.33 , 0.41]	0.36	[0.33 , 0.40]	0.35	[0.31 , 0.38]
σ_{ne}	IG (0.100 , 2.0000)	0.40	[0.37 , 0.44]	0.40	[0.37 , 0.44]	0.40	[0.37 , 0.44]
σ_g	IG (0.100 , 2.0000)	0.15	[0.14 , 0.17]	0.16	[0.14 , 0.17]	0.14	[0.13 , 0.16]
σ_{tra}	IG (0.100 , 2.0000)	0.28	[0.26 , 0.31]	0.28	[0.26 , 0.31]	0.27	[0.25 , 0.29]
σ_{tax}	IG (0.100 , 2.0000)	0.52	[0.49 , 0.57]	0.53	[0.49 , 0.58]	0.53	[0.49 , 0.57]
σ_{debt}	IG (1.000 , 2.0000)	5.65	[5.30 , 6.20]	5.73	[5.31 , 6.22]	5.82	[5.40 , 6.32]
ρ_a	B (0.500 , 0.1750)	0.97	[0.96 , 0.98]	0.97	[0.96 , 0.98]	0.97	[0.95 , 0.98]
ρ_b	B (0.500 , 0.1750)	0.93	[0.85 , 0.94]	0.91	[0.87 , 0.95]	0.75	[0.60 , 0.85]
ρ_l	B (0.500 , 0.1750)	0.87	[0.78 , 0.91]	0.86	[0.79 , 0.92]	0.88	[0.81 , 0.93]
ρ_r	B (0.500 , 0.1750)	0.18	[0.09 , 0.24]	0.15	[0.08 , 0.22]	0.12	[0.07 , 0.18]
ρ_{y1}	B (0.500 , 0.1750)	0.76	[0.70 , 0.83]	0.75	[0.68 , 0.82]	0.81	[0.74 , 0.87]
ρ_p	B (0.500 , 0.1750)	0.96	[0.90 , 0.97]	0.95	[0.92 , 0.97]	0.93	[0.88 , 0.95]
ρ_w	B (0.500 , 0.1750)	0.98	[0.96 , 0.99]	0.97	[0.95 , 0.98]	0.97	[0.96 , 0.98]
ρ_{ne}	B (0.500 , 0.1750)	0.24	[0.16 , 0.33]	0.26	[0.18 , 0.34]	0.24	[0.16 , 0.32]
ρ_g	B (0.500 , 0.1750)	0.93	[0.92 , 0.99]	0.93	[0.91 , 0.95]	0.91	[0.89 , 0.93]
ρ_{tra}	B (0.500 , 0.1750)	1.00	[0.99 , 1.00]	1.00	[0.99 , 1.00]	1.00	[1.00 , 1.00]
ρ_{tax}	B (0.500 , 0.1750)	0.92	[0.89 , 0.96]	0.93	[0.89 , 0.96]	0.92	[0.88 , 0.95]
μ_b	B (0.500 , 0.1750)	0.78	[0.59 , 0.84]	0.79	[0.69 , 0.87]	0.59	[0.40 , 0.73]
μ_p	B (0.500 , 0.1750)	0.89	[0.80 , 0.92]	0.89	[0.82 , 0.93]	0.87	[0.78 , 0.92]
μ_w	B (0.500 , 0.1750)	0.92	[0.86 , 0.97]	0.92	[0.87 , 0.95]	0.94	[0.91 , 0.96]
μ_{tra}	B (0.500 , 0.1750)	0.37	[0.23 , 0.48]	0.34	[0.22 , 0.45]	0.43	[0.35 , 0.51]
ζ_{ne}	B (0.500 , 0.1500)	0.01	[0.01 , 0.05]	0.02	[0.01 , 0.05]	0.06	[0.04 , 0.08]
ζ_{ne_d}	N (0.250 , 0.1250)	0.27	[0.22 , 0.39]	0.30	[0.22 , 0.39]	0.32	[0.24 , 0.39]
ζ_{ne_s}	N (0.500 , 0.2500)	0.51	[0.38 , 0.62]	0.50	[0.38 , 0.61]	0.50	[0.38 , 0.62]

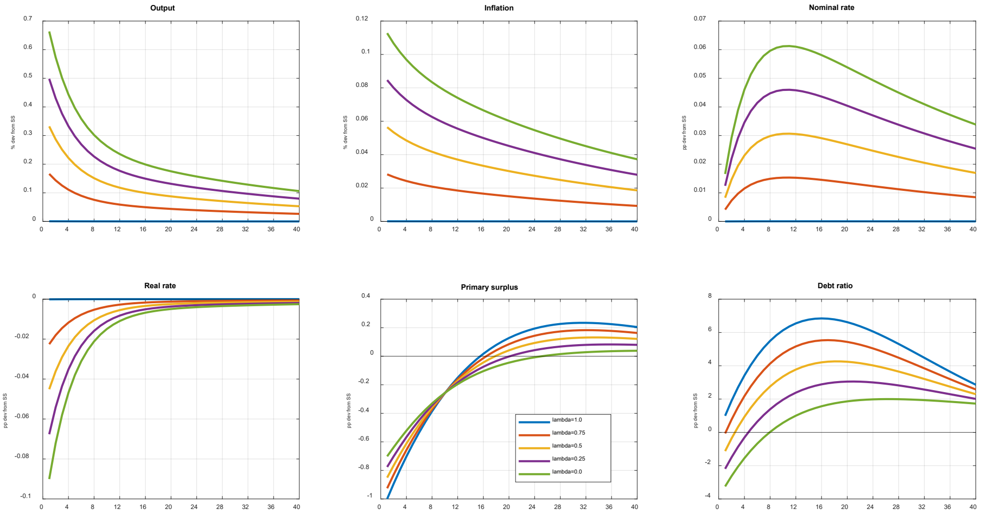
Fixed: π-cte=0.5, D/Y=2.4, G/Y=0.18,Tra/Y=0.10

Figure 1: Impact of transfer shock in the Fisherian model under different degree of fiscal backing



Notes: $\psi = 2.0$, $\psi^F = 0.0$, $\beta = 0.99$, $b = 1.0$, $\delta_b = 0.2$

Figure 2: Impulse responses to an expansionary transfer shock in the NK model under different degrees of fiscal backing



Notes: See Table A1 for the calibration of the parameters

Figure 3: Impulse response to an expansionary transfer shock ($\lambda = 0.5$) with different slopes of the Phillips curve ($\kappa = 0.05; 0.10; 0.20$)

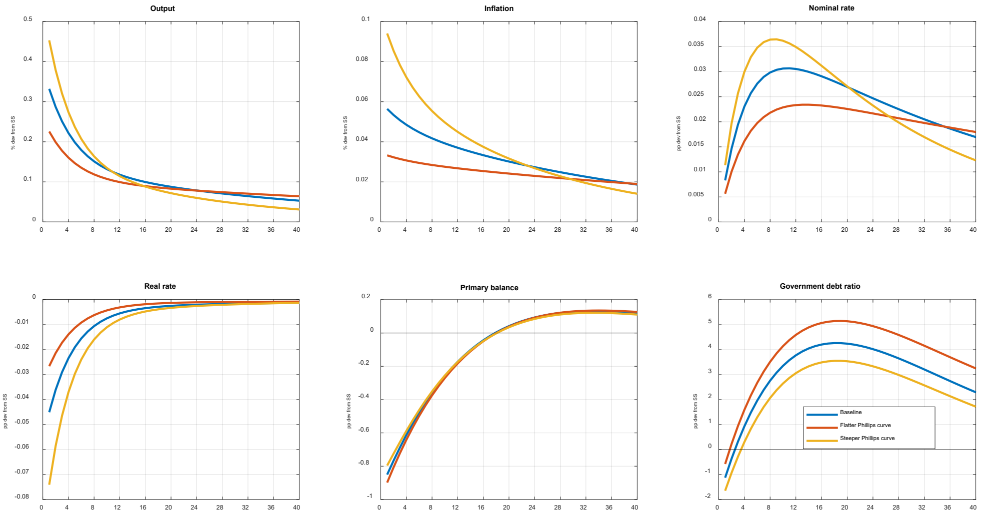


Figure 4: Impulse responses to an expansionary transfer shock ($\lambda = 0.5$) with different Fisherian effects ($\psi_{\pi}^{F} = 0.0; 0.4; 0.8$)

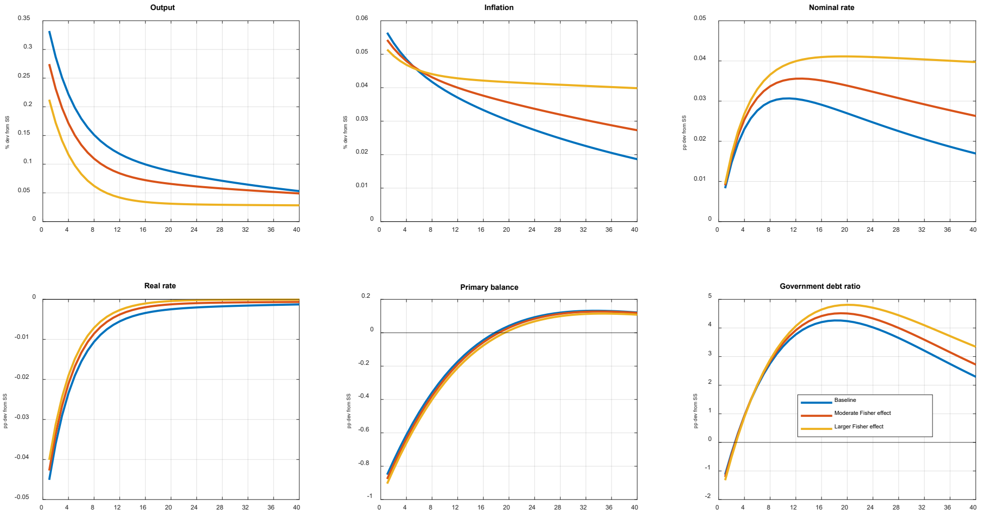


Figure 5: Impulse response to a contractionary monetary policy shock in the NK model under different degrees of fiscal backing.

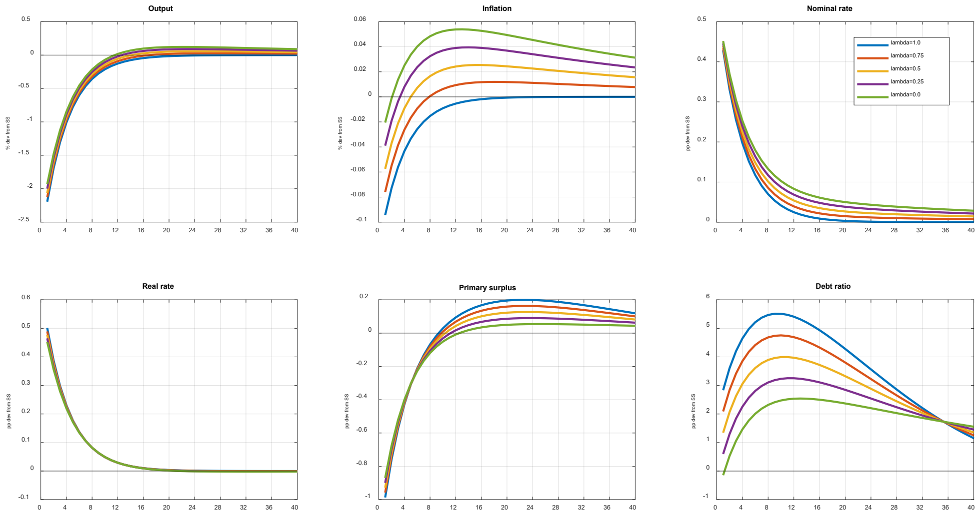


Figure 6: Impulse responses to a negative productivity shock in the NK model under different degrees of fiscal backing

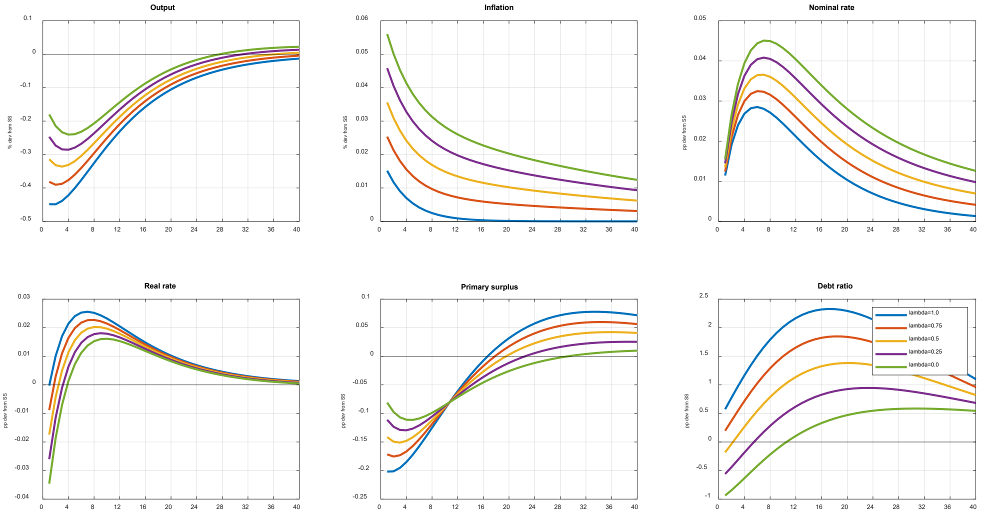


Figure 7: Impulse response to an expansionary demand shock in the NK model under different degrees of fiscal backing

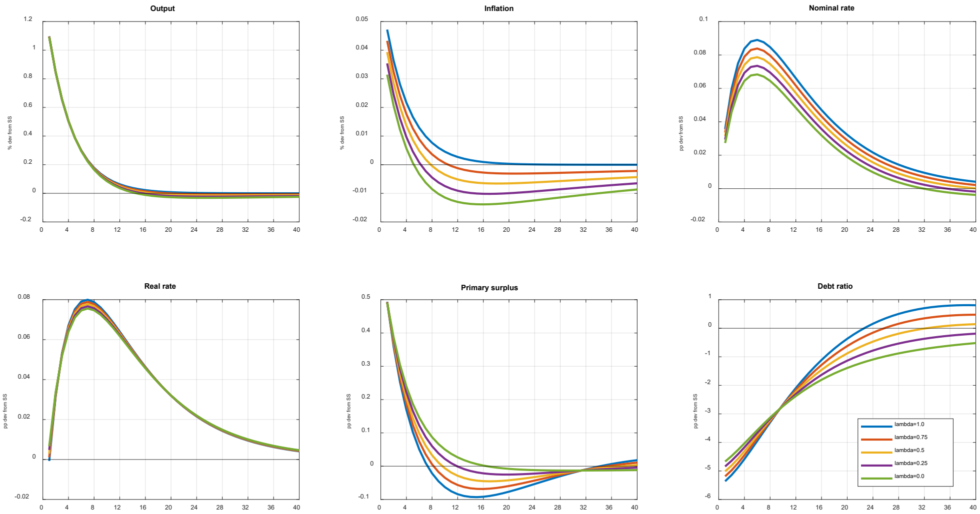


Figure 8: A public transfer shock in estimated SW model with partial fiscal backing

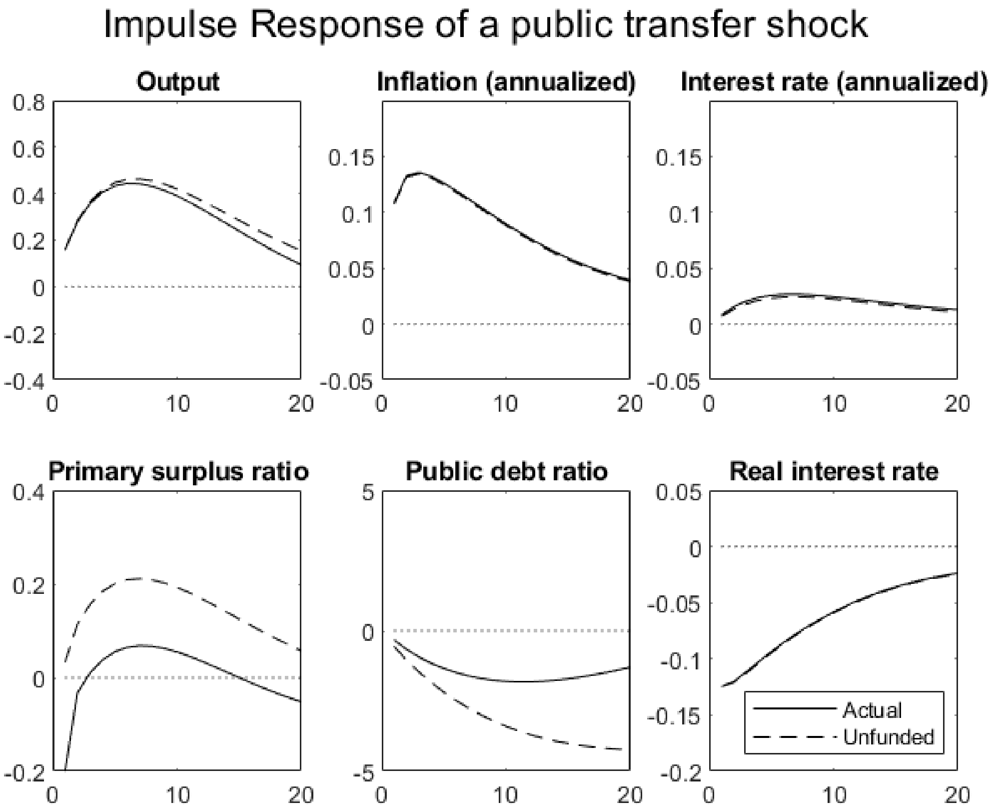


Figure 9: A monetary policy shock in estimated SW model with partial fiscal backing

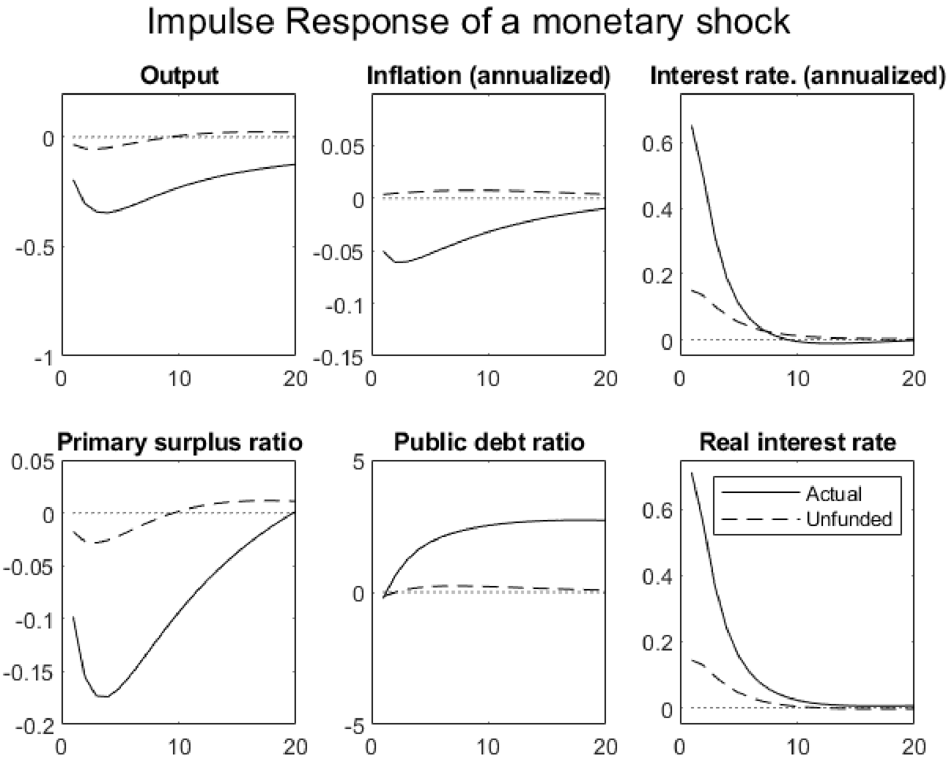


Figure 10: A productivity shock in estimated SW model with partial fiscal backing

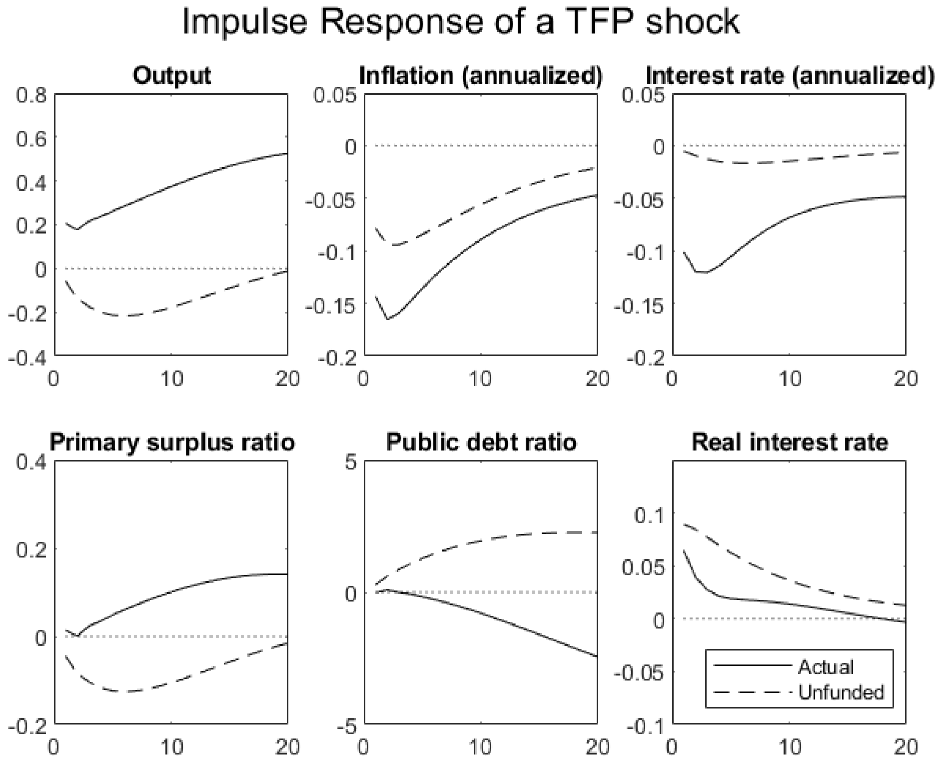


Figure 11: Impulse response to a price mark-up shock in estimated SW model with partial fiscal back-up

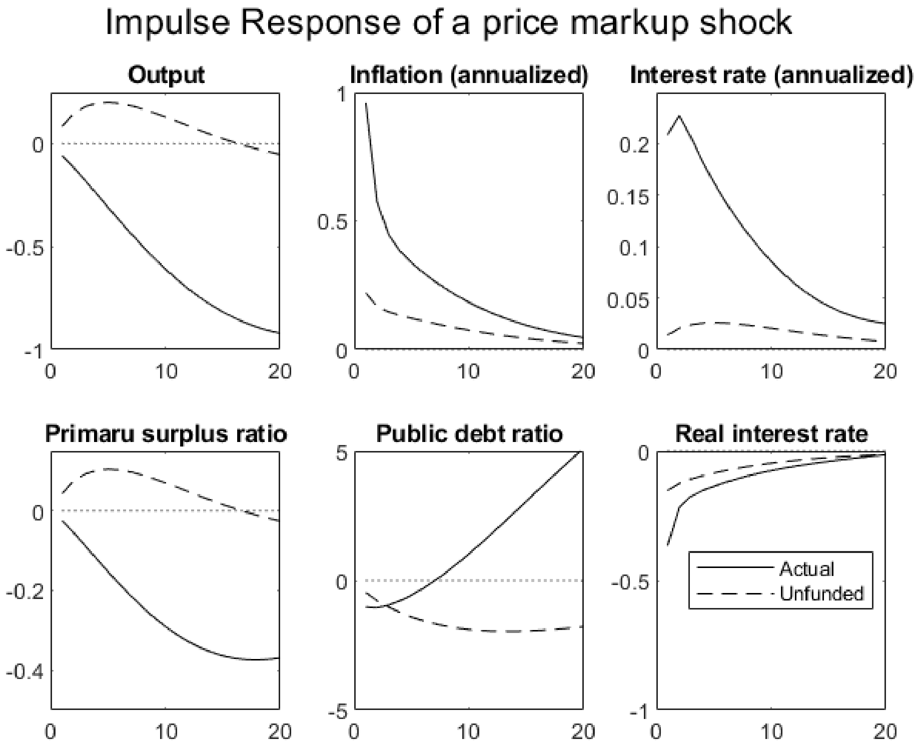


Figure 12: Risk premium shock in estimated SW model with partial fiscal backing

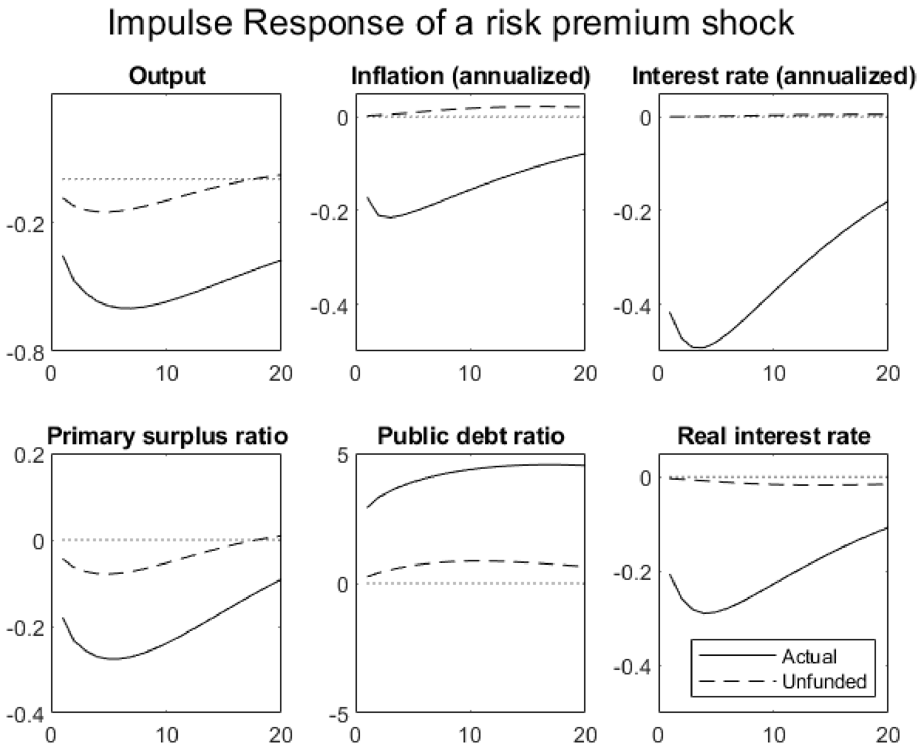


Figure 13: Decomposition of inflation and primary balance in monetary and fiscal-led components

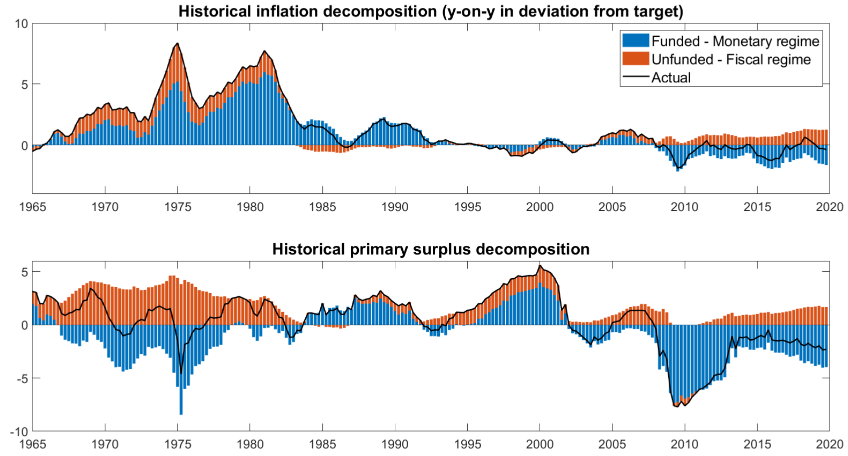


Figure 14: Decomposition of a) fiscally-led inflation and b) unfunded primary balance

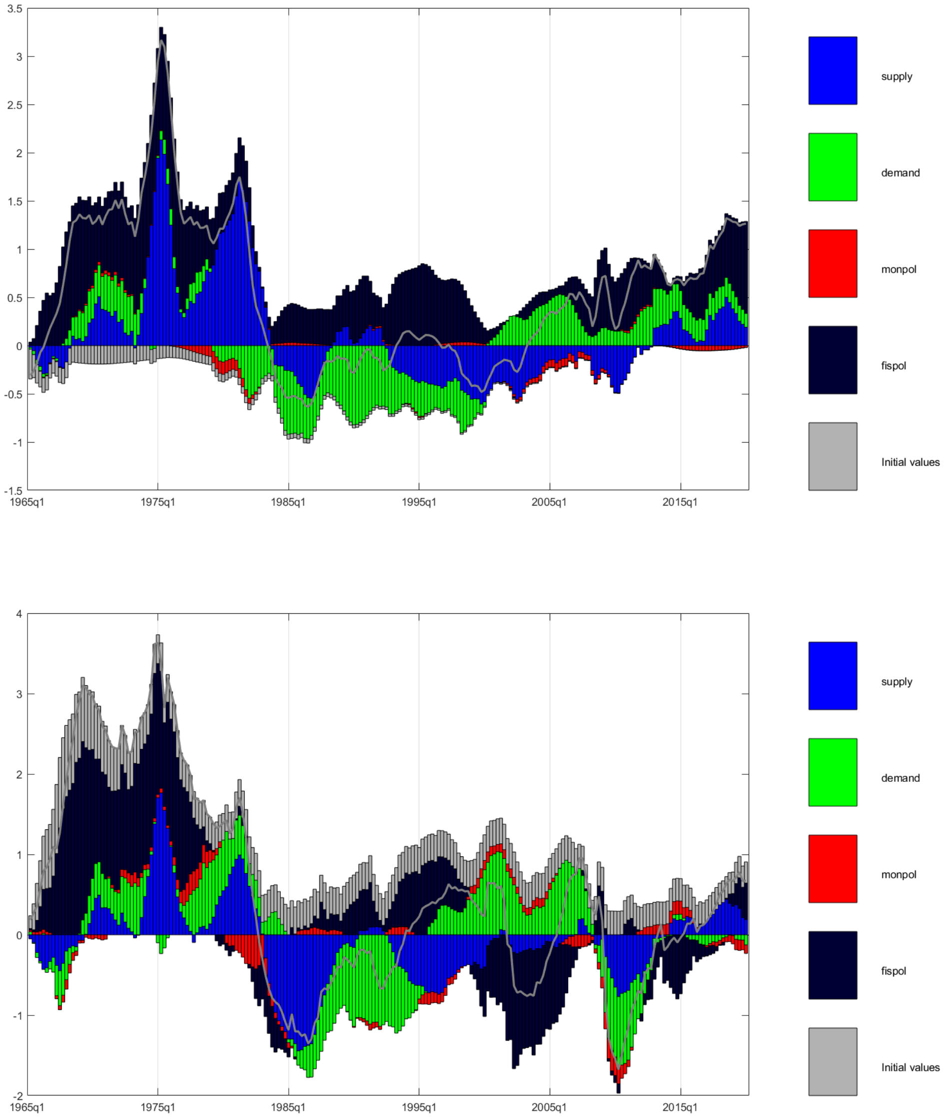
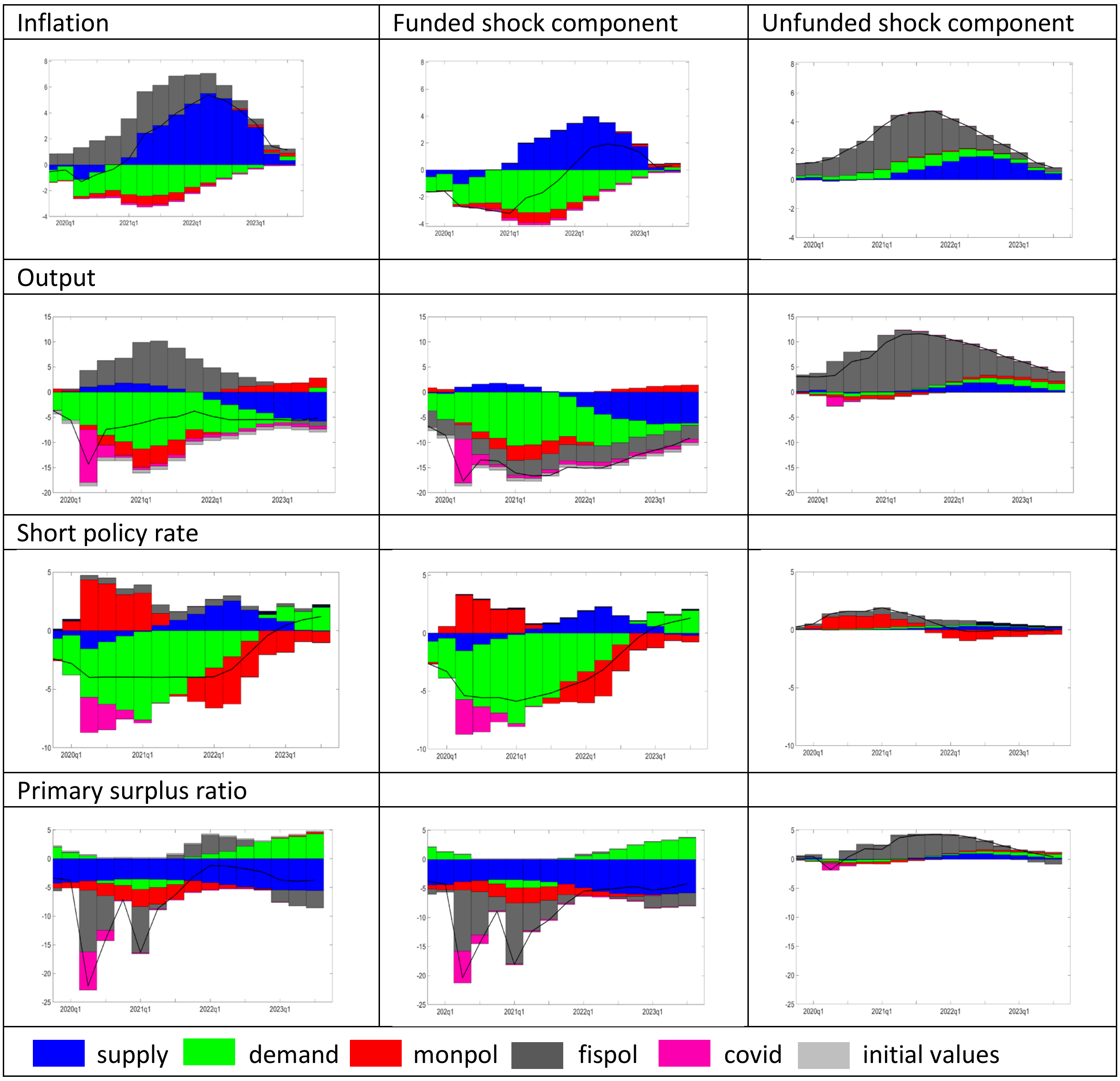
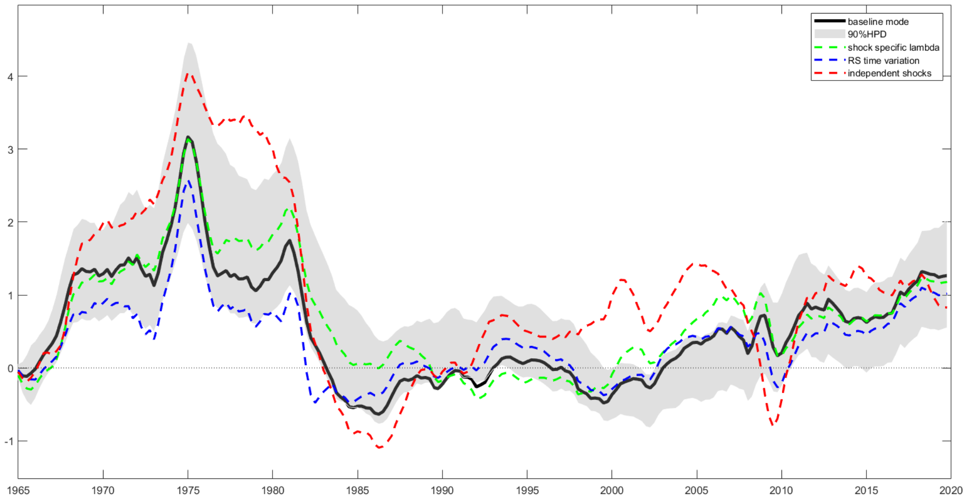


Figure 16: Historical decomposition of inflation, output, short-term interest rate and primary balance in the post-Covid period



Note: Inflation is measured as y-on-y rate in deviation from target. Output is measured in deviation from trend. The short rate is annualized and in deviation from the steady state rate.

Figure 17: Comparing fiscal inflation across models



Appendix

Figure A1: Transfer shock in Fisherian model with ψ_{π}^{F}=0.99

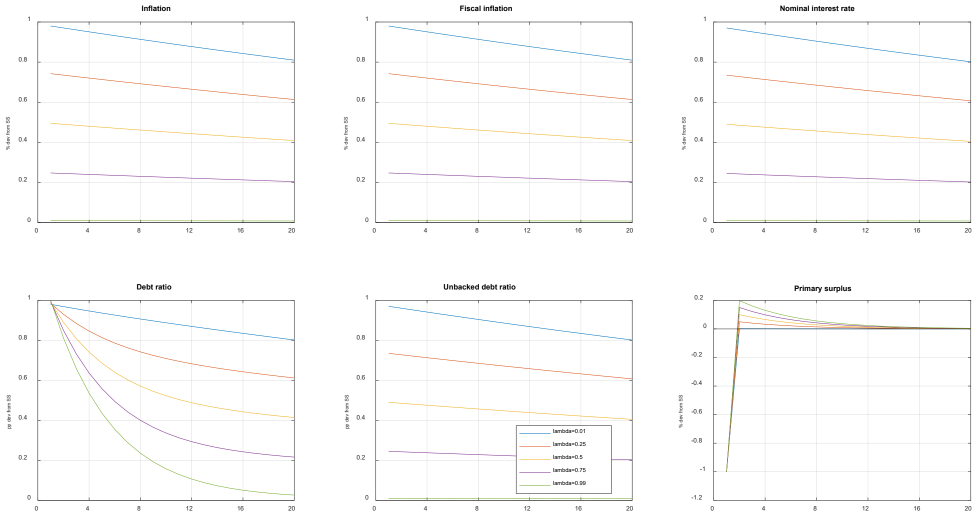


Figure A2: Impulse response to an expansionary transfer shock ($\lambda = 0.5$) with different fiscal output elasticities ($\delta_y = 0; 0.5; 1.0$ and $\delta_{dy} = 0.0; 0.4; 0.8$) respectively.

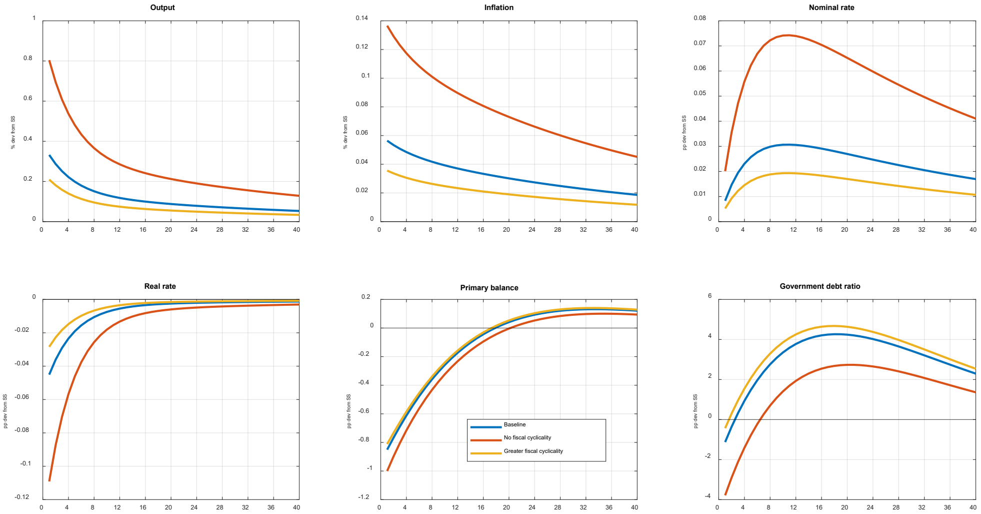
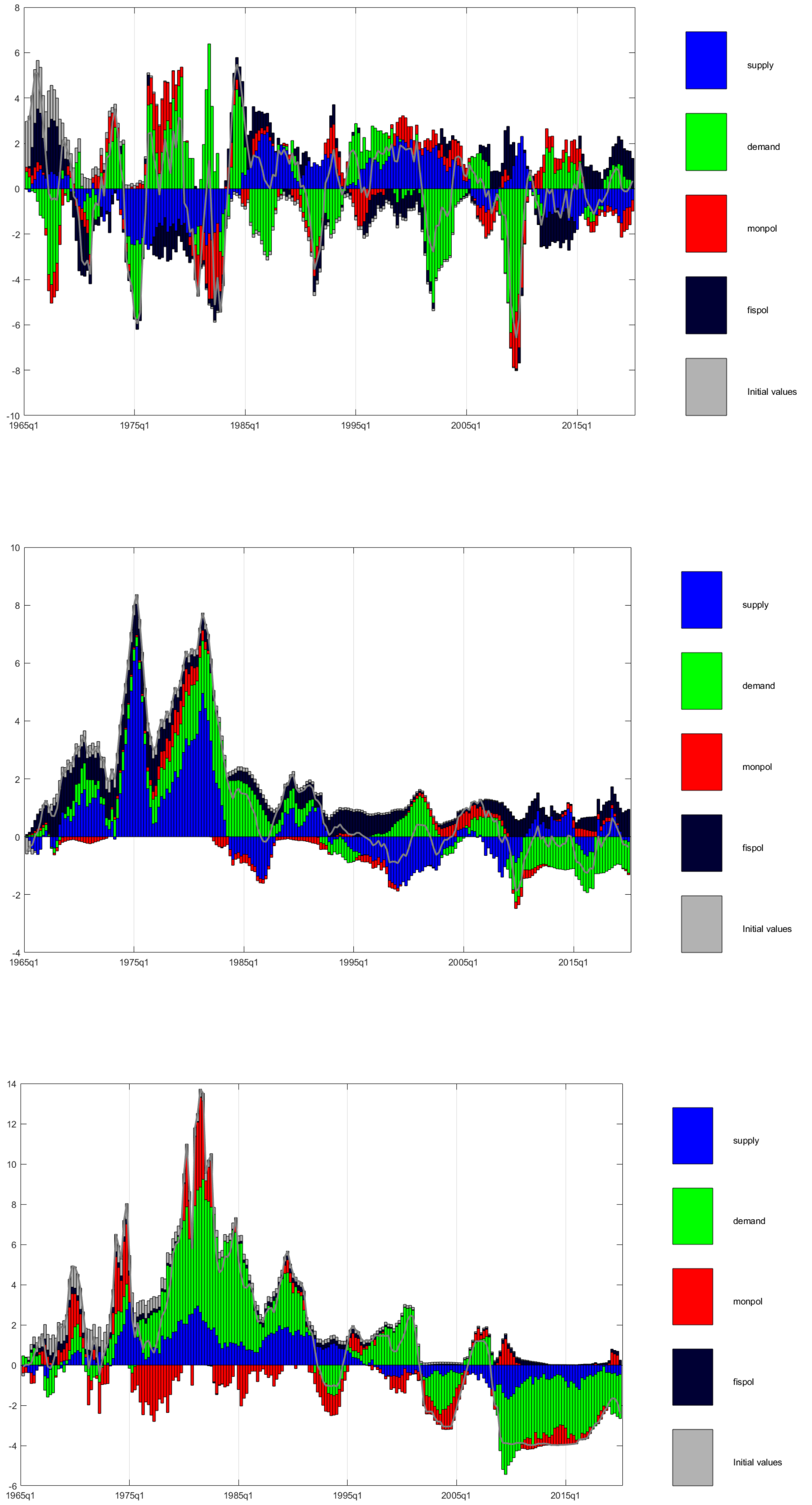


Figure A3: Historical decomposition of a) annual real GDP growth, b) annual inflation and c) the federal funds rate.

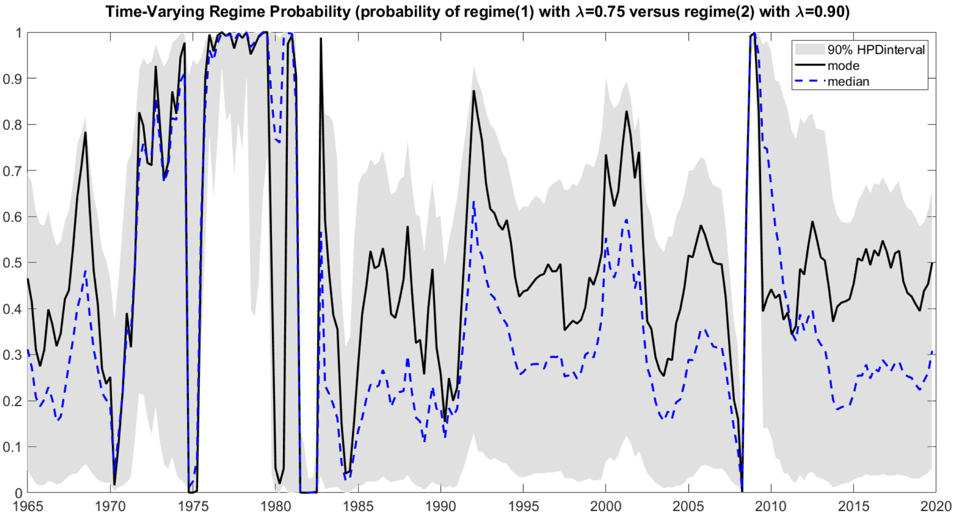


a)

b)

c)

Figure A4: Time-varying regime probability in the regime-switching models.



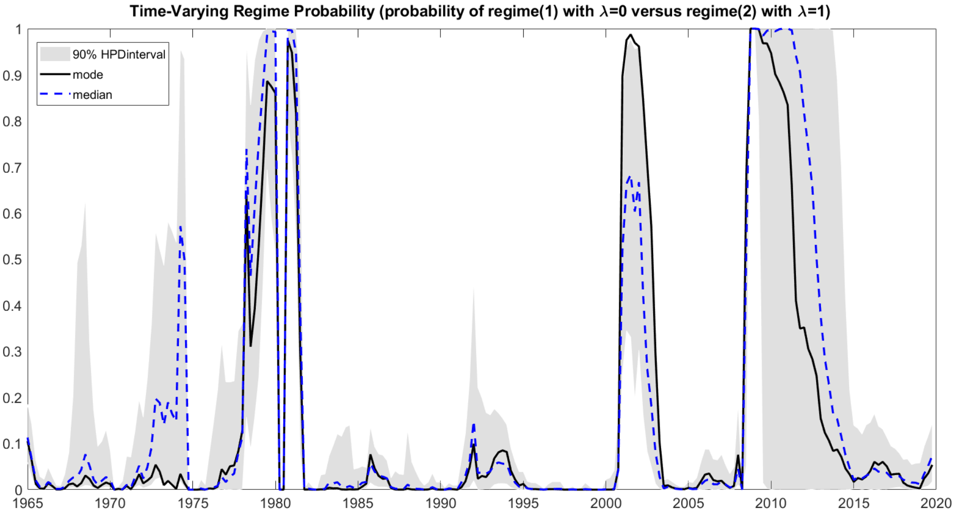


Table A1: Calibration of parameters of the New Keynesian model of Section 2

κ	0.01	BM22
β	0.995	Real rate of 2%
R^{-1}	0.99	Nominal rate of 4%
ρ_M	0.9593	Government debt average maturity of 6 years
b	2.4	Government debt ratio of 60%
ψ_π	1.75	BM22
ψ_y	0.25	BM22
ρ_R	0.9	
ψ_y^F	0.0	No inflation response in fiscal-led regime
δ_b	0.05	BM22
δ_y	0.5	BM22
δ_{dy}	0.4	
ρ_τ	0.9	
δ_b^F	0.0	No debt response in fiscal-led regime

Notes: Simulation results are in Fiscalbacking6.mod – set_parameters1.m – impulse_response_plots5.m

Table A2: Subsample estimations

		Baseline model		Subsample 1965q1-1979q2		Subsample 1984q1-2019q4	
		Log marg.lik. = -2757.72		Log marg.lik. = -756.98		Log marg.lik. = -1488.97	
	prior distribution	posterior distribution		posterior distribution		posterior distribution	
		mode	HPD interval	mode	HPD interval	mode	HPD interval
σ_c	N (1.500 , 0.3750)	1.10	[1.03 , 1.40]	0.85	[0.89 , 1.34]	1.14	[1,00 , 1.31]
h	B (0.700 , 0.1000)	0.62	[0.52 , 0.69]	0.7	[0.55 , 0.74]	0.58	[0.53 , 0.67]
σ_l	N (2.000 , 0.7500)	0.03	[0.03 , 0.37]	0.03	[0.03 , 0.24]	0.14	[0.03 , 1.01]
ξ_w	B (0.500 , 0.1000)	0.63	[0.51 , 0.74]	0.69	[0.57 , 0.77]	0.56	[0.45 , 0.79]
ξ_p	B (0.500 , 0.1000)	0.79	[0.74 , 0.85]	0.61	[0.45 , 0.7]	0.89	[0.87 , 0.94]
ι_w	B (0.500 , 0.1500)	0.54	[0.29 , 0.74]	0.49	[0.32 , 0.73]	0.45	[0.21 , 0.69]
ι_p	B (0.500 , 0.1500)	0.24	[0.11 , 0.36]	0.54	[0.22 , 0.73]	0.24	[0.1 , 0.4]
φ	N (4.000 , 1.0000)	3.83	[2.91 , 5.27]	3.72	[3.07 , 5.53]	5.62	[4.8 , 7.28]
ψ	B (0.500 , 0.1500)	0.6	[0.53 , 0.77]	0.34	[0.06 , 0.37]	0.85	[0.75 , 0.93]
Φ	N (1.250 , 0.2500)	1.74	[1.62 , 1.98]	1.62	[1.41 , 1.93]	1.78	[1.58 , 1.99]
α	N (0.300 , 0.0500)	0.27	[0.24 , 0.32]	0.26	[0.19 , 0.29]	0.29	[0.24 , 0.32]
r_π	N (1.500 , 0.2500)	1.76	[1.51 , 1.98]	1.32	[1.00 , 1.6]	1.62	[1.16 , 1.85]
r_ρ	B (0.750 , 0.1000)	0.72	[0.72 , 0.83]	0.83	[0.73 , 0.88]	0.85	[0.83 , 0.91]
r_y	B (0.125 , 0.0625)	0.02	[0.01 , 0.03]	0.06	[0.03 , 0.16]	0.02	[0.01 , 0.06]
$r_{\Delta y}$	B (0.125 , 0.0625)	0.23	[0.20 , 0.32]	0.3	[0.18 , 0.39]	0.24	[0.17 , 0.29]
r_{π_F}	N (0.500 , 0.2000)	0.22	[0.07 , 0.83]	1.00	[0.7 , 1.00]	0.93	[0.57 , 0.97]
l-cte	N (0.000 , 2.0000)	-0.11	[-2.61 , 2.04]	-3.6	[-3.35 , -0.69]	0.73	[-0.86 , 2.34]
γ-cte	N (0.430 , 0.0250)	0.38	[0.34 , 0.40]	0.39	[0.36 , 0.43]	0.43	[0.4 , 0.47]
β^{-1}-1	G (0.250 , 0.1000)	0.09	[0.05 , 0.17]	0.17	[0.09 , 0.29]	0.1	[0.05 , 0.19]
$y1$-cte	U (1.000 , 0.5774)	1.01	[0.94 , 1.15]	0.88	[0.8 , 1.21]	1.11	[1.04 , 1.24]
ω_{y1}	B (0.500 , 0.2000)	0.87	[0.60 , 0.97]	0.71	[0.3 , 0.89]	0.83	[0.52 , 0.96]
δ_y	N (0.280 , 0.1250)	0.49	[0.33 , 0.60]	0.6	[0.43 , 0.7]	0.44	[0.35 , 0.61]
$\delta_{\Delta y}$	N (0.280 , 0.1250)	0.39	[0.30 , 0.45]	0.27	[0.16 , 0.39]	0.41	[0.3 , 0.51]
$\delta_{\Delta h}$	N (0.250 , 0.1250)	0.18	[0.13 , 0.21]	0.27	[0.16 , 0.32]	0.1	[0.06 , 0.15]
δ_g	B (0.250 , 0.1250)	0.03	[0.02 , 0.04]	0.08	[0.04 , 0.13]	0.07	[0.05 , 0.11]
δ_{tra}	B (0.250 , 0.1250)	0.07	[0.00 , 0.27]	0.13	[0.01 , 0.17]	0.1	[0.01 , 0.17]
δ_{tax}	B (0.250 , 0.1250)	0.01	[0.00 , 0.03]	0.07	[0.04 , 0.12]	0.05	[0.01 , 0.11]
ρ_M	U (0.500 , 0.2887)	0.90	[0.83 , 0.94]	0.65	[0.37 , 0.83]	0.92	[0.75 , 0.97]
λ	U (0.500 , 0.2887)	0.83	[0.77 , 0.91]	0.75	[0.49 , 0.84]	0.71	[0.58 , 0.78]
σ_a	IG (0.100 , 2.0000)	0.43	[0.39 , 0.47]	0.51	[0.46 , 0.66]	0.36	[0.33 , 0.41]
σ_b	IG (1.000 , 2.0000)	0.85	[0.55 , 1.35]	1.22	[0.84 , 1.98]	0.36	[0.27 , 0.62]
σ_I	IG (0.100 , 2.0000)	0.28	[0.26 , 0.38]	0.26	[0.23 , 0.5]	0.26	[0.22 , 0.32]
σ_r	IG (0.100 , 2.0000)	0.22	[0.20 , 0.25]	0.24	[0.19 , 0.27]	0.1	[0.08 , 0.11]
σ_{y1}	IG (0.100 , 2.0000)	0.14	[0.13 , 0.16]	0.15	[0.13 , 0.2]	0.09	[0.07 , 0.1]
σ_p	IG (0.100 , 2.0000)	0.13	[0.11 , 0.15]	0.23	[0.18 , 0.28]	0.1	[0.09 , 0.12]
σ_w	IG (0.100 , 2.0000)	0.37	[0.33 , 0.41]	0.2	[0.15 , 0.24]	0.43	[0.36 , 0.48]
σ_{ne}	IG (0.100 , 2.0000)	0.40	[0.37 , 0.44]	0.42	[0.38 , 0.53]	0.3	[0.28 , 0.34]
σ_g	IG (0.100 , 2.0000)	0.15	[0.14 , 0.17]	0.17	[0.15 , 0.21]	0.11	[0.1 , 0.13]
σ_{tra}	IG (0.100 , 2.0000)	0.28	[0.26 , 0.31]	0.33	[0.3 , 0.43]	0.24	[0.22 , 0.27]
σ_{tax}	IG (0.100 , 2.0000)	0.52	[0.49 , 0.57]	0.54	[0.48 , 0.68]	0.5	[0.45 , 0.56]
σ_{debt}	IG (1.000 , 2.0000)	5.65	[5.30 , 6.20]	2.35	[2.00 , 2.77]	6.58	[6.08 , 7.46]
ρ_a	B (0.500 , 0.1750)	0.97	[0.96 , 0.98]	0.83	[0.73 , 0.91]	0.95	[0.93 , 0.97]
ρ_b	B (0.500 , 0.1750)	0.93	[0.85 , 0.94]	0.6	[0.46 , 0.76]	0.97	[0.94 , 0.98]
ρ_I	B (0.500 , 0.1750)	0.87	[0.78 , 0.91]	0.79	[0.49 , 0.86]	0.81	[0.73 , 0.89]
ρ_r	B (0.500 , 0.1750)	0.18	[0.09 , 0.24]	0.27	[0.15 , 0.37]	0.47	[0.4 , 0.5]
ρ_{y1}	B (0.500 , 0.1750)	0.76	[0.70 , 0.83]	0.78	[0.68 , 0.92]	0.71	[0.64 , 0.81]
ρ_p	B (0.500 , 0.1750)	0.96	[0.90 , 0.97]	0.52	[0.26 , 0.8]	0.8	[0.66 , 0.9]
ρ_w	B (0.500 , 0.1750)	0.98	[0.96 , 0.99]	0.53	[0.39 , 0.86]	0.98	[0.91 , 0.99]
ρ_{ne}	B (0.500 , 0.1750)	0.24	[0.16 , 0.33]	0.28	[0.14 , 0.43]	0.18	[0.1 , 0.28]
ρ_g	B (0.500 , 0.1750)	0.93	[0.92 , 0.99]	0.89	[0.86 , 0.96]	0.94	[0.93 , 0.96]
ρ_{tra}	B (0.500 , 0.1750)	1.00	[0.99 , 1.00]	0.99	[0.98 , 1.00]	0.99	[0.98 , 1,00]
ρ_{tax}	B (0.500 , 0.1750)	0.92	[0.89 , 0.96]	0.51	[0.4 , 0.74]	0.95	[0.91 , 0.98]
μ_b	B (0.500 , 0.1750)	0.78	[0.59 , 0.84]	0.31	[0.13 , 0.54]	0.73	[0.56 , 0.83]
μ_p	B (0.500 , 0.1750)	0.89	[0.80 , 0.92]	0.5	[0.24 , 0.69]	0.71	[0.52 , 0.87]
μ_w	B (0.500 , 0.1750)	0.92	[0.86 , 0.97]	0.5	[0.26 , 0.75]	0.91	[0.79 , 0.95]
μ_{tra}	B (0.500 , 0.1750)	0.37	[0.23 , 0.48]	0.43	[0.14 , 0.44]	0.46	[0.31 , 0.57]
ζ_{ne}	B (0.500 , 0.1500)	0.01	[0.01 , 0.05]	0.24	[0.13 , 0.43]	0.03	[0.02 , 0.05]
ζ_{ne_d}	N (0.250 , 0.1250)	0.27	[0.22 , 0.39]	0.33	[0.18 , 0.43]	0.37	[0.26 , 0.43]
ζ_{ne_s}	N (0.500 , 0.2500)	0.51	[0.38 , 0.62]	0.57	[0.29 , 0.68]	0.41	[0.26 , 0.52]

Fixed: π-cte=0.5, D/Y=2.4, G/Y=0.18,Tra/Y=0.10

Table A3: Shock-specific λ's (for baseline and alternative independent-shocks specification)

		Baseline model		Independent shocks		Independent shocks specific λ_i	
		Log marg.lik. = -2757.72		Log marg.lik. =-2746.07		Log marg.lik. = -2769,3	
	prior distribution	posterior distribution		posterior distribution		posterior distribution	
		mode	HPD interval	mode	HPD interval	mode	HPD interval
σ_c	N (1.500 , 0.3750)	1.10	[1.03 , 1.40]	0.85	[0.89 , 1.34]	1.17	[1.07 , 1.40]
h	B (0.700 , 0.1000)	0.62	[0.52 , 0.69]	0.7	[0.55 , 0.74]	0.54	[0.50 , 0.67]
σ_l	N (2.000 , 0.7500)	0.03	[0.03 , 0.37]	0.03	[0.03 , 0.24]	0.03	[0.03 , 0.07]
ξ_w	B (0.500 , 0.1000)	0.63	[0.51 , 0.74]	0.69	[0.57 , 0.77]	0.61	[0.49 , 0.74]
ξ_p	B (0.500 , 0.1000)	0.79	[0.74 , 0.85]	0.61	[0.45 , 0.7]	0.84	[0.83 , 0.92]
ι_w	B (0.500 , 0.1500)	0.54	[0.29 , 0.74]	0.49	[0.32 , 0.73]	0.47	[0.26 , 0.69]
ι_p	B (0.500 , 0.1500)	0.24	[0.11 , 0.36]	0.54	[0.22 , 0.73]	0.22	[0.13 , 0.41]
φ	N (4.000 , 1.0000)	3.83	[2.91 , 5.27]	3.72	[3.07 , 5.53]	3.80	[3.21 , 5.64]
ψ	B (0.500 , 0.1500)	0.6	[0.53 , 0.77]	0.34	[0.06 , 0.37]	0.61	[0.49 , 0.76]
Φ	N (1.250 , 0.2500)	1.74	[1.62 , 1.98]	1.62	[1.41 , 1.93]	1.80	[1.62 , 2.03]
α	N (0.300 , 0.0500)	0.27	[0.24 , 0.32]	0.26	[0.19 , 0.29]	0.28	[0.24 , 0.32]
r_π	N (1.500 , 0.2500)	1.76	[1.51 , 1.98]	1.32	[1.00 , 1.6]	1.77	[1.41 , 2.09]
r_ρ	B (0.750 , 0.1000)	0.72	[0.72 , 0.83]	0.83	[0.73 , 0.88]	0.73	[0.70 , 0.89]
r_y	B (0.125 , 0.0625)	0.02	[0.01 , 0.03]	0.06	[0.03 , 0.16]	0.03	[0.01 , 0.08]
$r_{\Delta y}$	B (0.125 , 0.0625)	0.23	[0.20 , 0.32]	0.3	[0.18 , 0.39]	0.33	[0.26 , 0.40]
r_{π_F}	N (0.500 , 0.2000)	0.22	[0.07 , 0.83]	1.00	[0.7 , 1.00]	0.43	[0.24 , 1.00]
l-cte	N (0.000 , 2.0000)	-0.11	[-2.61 , 2.04]	-3.6	[-3.35 , -0.69]	-1.12	[-3.40 , 0.85]
γ-cte	N (0.430 , 0.0250)	0.38	[0.34 , 0.40]	0.39	[0.36 , 0.43]	0.38	[0.36 , 0.41]
β^{-1}-1	G (0.250 , 0.1000)	0.09	[0.05 , 0.17]	0.17	[0.09 , 0.29]	0.10	[0.04 , 0.18]
y1-cte	U (1.000 , 0.5774)	1.01	[0.94 , 1.15]	0.88	[0.8 , 1.21]	1.05	[0.96 , 1.14]
ω_{y1}	B (0.500 , 0.2000)	0.87	[0.60 , 0.97]	0.71	[0.3 , 0.89]	0.86	[0.60 , 0.97]
δ_y	N (0.280 , 0.1250)	0.49	[0.33 , 0.60]	0.6	[0.43 , 0.7]	0.52	[0.00 , 0.66]
$\delta_{\Delta y}$	N (0.280 , 0.1250)	0.39	[0.30 , 0.45]	0.27	[0.16 , 0.39]	0.38	[0.32 , 0.46]
$\delta_{\Delta h}$	N (0.250 , 0.1250)	0.18	[0.13 , 0.21]	0.27	[0.16 , 0.32]	0.16	[0.12 , 0.19]
δ_g	B (0.250 , 0.1250)	0.03	[0.02 , 0.04]	0.08	[0.04 , 0.13]	0.04	[0.04 , 0.07]
δ_{tra}	B (0.250 , 0.1250)	0.07	[0.00 , 0.27]	0.13	[0.01 , 0.17]	0.15	[0.09 , 0.36]
δ_{tax}	B (0.250 , 0.1250)	0.01	[0.00 , 0.03]	0.07	[0.04 , 0.12]	0.01	[0.01 , 0.21]
ρ_M	U (0.500 , 0.2887)	0.90	[0.83 , 0.94]	0.65	[0.37 , 0.83]	0.90	[0.74 , 0.93]
λ	U (0.500 , 0.2887)	0.83	[0.77 , 0.91]	0.75	[0.49 , 0.84]	-	
λ_a	U (0.500 , 0.2887)	-		-		0.59	[0.39 , 0.69]
λ_b	U (0.500 , 0.2887)	-		-		1.00	[0.98 , 1.00]
λ_l	U (0.500 , 0.2887)	-		-		1.00	[0.97 , 1.00]
λ_r	U (0.500 , 0.2887)	-		-		1.00	[0.67 , 1.00]
λ_{y1}	U (0.500 , 0.2887)	-		-		1.00	[0.91 , 0.98]
λ_p	U (0.500 , 0.2887)	-		-		0.68	[0.40 , 1.00]
λ_w	U (0.500 , 0.2887)	-		-		0.71	[0.33 , 1.00]
λ_{ne}	U (0.500 , 0.2887)	-		-		0.00	[0.01 , 0.05]
λ_g	U (0.500 , 0.2887)	-		-		1.00	[0.93 , 0.99]
λ_{tra}	U (0.500 , 0.2887)	-		-		0.64	[0.14 , 0.91]
λ_{tax}	U (0.500 , 0.2887)	-		-		1.00	[0.97 , 1.00]
σ_a	IG (0.100 , 2.0000)	0.43	[0.39 , 0.47]	0.51	[0.46 , 0.66]	0.42	[0.39 , 0.47]
σ_b	IG (1.000 , 2.0000)	0.85	[0.55 , 1.35]	1.22	[0.84 , 1.98]	0.59	[0.47 , 1.23]
σ_l	IG (0.100 , 2.0000)	0.28	[0.26 , 0.38]	0.26	[0.23 , 0.5]	0.29	[0.27 , 0.37]
σ_r	IG (0.100 , 2.0000)	0.22	[0.20 , 0.25]	0.24	[0.19 , 0.27]	0.21	[0.18 , 0.25]
σ_{y1}	IG (0.100 , 2.0000)	0.14	[0.13 , 0.16]	0.15	[0.13 , 0.2]	0.14	[0.12 , 0.16]
σ_p	IG (0.100 , 2.0000)	0.13	[0.11 , 0.15]	0.23	[0.18 , 0.28]	0.13	[0.12 , 0.16]
σ_w	IG (0.100 , 2.0000)	0.37	[0.33 , 0.41]	0.2	[0.15 , 0.24]	0.36	[0.33 , 0.41]
σ_{ne}	IG (0.100 , 2.0000)	0.40	[0.37 , 0.44]	0.42	[0.38 , 0.53]	0.40	[0.37 , 0.44]
σ_g	IG (0.100 , 2.0000)	0.15	[0.14 , 0.17]	0.17	[0.15 , 0.21]	0.14	[0.13 , 0.15]
σ_{tra}	IG (0.100 , 2.0000)	0.28	[0.26 , 0.31]	0.33	[0.3 , 0.43]	0.26	[0.25 , 0.29]
σ_{tax}	IG (0.100 , 2.0000)	0.52	[0.49 , 0.57]	0.54	[0.48 , 0.68]	0.52	[0.49 , 0.58]
σ_{debt}	IG (1.000 , 2.0000)	5.65	[5.30 , 6.20]	2.35	[2.00 , 2.77]	5.63	[5.26 , 6.17]
ρ_a	B (0.500 , 0.1750)	0.97	[0.96 , 0.98]	0.83	[0.73 , 0.91]	0.96	[0.95 , 0.98]
ρ_b	B (0.500 , 0.1750)	0.93	[0.85 , 0.94]	0.6	[0.46 , 0.76]	0.90	[0.84 , 0.96]
ρ_l	B (0.500 , 0.1750)	0.87	[0.78 , 0.91]	0.79	[0.49 , 0.86]	0.89	[0.75 , 0.90]
ρ_r	B (0.500 , 0.1750)	0.18	[0.09 , 0.24]	0.27	[0.15 , 0.37]	0.12	[0.04 , 0.17]
ρ_{y1}	B (0.500 , 0.1750)	0.76	[0.70 , 0.83]	0.78	[0.68 , 0.92]	0.76	[0.70 , 0.85]
ρ_p	B (0.500 , 0.1750)	0.96	[0.90 , 0.97]	0.52	[0.26 , 0.8]	0.92	[0.64 , 0.92]
ρ_w	B (0.500 , 0.1750)	0.98	[0.96 , 0.99]	0.53	[0.39 , 0.86]	0.98	[0.98 , 0.99]
ρ_{ne}	B (0.500 , 0.1750)	0.24	[0.16 , 0.33]	0.28	[0.14 , 0.43]	0.22	[0.16 , 0.33]
ρ_g	B (0.500 , 0.1750)	0.93	[0.92 , 0.99]	0.89	[0.86 , 0.96]	0.91	[0.90 , 0.95]
ρ_{tra}	B (0.500 , 0.1750)	1.00	[0.99 , 1.00]	0.99	[0.98 , 1.00]	0.99	[0.99 , 1.00]
ρ_{tax}	B (0.500 , 0.1750)	0.92	[0.89 , 0.96]	0.51	[0.4 , 0.74]	0.93	[0.93 , 1.00]
μ_b	B (0.500 , 0.1750)	0.78	[0.59 , 0.84]	0.31	[0.13 , 0.54]	0.65	[0.54 , 0.88]
μ_p	B (0.500 , 0.1750)	0.89	[0.80 , 0.92]	0.5	[0.24 , 0.69]	0.86	[0.52 , 0.88]
μ_w	B (0.500 , 0.1750)	0.92	[0.86 , 0.97]	0.5	[0.26 , 0.75]	0.92	[0.89 , 0.98]
μ_{tra}	B (0.500 , 0.1750)	0.37	[0.23 , 0.48]	0.43	[0.14 , 0.44]	0.49	[0.31 , 0.56]
ζ_{ne}	B (0.500 , 0.1500)	0.01	[0.01 , 0.05]	0.24	[0.13 , 0.43]	0.03	[0.02 , 0.05]
ζ_{ne_d}	N (0.250 , 0.1250)	0.27	[0.22 , 0.39]	0.33	[0.18 , 0.43]	0.26	[0.19 , 0.42]
ζ_{ne_s}	N (0.500 , 0.2500)	0.51	[0.38 , 0.62]	0.57	[0.29 , 0.68]	0.50	[0.36 , 0.60]

Fixed: π-cte=0.5, D/Y=2.4, G/Y=0.18,Tra/Y=0.10

Data appendix for the estimated version of SW

The model is estimated using twelve quarterly U.S. macro-economic time series. The basic dataset is similar to SW2007: real GDP, consumption, investment, hours worked, real wages, prices and a short-term interest rate. This dataset is augmented with four data series describing the government sector and a long term yield.

GDP, consumption and investment are taken from the U.S. Bureau of Economic Analysis. Real Gross Domestic Product (GDPC1) is expressed in Billions of Chained 2017 Dollars. Nominal Personal Consumption Expenditures (PCEC) and Fixed Private Domestic Investment (FPI) are deflated with the GDP-deflator. Inflation is the first difference of the log of the Implicit Price Deflator of GDP (GDPDEF). Hours and wages come from the BLS (hours and hourly compensation for the NFB sector for all persons). Hourly compensation (COMPNFB/PRS85006103) is divided by the GDP price deflator in order to get the real wage variable. Hours are adjusted to take into account the limited coverage of the NFB sector compared to GDP (the index of average weekly hours for the NFB sector (PRS85006023) is multiplied with the Civilian Employment (16 years and over - CE16OV).

Government consumption expenditures and gross investment (GCE) and federal government transfers (government social benefits B087RC1Q027SBEA - GSB) are also deflated by the GDP deflator.

The interest rate is the Federal Funds Rate. The long term yields are zero-coupon yields (SVENYXX) available on the Federal Reserve webpage “Nominal Yield Curve” and based on: “The U.S. Treasury Yield Curve: 1961 to the Present” by Refet S. Gurkaynak, Brian Sack, and Jonathan H. Wright.

The aggregate real variables are expressed per capita by dividing with the population over 16 trend (CNP16OV). All series are seasonally adjusted. Consumption, investment, GDP, wages, hours, government consumption and investment and government transfers are expressed in 100 times log. The interest rate and inflation rate are expressed on a quarterly basis corresponding with their appearance in the model.

The primary public surplus is defined as the sum of net government savings (TGDEF) plus government interest payments (Government current expenditures: Interest payments A180RC1Q027SBEA).

The government debt is the sum of the outstanding Treasury debt at Market Value plus the residual of general government (consolidated) total liabilities (FL374190005) at par value. The series at market value is from: George Hall, Jonathan Payne, Thomas J. Sargent, 2018. “US Federal Debt 1776-1960: Quantities and Prices,” Working Papers 18-25, New York University.

consumption = LN((PCEC / GDPDEF) / LNSindex) * 100
investment = LN((FPI / GDPDEF) / LNSindex) * 100
output = LN(GDPC96 / LNSindex) * 100
hours = LN((PRS85006023 * CE16OV / 100) / LNSindex) * 100
inflation = LN(GDPDEF / GDPDEF(-1)) * 100
real wage = LN(PRS85006103 / GDPDEF) * 100
interest rate = Federal Funds Rate / 4
1Y yield = SVENYXX / 4
government consumption and investment = LN((GCE / GDPDEF) / LNSindex) * 100
government transfers = LN((GSB / GDPDEF) / LNSindex)*100
primary surplus ratio = (TGDEF + GIP) / (GDP / 4)
public debt ratio = (Total Debt) / (GDP / 4)