

Fiscal Inflation in Japan: The Role of Unfunded Fiscal Shocks

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First draft: July 2025; This draft: December 2025

Abstract

We investigate the extent to which fiscal factors have contributed to inflation in Japan over the past four decades. Despite sustained fiscal expansion and rising debt since the 1990s, inflation remained low until recent years. Using the medium-scale DSGE model developed by Bianchi et al. (2023), we estimate the model with Japanese data and find that, in contrast to the U.S. case, unfunded fiscal shocks are not the main drivers of inflation in Japan. Instead, real demand and supply shocks, along with accommodative monetary policy, have played more significant roles in shaping inflation dynamics.

Keywords: Inflation; Fiscal Theory of Price Level; Japan.

JEL classification: E31, E52, E62, H63

1 Introduction

We investigate the extent to which fiscal factors have contributed to inflation in Japan over the past four decades, encompassing the bubble economy and the so-called “lost three decades.” Figure 1 plots the inflation rate and the debt-to-GDP ratio for Japan and the United States. In Japan, a prolonged period of low inflation has persisted since the bursting of the asset price bubble in the early 1990s, despite the Bank of Japan’s implementation of large-scale monetary easing. More recently, after the COVID-19 pandemic crisis in 2020, signs of rising inflation have emerged amid global inflationary pressures; however, it remains uncertain whether this trend will be sustained.

Throughout this period, Japan’s government debt has steadily increased, accompanied by repeated large-scale fiscal stimulus measures. Concerns about the sustainability of government debt may give rise to inflation, as suggested by the Fiscal Theory of the Price Level (FTPL) (among many others, Sargent and Wallace, 1981; Leeper, 1991; Sims, 1994; Woodford, 1994; Cochrane, 1999). Thus, analyzing fiscal determinants of inflation is essential not only for understanding the current inflationary environment, but also for explaining the persistently low inflation observed in the past.

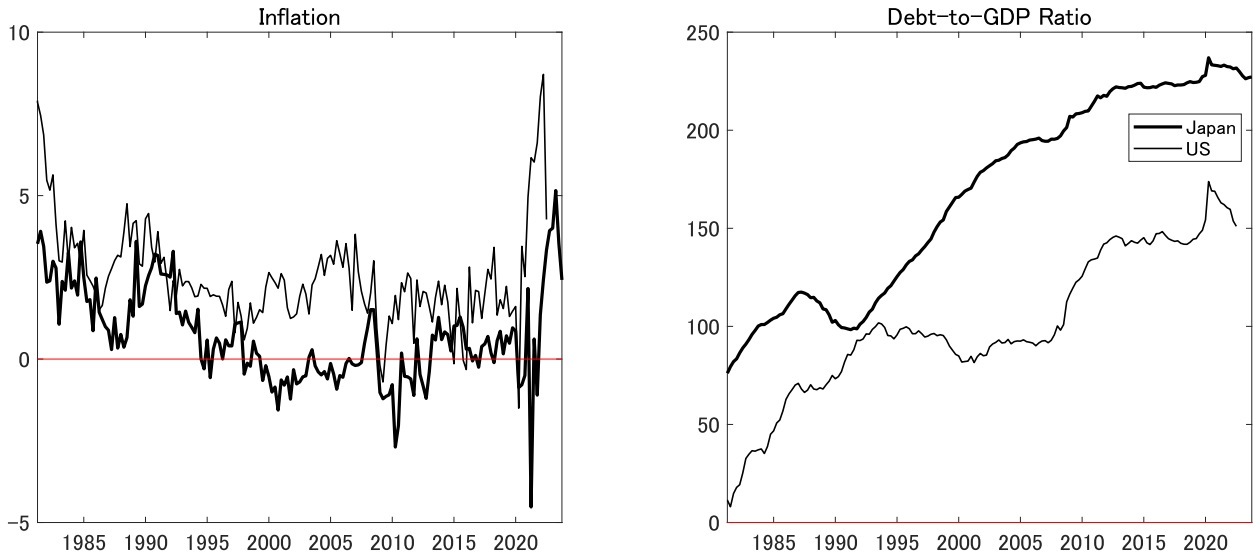


Figure 1. Inflation and Debt-to-GDP ratio: Japan vs. US.

We employ a new general equilibrium model to examine the fiscal origins of inflation in Japan. The model demonstrates that inflation can be driven by shocks to government transfers that lack future repayment guarantees, under which the Ricardian equivalence does not hold, and households receiving cash transfers spend rather than save them for future tax increases, thereby causing demand and raising inflation. We refer to such shocks as *unfunded*

fiscal shocks.

Using the estimated model based on Japanese data, we find that the historical dynamics of inflation can be summarized as follows. Excluding the bubble period, unfunded fiscal shocks have exerted upward pressure on inflation. However, the inflation rate remained low, particularly due to demand and supply shocks in the real economy. These non-policy shocks account for much of the recent increase in inflation in the post-pandemic period. Other policy shocks, including monetary policy shocks—especially after the launch of Quantitative and Qualitative Monetary Easing (QQE) policy by the Bank of Japan since 2013—have also contributed to maintaining inflation.¹

Why can government transfers without repayment guarantees potentially lead to higher inflation? Suppose there is an unexpected increase in government transfers without a corresponding future tax increase. In this case, the Ricardian equivalence fails to hold, and households perceive a rise in their permanent income.² If monetary policy does not respond by tightening, household consumption and the price level increase, leading to higher inflation and a stabilization of the real value of government debt.

When monetary policy does not respond to inflation, it is regarded as passive, whereas fiscal policy that is not accompanied by future tax hikes may generate inflation and is therefore considered active. When monetary policy is passive and fiscal policy is active, inflation is determined by fiscal policy (Leeper, 1991).³ In the case of funded fiscal shocks—those accompanied by credible future repayments—the central bank stabilizes inflation, and the fiscal authority maintains debt sustainability. Unfunded fiscal shocks, which lack such repayment guarantees, instead lead the central bank to accommodate persistent inflation in order to stabilize the real value of government debt.

Our finding—that fiscal factors play a limited role in explaining inflation in Japan—relates closely to the extent to which the Ricardian equivalence holds in the Japanese context. If the Ricardian equivalence holds, households do not increase consumption in response to government transfer spending, and consequently, the price level remains unaffected. In other words, fiscal factors have a limited impact on inflation precisely because households believe that current government spending will eventually be repaid by future taxation and that

¹A closely related study, Bianchi et al. (2023) (hereafter BFM), estimates a medium-scale New Keynesian model using U.S. data and find that unfunded fiscal shocks play a central role in explaining U.S. inflation dynamics. In contrast, we estimate the same model using Japanese data and find that such shocks are not the primary drivers of inflation in Japan.

²According to the Ricardian equivalence, government spending is offset by future taxation, leaving households' permanent income—and thus their behavior—unchanged.

³In the standard New Keynesian framework, monetary policy is responsible for controlling inflation through adjustments in the nominal interest rate, while fiscal policy ensures debt sustainability by adjusting taxes or transfers. Under this regime, monetary policy is considered active and fiscal policy passive.

government debt will not become unsustainable. However, if this belief were to erode for any reason, the Ricardian equivalence would no longer hold, and fiscal factors could begin to influence inflation dynamics.

Related Literature The causes of post-pandemic inflation in the United States have been widely discussed in recent literature, which can be broadly categorized into three strands: the price-wage spiral, supply chain disruptions, and fiscal policy.

Price-Wage Spiral: Blanchard and Bernanke (2023) argue that the post-pandemic inflation resulted from a sharp increase in aggregate demand driven by fiscal stimulus combined with supply constraints. In particular, tight labor market conditions led to rising wages, which subsequently pushed up service prices. Although signs of a price-wage spiral were observed, they conclude that self-reinforcing inflationary dynamics did not materialize due to well-anchored inflation expectations. Lorenzoni and Werning (2023) suggest a mechanism through which nominal wage growth can pass through to prices, but empirically they find little evidence of a sustained spiral.

Supply Chain Disruptions: Comin et al. (2023) provide empirical evidence that pandemic-induced supply chain disruptions significantly contributed to core goods inflation. Although supply shocks are transitory, their impact on inflation is found to be statistically significant.

Fiscal Policy: Bianchi and Melosi (2022) argue that fiscal stimulus during the pandemic, coupled with accommodative monetary policy, fueled inflation. They show that government spending without repayment guarantees can raise inflation expectations. Bianchi et al. (2023) estimate a medium-scale New Keynesian model using U.S. data and find that unfunded transfer shocks account for the bulk of inflation since 2021. They conclude that fiscal shocks play a more dominant role in inflation dynamics than conventional demand or supply shocks. Smets and Wouters (2024) extend the standard Smets-Wouters DSGE model to account for the effects of fiscal policy on inflation. They find that around 80% of fiscal shocks are funded, distinguishing their findings from BFM.

A few papers have examined recent developments in inflation and the role of fiscal policy in Japan. Nakamura et al. (2024) apply the Bernanke-Blanchard model to the Japanese economy. They find that the rise in inflation since 2022 is driven by supply constraints, rising import prices, and a tightening labor market that puts upward pressure on wages. Abe et al. (2019) conduct a study more closely related to the present paper. They develop a Markov-switching DSGE model to examine how different fiscal regimes affect macroeconomic outcomes. Their analysis reveals that the impact of fiscal shocks depends significantly on the prevailing policy regime, and that regime uncertainty is a key driver of macroeconomic fluctuations. However, their dataset does not cover the post-pandemic period, and inflation

is not a central focus of their analysis.

The remainder of the paper proceeds as follows. Section 2 outlines the mechanism of how FTPL works using a stylized toy model and introduces the medium-scale New Keynesian model employed for our quantitative analysis. Section 3 describes the data and estimation methodology. Section 4 presents the main results, including impulse response analyses and historical decompositions. Section 5 concludes. Additional materials—such as the model’s steady-state and log-linearized equations, along with detailed descriptions of the data—are provided in the Appendix.

2 Model

2.1 Toy Model

We illustrate how unfunded fiscal shocks can generate inflation using a simplified toy model. The baseline model, following BFM, consists of the following four equations:

$$\begin{aligned}\hat{r}_{n,t} &= \mathbb{E}_t \hat{\pi}_{t+1}, \\ \hat{s}_{b,t} &= \beta^{-1}[\hat{s}_{b,t-1} + \hat{r}_{n,t-1} - \hat{\pi}_t - (1 - \beta)\hat{\tau}_t], \\ \hat{r}_{n,t} &= \phi \hat{\pi}_t, \\ \hat{\tau}_t &= \gamma \hat{s}_{b,t} + \zeta_t,\end{aligned}$$

where $\hat{r}_{n,t}$ denotes the nominal interest rate, $\hat{\pi}_t$ the inflation rate, $\hat{s}_{b,t}$ the debt-to-GDP ratio, and $\hat{\tau}_t$ the tax rate. $\beta \in (0, 1)$ denotes the household’s discount factor. All variables are expressed as deviations from their steady-state values. The first equation is the log-linearized Fisher equation. The second is the government’s log-linearized intertemporal budget constraint. The third and fourth equations describe the monetary and fiscal policy rules, respectively. ζ_t represents an exogenous fiscal policy shock.

There are two key parameters, ϕ and γ , which determine the prevailing policy regime. When $\phi > 1$ and $\gamma > 1$, the policy mix corresponds to the Active-Monetary and Passive-Fiscal (AM/PF) regime, also known as the monetary-led regime. In contrast, when $\phi \leq 1$ and $\gamma \leq 1$, the policy mix corresponds to the Passive-Monetary and Active-Fiscal (PM/AF) regime, referred to as the fiscal-led regime.

We extend the baseline model to incorporate two blocks of the economy: the actual economy, which operates under a monetary-led regime, and the shadow economy, which operates under a fiscal-led regime. The variables in each regime are denoted by superscripts “M” and “F,” respectively. The monetary and fiscal policy rules in each economy are specified

as follows:

$$\begin{aligned}
\hat{\tau}_t &= \gamma^M (\hat{s}_{b,t-1} - \hat{s}_{b,t-1}^F) + \gamma^F \hat{s}_{b,t-1}^F + \zeta_t^M + \zeta_t^F, \\
\hat{r}_{n,t} &= \phi^M (\hat{\pi}_t - \hat{\pi}_t^F) + \phi^F \hat{\pi}_t^F, \\
\hat{\tau}_t^F &= \gamma^F \hat{s}_{b,t-1}^F + \zeta_t^F, \\
\hat{r}_{n,t}^F &= \phi^F \hat{\pi}_t^F,
\end{aligned}$$

where the actual economy follows a monetary-led regime with $\phi^M > 1$ and $\gamma^M > 1$, while the shadow economy follows a fiscal-led regime with $\phi^F \leq 1$ and $\gamma^F \leq 1$. In this framework, policies in the actual economy also respond to variables from the shadow economy. Both government debt and inflation in the actual economy are only partially funded; policy responses are based on funded debt, defined as $\hat{s}_{b,t-1} - \hat{s}_{b,t-1}^F$, and on funded inflation, defined as $\hat{\pi}_t - \hat{\pi}_t^F$.

Figure 2 presents the impulse responses of inflation and the debt-to-GDP ratio to funded and unfunded fiscal shocks. We set the parameters as follows: $\beta = 0.99$, $\phi^M = 2.0$, $\gamma^M = 20$, and $\phi^F = \gamma^F = 0$. In the baseline model, inflation rises in response to a negative ζ_t shock under the fiscal-led regime, whereas it remains muted under the monetary-led regime. Similarly, in the extended model, inflation increases in response only to an unfunded fiscal shock, ζ_t^F , but it shows no reaction to a funded fiscal shock, ζ_t^M . These results highlight that unfunded fiscal shocks are inflationary.

In the monetary-led regime, the debt-to-GDP ratio rises. Interestingly, in the fiscally-led regime, it declines, driven by an increase in inflation and nominal GDP. We will demonstrate that this pattern also holds in the quantitative model, and we will leverage this feature to identify unfunded and funded shocks.

2.2 Medium-scale Quantitative DSGE Model

We introduce a medium-scale New Keynesian model that has been extensively examined in the literature (Smets and Wouters, 2007). The model includes saver and hand-to-mouth (HtM) households, intermediate and final goods producers, labor unions, and monetary and fiscal authorities.

2.2.1 A Summary of The Model Economy

In this subsection, we provide an overview of the model. The model employed in this paper is nearly identical to that analyzed in BFM; interested readers are encouraged to refer to

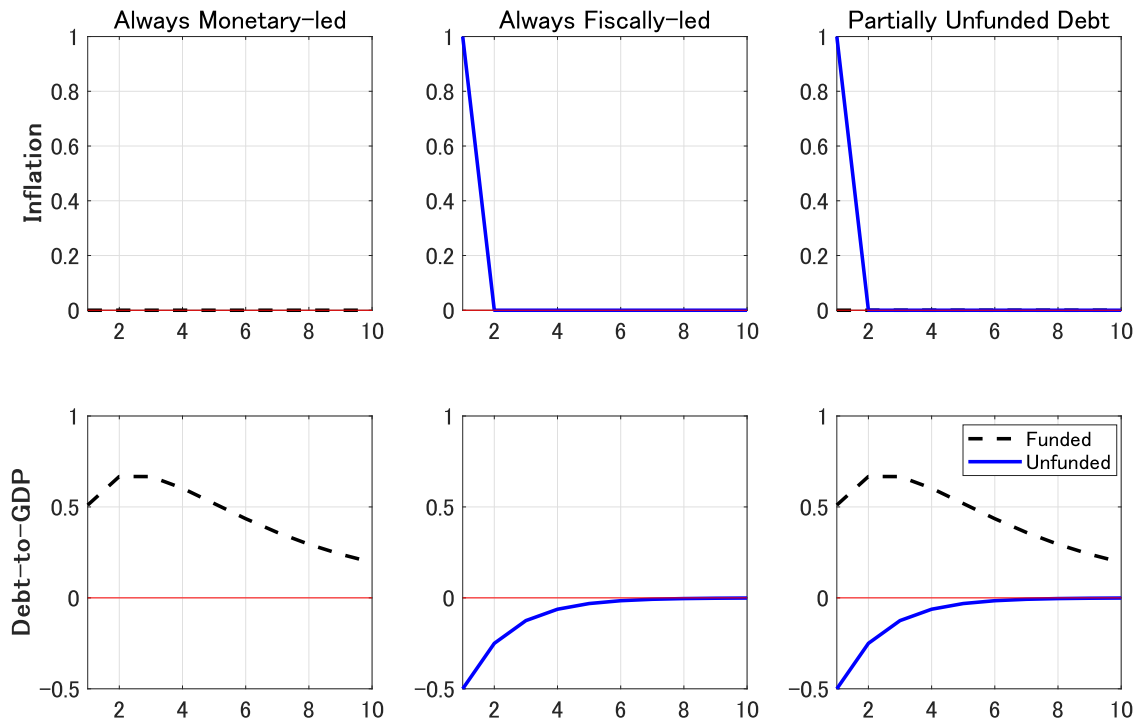


Figure 2. Impulse responses in the toy model

their paper for further details. The steady-state and log-linearized equations of the model are presented in Appendix A.

Saver households derive utility from the difference in composite consumption—comprising private and government consumption—relative to its lagged value (i.e., external habit formation). They experience disutility from labor supply, which provides labor income. In addition, saver households invest in capital goods and earn capital income by lending them out. They also trade both short-term and long-term government bonds, earning different returns. Furthermore, they receive government transfers and dividends from firms. HtM households, by contrast, consume all of their labor income and government transfers, deriving utility from this consumption.

Final goods producers operate under perfect competition and produce final goods by aggregating differentiated intermediate goods, which they sell to households. Each intermediate goods producer uses labor and capital as inputs to produce intermediate goods. These firms set prices under monopolistic competition, and their prices can only be adjusted with a certain probability in each period. Intermediate goods prices are also partially indexed to past prices.

Saver and HtM households are organized into labor unions, which supply differentiated labor services to intermediate goods producers. As a result, households set the price of labor

services (i.e., nominal wages) under monopolistic competition. Similar to intermediate goods prices, nominal wages can be adjusted only with a certain probability in each period and are partially indexed to past nominal wages.

The fiscal authority issues long-term government bonds, while short-term bonds are traded among households and net to zero. The fiscal authority also levies taxes on private consumption, labor income, and capital income, while providing income transfers and government consumption to households. Government consumption, transfers, and interest payments on long-term debt are financed through taxation and the issuance of new bonds.

Finally, the monetary authority sets the nominal interest rate according to a Taylor-type policy rule, responding to inflation and the output gap.

2.2.2 Monetary and Fiscal Policy Rules

Based on the model presented in the previous subsection, we extend the model to incorporate the actual and shadow economies, as in the toy model. Unfunded debt affects the actual economy via government variables. Specifically, in the actual economy, government consumption \hat{g}_t , transitory transfers \hat{z}_t^b , and tax rates on consumption, labor, and capital $\hat{\tau}_{J,t}$ for $J \in \{C, L, K\}$ respond only to funded debt, the total debt minus unfunded debt, $\hat{s}_{b,t-1} - \hat{s}_{b,t-1}^F$:

$$\hat{g}_t = \rho_G \hat{g}_{t-1} - (1 - \rho_G) \gamma_G (\hat{s}_{b,t-1} - \hat{s}_{b,t-1}^F) + \hat{u}_t^g, \quad (1)$$

$$\hat{z}_t^b = \rho_Z \hat{z}_{t-1}^b - (1 - \rho_Z) \gamma_Z [(\hat{s}_{b,t-1} - \hat{s}_{b,t-1}^F) + \phi_{zy} \hat{y}_t] + \hat{u}_t^z, \quad (2)$$

$$\hat{\tau}_{J,t} = \rho_J \hat{\tau}_{J,t-1} + (1 - \rho_J) \gamma_J (\hat{s}_{b,t-1} - \hat{s}_{b,t-1}^F), \quad (3)$$

where $\rho_J \in [0, 1)$ and $\gamma_J > 0$ for $J \in \{G, Z, C, L, K\}$ show the fiscal policy is passive in the actual economy. The shocks \hat{u}_t^g and \hat{u}_t^z follow AR(1) processes.

Transfers have transitory and permanent components, and the permanent component is divided into funded and unfunded shocks:

$$\hat{z}_t = \hat{z}_t^b + \zeta_t^M + \zeta_t^F,$$

where ζ_t^M and ζ_t^F follow AR(1) processes. These processes are assumed to be highly persistent, reflecting the long-lasting effects of transfer shocks. As in the toy model, only unfunded transfer shocks ζ_t^F are inflationary.

Likewise, in the actual economy, the nominal interest rate responds solely to funded inflation:

$$\hat{r}_{n,t} = \rho_r \hat{r}_{n,t-1} + (1 - \rho_r) [\phi_\pi (\hat{\pi}_t - \hat{\pi}_t^F) + \phi_y \hat{y}_t] + \hat{u}_t^m, \quad (4)$$

where $\phi_\pi > 1$ shows the monetary policy is active in the actual economy, and \hat{u}_t^m follows an AR(1) process.

One of the main objectives of this analysis is to examine which shocks in the model account for the long-term behavior of inflation. To this end, we assume that the long-term price markup shock, like funded and unfunded transfer shocks, follows a highly persistent AR(1) process. Specifically, we employ the following New Keynesian Phillips Curve in its log-linearized form:

$$\hat{\pi}_t = \frac{\beta}{1 + \chi_p \beta} \mathbb{E}_t \hat{\pi}_{t+1} + \frac{\chi_p}{1 + \chi_p \beta} \hat{\pi}_{t-1} + \kappa_p \hat{m}c_t + \kappa_p \hat{\eta}_t^p + \kappa_p \hat{u}_t^{NKPC} \quad (5)$$

where $\hat{\eta}_t^p$ denotes the short-term price markup shock, which has only transitory effects, while \hat{u}_t^{NKPC} denotes the long-term price markup shock, which has permanent effects on inflation.

3 Inference

3.1 Data

For the model estimation, we use quarterly data of 10 variables for the Japanese economy from 1982:Q1 to 2023:Q4. For GDP, private consumption, private investment, wages, government consumption, and government transfers, we use the growth rates of real values deflated by the GDP deflator. The debt-to-GDP ratio is calculated as the nominal debt divided by the nominal GDP. For inflation, we use the consumer price index excluding fresh food and energy, adjusted to remove the direct effects of consumption tax hikes. Further details on the data construction are provided in Appendix B.

Figure 3 illustrates the time series of government transfers, government purchases, and the debt-to-GDP ratio. Focusing on government transfers, we observe an overall increasing trend over the sample period, with notable jumps in 1998:Q2, 2009:Q4, and 2020:Q2. These spikes correspond to fiscal responses to the 1997-1998 Japanese financial crisis, the 2008 global financial crisis, and the COVID-19 pandemic crisis in 2020, respectively.

In contrast, government purchases increased toward the end of the 1980s but declined during the middle of the 1990s, likely as a correction to the earlier expansion. Reflecting these developments, the debt-to-GDP ratio decreased slightly in the early 1990s but has exhibited a persistent upward trend since then.

For the nominal interest rate, we use the uncollateralized overnight call rate prior to 1994:Q4 and primarily the shadow rate (Krippner, 2015) from 1995:Q1 onward, as shown in Figure 4. The shadow rate is constructed by fitting a term structure model to the yield

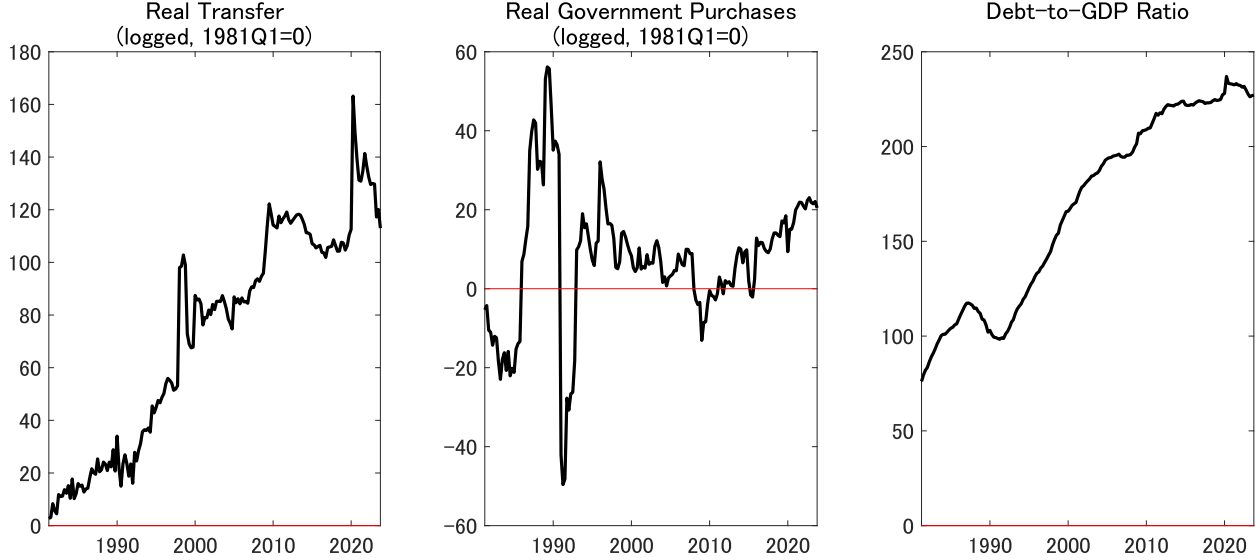


Figure 3. Fiscal variables

curve and inferring the implicit policy rate that would prevail absent the zero lower bound.

The shadow rate is designed to capture the effects of unconventional monetary policies⁴. The use of the shadow rate, in combination with the log-linearized structure of the model, enables us to apply the standard Kalman filter⁵.

3.2 Priors

The prior distributions are employed to estimate the structural parameters of the model using a Bayesian approach. In the estimation, some parameters are fixed or derived from steady-state relationships, as shown in Table 1. The household discount factor, β , is set to 0.99. The real interest rate in the model, $r = e^{\varkappa}/\beta - 1$, also depends on the balanced growth rate \varkappa , which is estimated in Section 3.3. The capital depreciation rate, δ , is set at 2.5%, and the capital share, α , at 0.33—both of which are standard values in the literature. The steady-state markup rates for wages and prices, η_w and η_p , are set to 0.14, following Leeper et al. (2017). The share of government consumption in GDP, s_{gc} , is set to 0.2.

The steady-state tax rates on labor and capital are set to 0.298 and 0.398, respectively,

⁴Using the shadow rate implicitly assumes that conventional and unconventional monetary policies are equally effective. While recent studies suggest that unconventional policy may be less effective (Wu and Zhang, 2019; Ikeda et al., 2024), our main conclusions are unlikely to be affected, as our identification of unfunded fiscal shocks relies primarily on long-run comovement between inflation and debt, rather than on short-run interest rate dynamics.

⁵In Section 4.3 and Appendix D, to account for potential biases in parameter estimation arising from the zero lower bound, the model is estimated using data from the period before the Japanese economy became subject to the zero lower bound.

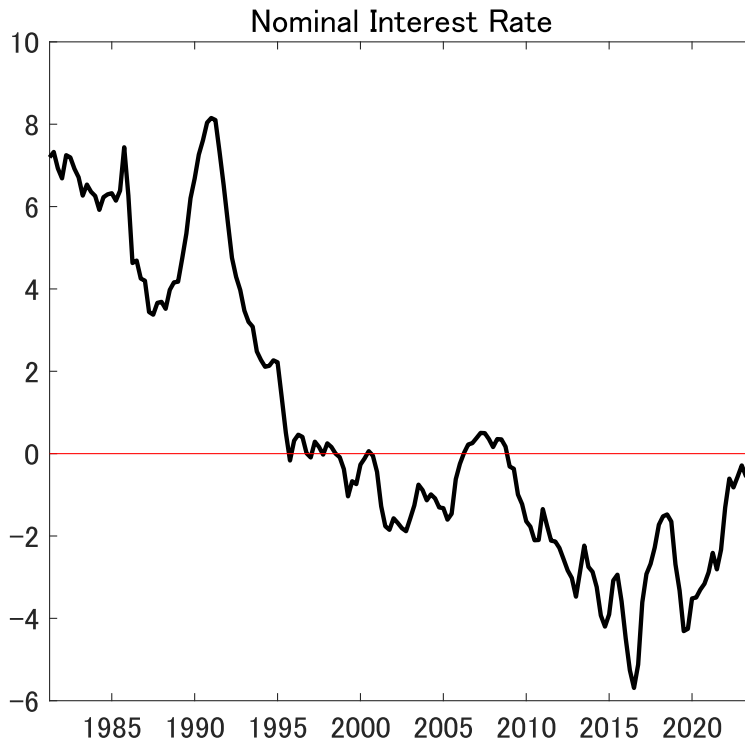


Figure 4. Nominal interest rate (Krippner, 2015)

following Imrohorglu and Sudo (2011). The consumption tax rate is calibrated to its sample mean over the period 1982:Q1-2023:Q4, which is 0.047. In the steady state of the model, the decay rate of long-term bonds, ρ , depends on the average duration (AD) of government bonds and is given by $\rho = (1/\beta)(1 - 1/AD)$. According to the Ministry of Finance, the average remaining maturity of Japanese government bonds during the sample period is 6.52 years, which implies that the value of ρ is 0.9714.⁶

We estimate the remaining parameters. The left panel of Tables 2 and 3 presents the prior distributions of the structural and shock parameters, respectively. The prior distributions for macroeconomic and monetary and fiscal policy parameters are broadly consistent with BFM and are generally set to be highly diffuse.

For the long-term components of government transfers—namely, the exogenous funded and unfunded transfer shocks—the prior distributions of their autoregressive coefficients, ρ_{eZ}^M and ρ_{eZ}^F , are highly persistent and tightly concentrated, with a mean of 0.995 and a standard deviation of 0.001. This reflects the assumption that these exogenous shocks have

⁶We construct fiscal-year-end values for the period 1982-2023 using the Ministry of Finance’s Debt Management Report. Due to data limitations, for fiscal years prior to 1995 we set the average remaining maturity equal to its value at the end of fiscal year 1996. This assumption is consistent with existing evidence that the maturity structure of Japanese government bonds remained broadly stable during the 1980s and 1990s (Koeda and Kimura, 2025).

| Parameter | Value | Description |
|-----------|--------|--|
| β | 0.99 | Discount factor |
| δ | 0.025 | Depreciation rate |
| α | 0.33 | Capital elasticity of output |
| s_{gc} | 0.20 | Government expenditure-to-output ratio |
| η_w | 0.14 | Steady-state wage markup |
| η_p | 0.14 | Steady-state price markup |
| τ_L | 0.298 | Steady-state labor income tax rate |
| τ_K | 0.398 | Steady-state capital income tax rate |
| τ_C | 0.047 | Steady-state consumption tax rate |
| ρ | 0.9714 | Implied by an average remaining maturity of 6.52 years |

Table 1. Fixed Parameters

long-lasting effects on government transfers, inflation, and other macroeconomic variables.

The prior distribution of the autoregressive coefficient for the long-term price markup, ρ_μ^{NKPC} , is also set to be highly persistent and tightly concentrated, with a mean of 0.995 and a standard deviation of 0.001. As noted earlier, one of the main objectives of this paper is to assess whether the long-term behavior of inflation is better explained by long-term price markup shocks or unfunded transfer shocks.

3.3 Posteriors

Posterior distributions are computed using the standard Random-Walk Metropolis-Hastings algorithm. A total of 200,000 draws are generated, with the first half discarded as burn-in.

The right panel of Tables 2 and 3 presents the posterior distributions of the structural and shock parameters estimated using Japanese data from the full sample period.

In what follows, we discuss the characteristics of the posterior means of the structural parameters by comparing them with estimates based on U.S. data—where, in contrast to BFM, the shadow rate is used instead of forward nominal interest rates. Additional details of the U.S. estimation results are provided in Appendix C.

The probabilities of wage and price adjustment are estimated as $1 - \omega_w = 0.1808$ and $1 - \omega_p = 0.0740$, respectively (compared to $1 - \omega_w = 0.2534$ and $1 - \omega_p = 0.0812$ in the U.S.). These imply that, on average, wages (prices) are adjusted once every 5.5 (13.5) quarters. The degree of wage indexation is very low at $\chi_w = 0.0149$ (U.S.: $\chi_w = 0.0944$), while price indexation is relatively high at $\chi_p = 0.8930$ (U.S.: $\chi_p = 0.2416$). This finding is consistent with earlier research suggesting that inflation expectations in Japan are backward-looking.

The parameter representing consumption habits is high at $\theta = 0.9743$ (U.S.: $\theta = 0.99$).⁷ The share of hand-to-mouth households is estimated at $\mu = 0.0904$ (U.S.: $\mu = 0.087$). The parameter representing the complementability between government and private consumption is $\alpha_g = -0.0132$ (U.S.: $\alpha_g = -0.1322$), although not statistically significant; however, the degree of complementability is lower in Japan than in the United States.

Regarding the monetary policy rule, the parameter indicating the degree of interest rate smoothing in the Taylor rule is estimated at $\rho_e = 0.8769$ (U.S.: $\rho_e = 0.7971$). This higher value for Japan reflects the prolonged period during which the nominal interest rate remained at the zero lower bound. The response coefficients to inflation and the output gap are $\phi_\pi = 1.9456$ and $\phi_y = -0.0592$, respectively (U.S.: $\phi_\pi = 1.9729$ and $\phi_y = 0.0024$). In Japan, the estimated response coefficient to the output gap is negative. This result should be interpreted as reflecting the prolonged period during which the policy rate was constrained by the zero lower bound and monetary policy accommodated fiscally driven inflation, rather than as a conventional countercyclical policy response.

Regarding the fiscal policy rule, the response coefficient of income transfers to the output gap is estimated at $\phi_{zy} = 0.0937$, which is substantially smaller than its U.S. counterpart ($\phi_{zy} = 0.2132$). This result suggests that income transfers in Japan are less countercyclical than in the United States. In contrast, the response of fiscal instruments to government debt is relatively strong. The response coefficient of the labor income tax rate to the debt-to-GDP ratio is $\gamma_L = 0.5368$ (U.S.: $\gamma_L = 0.0185$), while that of transfer payments is $\gamma_Z = 0.2481$ (U.S.: $\gamma_Z = 0.143$), indicating that fiscal adjustment in Japan relies more heavily on labor taxation and transfers than in the United States. It is worth noting that, in the baseline estimation using Japanese data, the response coefficients of the capital income tax rate and government consumption to the debt-to-GDP ratio are set to zero, $\gamma_G = \gamma_K = 0$. This modeling choice may affect the estimated magnitudes of the remaining response coefficients. See Section 4.3 for further discussion.

GDP growth experienced a sharp decline during both the 2008 global financial crisis and the 2020 COVID-19 pandemic crisis. Such abrupt contractions cannot be adequately captured by a linear Gaussian model like the one employed in this study; hence, measurement errors are introduced in the observation equation.⁸ The measurement error for GDP growth is relatively large, with an estimated standard deviation of $\sigma_{dGDP}^m = 1.7037$ (U.S.: $\sigma_{dGDP}^m = 0.8882$). In addition, the measurement error for the debt-to-GDP ratio is estimated at $\sigma_{BY}^m = 0.3313$ (U.S.: $\sigma_{BY}^m = 0.3964$).

⁷This result is broadly consistent with previous findings. In BFM, the estimate is 0.91, while Leeper et al. (2017) report a value of 0.99.

⁸Appendix B presents the observation equations used in the estimation.

| Param. | Description | Prior | | | Posterior | | |
|---------------|----------------------------|-------|------|------|-----------|---------|---------|
| | | Type | Mean | Std. | Mean | 5% | 95% |
| s_b | Debt-to-GDP annualized | N | 2.4 | 0.05 | 2.4721 | 2.3931 | 2.5519 |
| 100 λ | SS growth rate | N | 0.5 | 0.05 | 0.4399 | 0.3552 | 0.5150 |
| 100 ln Π | SS inflation | N | 0.5 | 0.05 | 0.4978 | 0.4201 | 0.5796 |
| ξ | Inverse Frisch elasticity | G | 2 | 0.25 | 1.8333 | 1.5128 | 2.1426 |
| μ | Share of hand-to-mouth | B | 0.11 | 0.01 | 0.0904 | 0.0752 | 0.1029 |
| ω_w | Wage Calvo param. | B | 0.5 | 0.1 | 0.8192 | 0.7966 | 0.8421 |
| ω_p | Price Calvo param. | B | 0.5 | 0.1 | 0.9260 | 0.9120 | 0.9398 |
| ψ | Capital util. cost | B | 0.5 | 0.1 | 0.3912 | 0.2524 | 0.5492 |
| s | Investment adj. cost | N | 6 | 0.5 | 7.2316 | 6.3845 | 7.9458 |
| χ_w | Wage infl. indexation | B | 0.5 | 0.2 | 0.0149 | 0.0043 | 0.0263 |
| χ_p | Price infl. indexation | B | 0.5 | 0.2 | 0.8930 | 0.8196 | 0.9630 |
| θ | Habits in consumption | B | 0.5 | 0.2 | 0.9743 | 0.9693 | 0.9790 |
| α_G | Subs. private/gov. cons. | N | 0 | 0.1 | -0.0132 | -0.0757 | 0.0619 |
| ϕ_y | Interest response to GDP | N | 0.25 | 0.1 | -0.0592 | -0.0797 | -0.0394 |
| ϕ_π | Interest response to infl. | N | 2 | 0.1 | 1.9456 | 1.8000 | 2.1127 |
| ϕ_{zy} | Transfer response to GDP | G | 0.1 | 0.05 | 0.0937 | 0.0226 | 0.1705 |
| γ_L | Labor tax response to debt | N | 0.25 | 0.1 | 0.5368 | 0.4223 | 0.6362 |
| γ_Z | Transfer response to debt | N | 0.25 | 0.1 | 0.2481 | 0.1237 | 0.3882 |
| ρ_c | AR coeff. monetary rule | B | 0.5 | 0.1 | 0.8769 | 0.8529 | 0.9030 |
| ρ_G | AR coeff. gov. cons. rule | B | 0.5 | 0.1 | 0.5339 | 0.3803 | 0.6872 |
| ρ_Z | AR coeff. transfers rule | B | 0.5 | 0.1 | 0.5285 | 0.3558 | 0.6985 |

Table 2. Priors and posteriors for the structural parameters: Japan, 1981:Q1-2023:Q4

4 Results

4.1 Identification of Unfunded Transfer Shocks

In this subsection, we examine the effects of unfunded transfer shocks, funded transfer shocks, and both long- and short-term price markup shocks on the economy. Figure 5 presents the impulse responses of inflation, the real interest rate, and the debt-to-GDP ratio to these shocks. We exploit the distinct dynamics of these variables to identify the structural shocks in the model estimation.

Funded transfer shocks (dashed black line) lead to a slight fall in the inflation rate in the long run. This is due not only to the presence of hand-to-mouth households but also to the fiscal rules governing income taxes and transfers (equations (2)–(3)), which imply

| Param. | Description | Prior | | | Posterior | | |
|---------------------|------------------------------|-------|-------|-------|-----------|---------|---------|
| | | Type | Mean | Std. | Mean | 5% | 95% |
| ρ_{eG} | AR coeff. gov. cons | B | 0.5 | 0.1 | 0.5384 | 0.3782 | 0.6986 |
| ρ_{eZ}^M | AR coeff. funded trans. | B | 0.995 | 0.001 | 0.9949 | 0.9932 | 0.9963 |
| ρ_{eZ}^F | AR coeff. unfunded trans. | B | 0.995 | 0.001 | 0.9958 | 0.9946 | 0.9972 |
| ρ_z | AR coeff. short-term trans. | B | 0.5 | 0.1 | 0.4987 | 0.3372 | 0.6824 |
| ρ_a | AR coeff. technology | B | 0.5 | 0.1 | 0.2166 | 0.1464 | 0.2740 |
| ρ_b | AR coeff. preference | B | 0.5 | 0.1 | 0.1356 | 0.0702 | 0.1857 |
| ρ_m | AR coeff. mon. policy | B | 0.5 | 0.1 | 0.4323 | 0.3498 | 0.5281 |
| ρ_i | AR coeff. investment | B | 0.5 | 0.1 | 0.9302 | 0.8977 | 0.9617 |
| ρ_{rp} | AR coeff. risk premium | B | 0.5 | 0.1 | 0.8910 | 0.8605 | 0.9213 |
| $\rho_{\mu NKPC}$ | AR coeff. pers. cost push | B | 0.995 | 0.001 | 0.9956 | 0.9942 | 0.9970 |
| σ_G | St.dev. gov. cons. | IG | 0.5 | 0.2 | 5.6459 | 5.1638 | 6.0953 |
| σ_Z^M | St.dev. funded transfers | IG | 0.5 | 0.2 | 8.0353 | 7.3403 | 8.7213 |
| σ_Z^F | St.dev. unfunded transfers | IG | 0.5 | 0.2 | 1.1360 | 0.8057 | 1.4858 |
| σ_z | St.dev. short-term trans. | IG | 0.5 | 0.2 | 0.4750 | 0.2508 | 0.7053 |
| σ_a | St.dev. technology | IG | 0.5 | 0.2 | 3.0255 | 2.7845 | 3.2520 |
| σ_b | St.dev. preference | IG | 0.5 | 0.2 | 53.7919 | 44.8194 | 59.5596 |
| σ_m | St.dev. mon. policy | IG | 0.5 | 0.2 | 0.1443 | 0.1288 | 0.1597 |
| σ_i | St.dev. investment | IG | 0.5 | 0.2 | 0.3109 | 0.2568 | 0.3599 |
| σ_w | St.dev. wage markup | IG | 0.5 | 0.2 | 0.2707 | 0.2451 | 0.2987 |
| σ_p | St.dev. transitory cost push | IG | 0.5 | 0.2 | 0.1794 | 0.1614 | 0.1952 |
| σ_{rp} | St.dev. risk premium | IG | 0.5 | 0.2 | 0.2968 | 0.2453 | 0.3464 |
| $\sigma_{\mu NKPC}$ | St.dev. persistent cost push | IG | 0.5 | 0.2 | 1.0745 | 0.6845 | 1.4495 |
| σ_{GDP}^m | Measur. error GDP | IG | 0.5 | 0.2 | 1.7037 | 1.5467 | 1.8294 |
| σ_{by}^m | Measur. error Debt/GDP | IG | 0.5 | 0.2 | 0.3313 | 0.2399 | 0.4233 |

Table 3. Priors and posteriors for the exogenous shock parameters: Japan, 1981:Q1-2023:Q4

that taxes will ultimately finance an increase in public debt resulting from transfers.⁹ Since income taxes are distortionary, such tax adjustments reduce household labor supply, thereby exerting downward pressure on inflation. In Japan, the long-term contractionary effects of future tax increases outweigh the expansionary effects of higher transfers, resulting in a net decline in inflation. The deflationary effects of funded shocks may have non-negligible implications for the long-run trajectory of inflation.¹⁰

⁹When $\mu = 0$ (i.e., the share of non-Ricardian households) and $\gamma_G = \gamma_K = \gamma_L = 0$ (i.e., the response coefficients of fiscal rules to the debt-to-GDP ratio), the inflation rate does not respond to funded transfer shocks, as in the toy model in Section 2.1.

¹⁰In contrast, Figure 8 in Appendix C shows that in the United States, the inflationary effects of increased transfers dominate over time, resulting in a modest rise in inflation.

Unfunded transfer shocks (solid blue line) raise the inflation rate and lower the real interest rate. This occurs because the monetary authority tolerates higher inflation to stabilize the debt-to-GDP ratio. The decline in the real interest rate also boosts GDP, which further contributes to stabilizing the debt-to-GDP ratio. However, in Japan, the peak level and persistence of inflation are lower than in the United States. Approximately five years (20 quarters) after the shock, the inflation rate in Japan turns negative. In contrast, in the United States, inflation remains positive even ten years after the shock.

Long-run price markup shocks (dot-dashed red line) initially raise the inflation rate for a few quarters, followed by a decline. This is because the accompanying rise in the real interest rate depresses GDP, which in turn places downward pressure on inflation over the medium to long term. Short-run price markup shocks (dotted pink line) result in a greater rise in inflation than long-run price markup shocks, accompanied by a temporary decline in the real interest rate. Price markup shocks also lead to an increase in the debt-to-GDP ratio through a reduction in GDP.

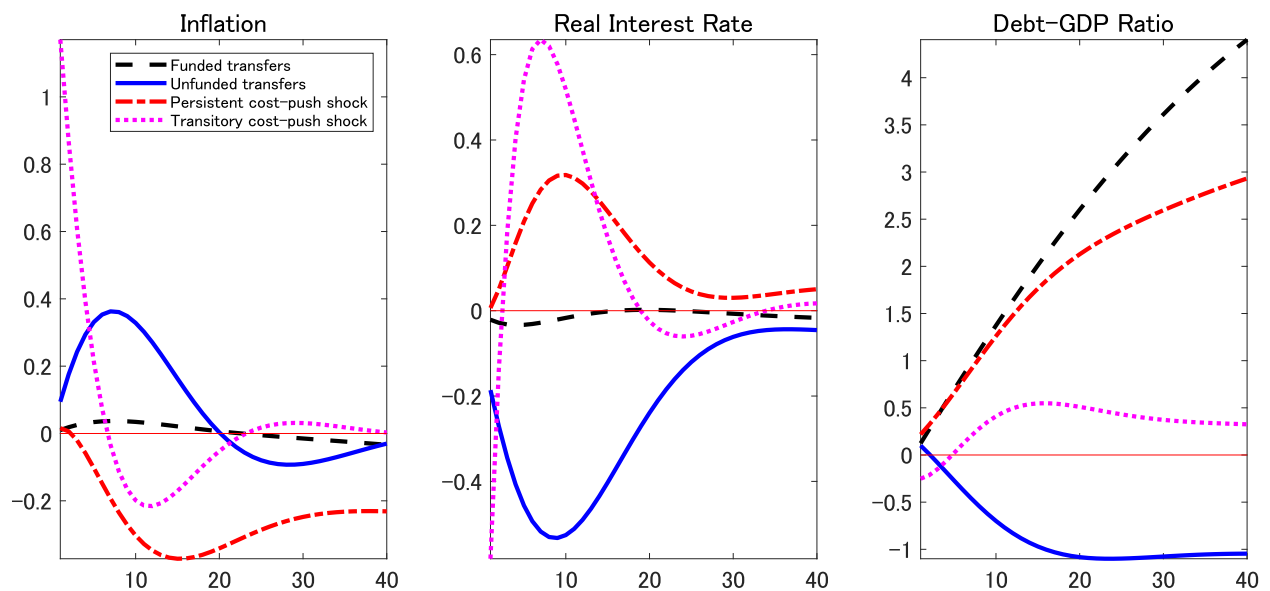


Figure 5. Impulse responses in the medium-scale model: Japan

4.2 Drivers of Inflation and GDP growth

Let us now examine the relationship between unfunded transfer shocks and the historical movements of inflation and GDP growth. Figure 6 presents a historical decomposition of inflation and GDP growth. The black bars represent the contributions of unfunded transfer shocks to changes in inflation and GDP growth. The red, blue, and gray bars indicate the

contributions of monetary policy shocks, funded transfer shocks, and other policy shocks (including government consumption and short-term funded transfer shocks), respectively. The white bars represent the contributions of non-policy shocks and the steady-state component.

The main finding is that, unlike in the United States, fiscal factors have not been the primary driver of inflation dynamics in Japan.¹¹ In particular, the rise in inflation since 2022 is largely explained by supply-side disturbances, such as price markup shocks. That said, unfunded transfer shocks have exerted upward pressure on inflation, except for a brief period in the early 1990s following the collapse of the asset price bubble. Funded transfer shocks, by contrast, have contributed to lower inflation by reinforcing fiscal credibility.¹² Moreover, monetary policy shocks have provided support to inflation, particularly following the introduction of the Bank of Japan’s QQE policy in 2013, while real economic shocks—such as demand and supply disturbances—have acted as downward forces, keeping inflation persistently low over much of the sample period.

Regarding GDP growth, the impact of unfunded transfer shocks on real economic activity has been limited over most of the sample period, except for the late 1980s to early 1990s, when Japan experienced the formation and subsequent collapse of the asset price bubble. During this period, increases in government spending following the bubble collapse appear to have contributed positively to GDP growth. However, these fiscal expansions were not backed by credible future repayments, and our estimation results suggest that their expansionary effects were partly offset by unfunded transfer shocks.¹³

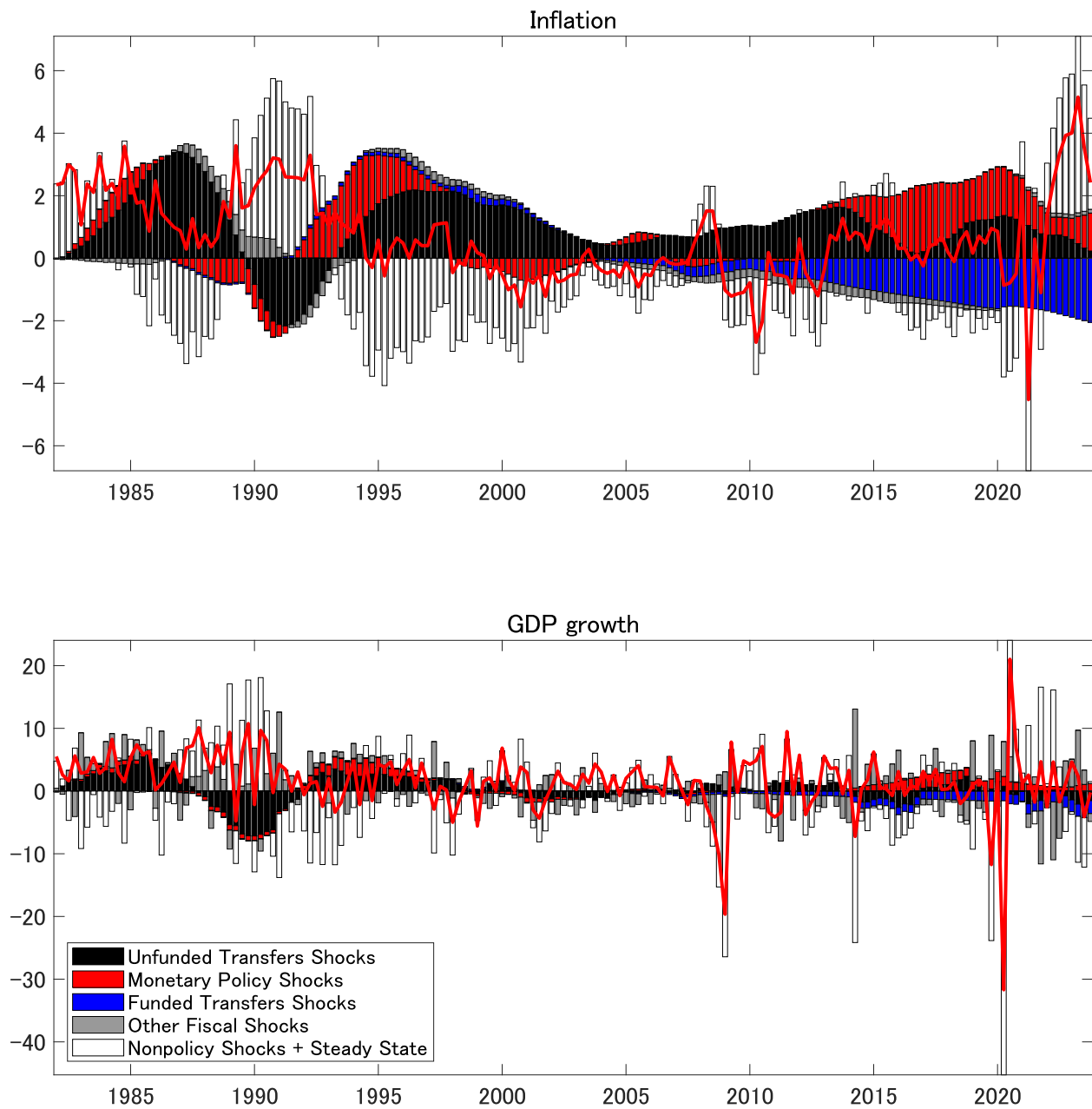
Figure 7, following the same approach as before, presents a historical decomposition of the debt-to-GDP ratio and income transfers. For income transfers, the cumulative sum of growth rates is used. As shown in the impulse responses in Figure 5, unfunded transfer shocks exert downward pressure on the debt-to-GDP ratio, while funded transfer shocks act as upward drivers. The decomposition suggests that in Japan, unfunded transfer shocks have played a significant role in stabilizing the debt-to-GDP ratio.

Turning to income transfers, the contribution attributable to unfunded transfer shocks has increased in recent years. However, most of the additional fiscal measures undertaken during the COVID-19 pandemic crisis are explained by funded transfer shocks. Similarly, the increases in income transfers in the 1997-1998 Japanese financial crisis and the 2008 global financial crisis are also largely accounted for by funded transfer shocks. While some studies

¹¹Appendix C presents a historical decomposition of inflation for the United States based on estimation results from a comparable model. The appendix shows that fiscal factors are the primary drivers of inflation dynamics in the United States, broadly consistent with the findings of BFM.

¹²This result also differs from the U.S. estimation; see Section 4.3 for further discussion of the role of funded transfer shocks in exerting downward pressure on inflation.

¹³Interestingly, in the recent post-COVID-19 period, unfunded transfer shocks have had a modest negative effect on GDP growth.



Note: Nonpolicy shocks include technology, preference, IST, risk-premium, wage markup, and short-run and long-run price markup shocks. Other policy shocks are transitory transfer and government spending shocks.

Figure 6. Drivers of Inflation and GDP growth: Japan

(e.g., Ihori et al., 2001) argue that Japan de facto relaxed fiscal consolidation during the late 1990s, our classification of funded and unfunded transfer shocks is based on ex post fiscal adjustments implied by the estimated fiscal rules, rather than on ex ante policy intentions.

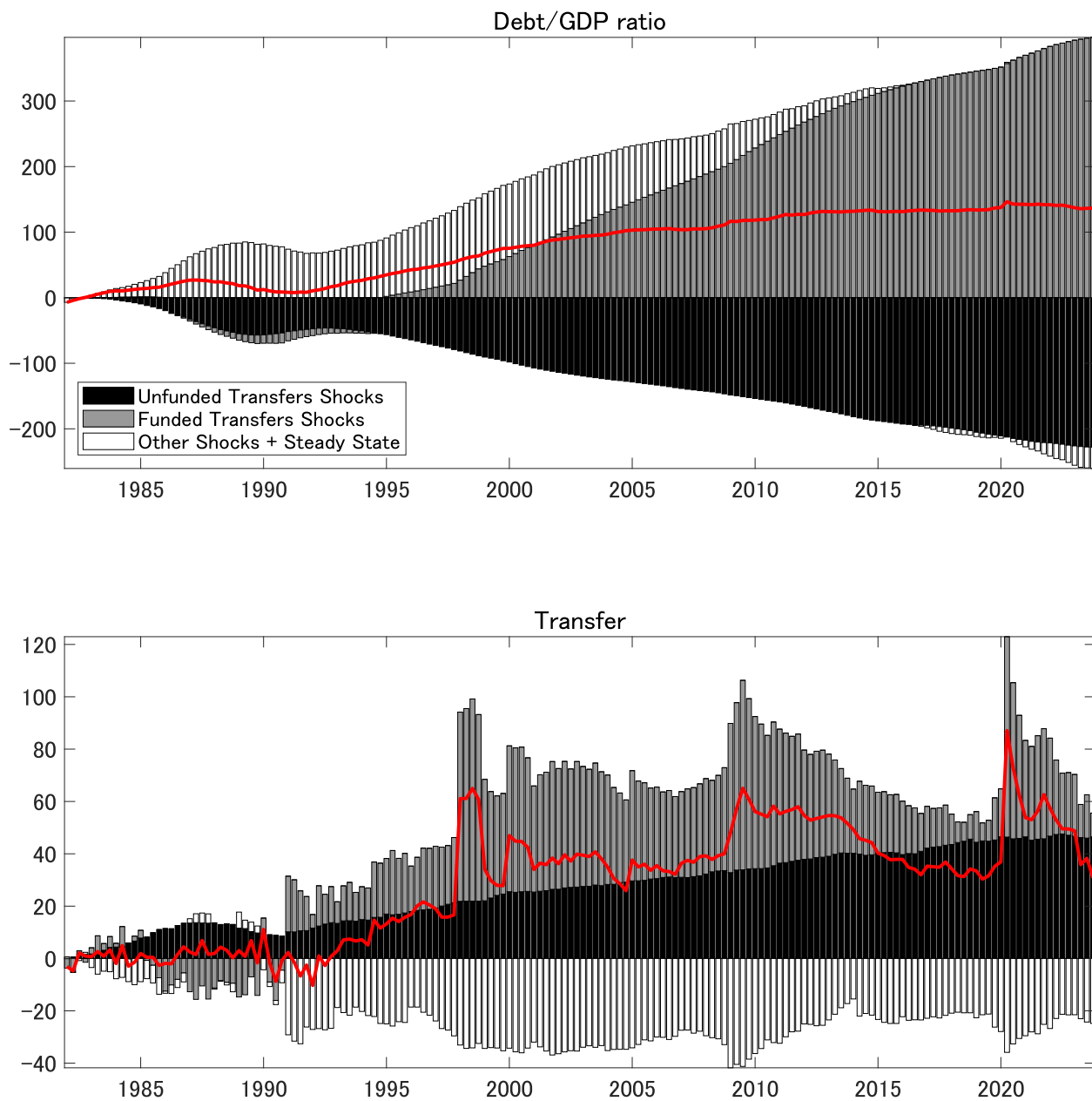


Figure 7. Drivers of Debt-to-GDP ratio and Transfers: Japan

4.3 Robustness Checks

In this subsection, we assess the robustness of our main findings to alternative fiscal rules and estimation strategies.

Alternative Fiscal Rules: As previously discussed in Section 3.3, the baseline estimation using Japanese data imposes the restriction that the response coefficients of the capital tax rate and government consumption to the debt-to-GDP ratio are zero, i.e., $\gamma_G = \gamma_K = 0$. These restrictions are imposed to prevent funded transfer shocks from exerting excessive downward pressure on inflation.¹⁴ However, even if these parameters were estimated rather than fixed, our main conclusion—that unfunded transfer shocks are not the primary drivers of inflation dynamics in Japan—remains unchanged.¹⁵

Subsample Estimation: This study employs the shadow interest rate to estimate the model without explicitly accounting for the zero lower bound (ZLB) on nominal interest rates. The shadow rate incorporates the easing effects of unconventional monetary policies, such as forward guidance and quantitative easing (Wu and Xia, 2016). However, this method does not capture the nonlinear effects of the ZLB, and ignoring it may introduce biases into the estimated parameters (Hirose and Inoue, 2016; Hirose and Sunakawa, 2015). To address this concern, a two-step estimation procedure is conducted as follows:

Step 1: Estimate the structural parameters of the model using the pre-ZLB sample period, specifically from 1982:Q1 to 1998:Q4 (sample size: 68), prior to the onset of the ZLB constraint around 1999:Q1.

Step 2: Hold all structural parameters fixed at the values estimated in Step 1—except for the autoregressive coefficients and standard deviations of the exogenous shocks—and re-estimate only the shock parameters using the full sample period (1982:Q1 to 2023:Q3; sample size: 168).

Appendix D summarizes the results from the subsample estimation. Even in this case, the main conclusion of the paper remains unchanged: unfunded transfer shocks are not the primary driver of inflation dynamics in Japan, and the rise in inflation since 2022 is mainly attributable to supply-side shocks.

¹⁴Figure 5 in Section 4.1 shows that funded transfer shocks exert downward pressure on inflation in Japan, potentially capturing ultra-long-run inflation dynamics through gradual fiscal adjustments.

¹⁵Estimating γ_G and γ_K improves the marginal likelihood (-3281.1 vs. -3286.6) but substantially amplifies the deflationary effects of funded transfer shocks. Given our focus on identifying unfunded fiscal shocks, we therefore retain the more parsimonious benchmark specification.

5 Concluding Remarks

In this paper, we examined the role of fiscal factors in Japan’s inflation dynamics using a medium-scale New Keynesian model adapted from Bianchi et al. (2023). While their analysis of U.S. data finds that unfunded fiscal shocks are key drivers of inflation, our estimation using Japanese data suggests that such shocks play a limited role. Instead, inflation in Japan has been primarily shaped by real demand and supply shocks, alongside monetary policy measures—particularly the Bank of Japan’s QQE policy since 2013.

Looking ahead, we may refine the model to better reflect the macroeconomic environment in Japan. First, we could incorporate expected forward interest rates instead of the shadow rate to more accurately capture the effects of the zero lower bound and forward guidance, as discussed in Sudo and Tanaka (2021). Second, following Smets and Wouters (2024), we may consider fiscal shocks with partial repayment guarantees rather than relying solely on a binary distinction between funded and unfunded shocks. Finally, to account for Japan’s prolonged low inflation and deflationary pressures, it may be fruitful to incorporate a framework with persistent deflation dynamics, such as that proposed by Cuba-Borda and Singh (2024). These extensions would provide a better understanding of the interaction between monetary and fiscal policies and inflation in Japan.

Declarations

Acknowledgments This paper was presented at the JER–HIAS–Kakenhi Conference, “*Macroeconomics and Japan’s Reality: Effects of Monetary and Fiscal Policies*,” held on August 24–25, 2025. The author is grateful to the guest editors, Etsuro Shioji and Jouchi Nakajima, an anonymous referee, and Kosuke Aoki, Shunsuke Endo, Laura Britt Fermo, Takuji Fueki, Daisuke Ikeda, Mitsuru Katagiri, Timothy Kam, Taisuke Nakata, Runchana Pongsaparn, Nao Sudo, Toshitaka Sekine, Aruhan Rui Shi, Mototsugu Shintani, Shigenori Shiratsuka, Takayuki Tsuruga, Kozo Ueda, Tsutomu Watanabe, as well as participants at the Sixth Annual Conference of the Japan Economy Network, SWET 2024, the 2024 Fall Meeting of the Japanese Economic Association, the JER–HIAS–Kakenhi Conference, and the AMRO Café Friday Seminar for their valuable comments and suggestions. Any remaining errors are solely the responsibility of the author.

Conflict of interest The author declares that there are no competing interests.

Data availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Appendix A Model equations

The model employed in this paper is nearly identical to that analyzed in BFM; interested readers are encouraged to refer to their paper for further details.

A.1 Steady-state conditions

Given the parameter values shown in Tables 1-3, the model's steady-state conditions imply the following set of equations:

$$\begin{aligned}
\rho &= (1/\beta)(1 - 1/AD), \\
R &= (e^z/\beta)\Pi, \\
P^m &= 1/(R - \rho), \\
r_K &= (e^z/\beta - 1 + \delta)/(1 - \tau_K), \\
\psi'(1) &= r_K(1 - \tau_K), \\
mc &= 1/(1 + \eta^p), \\
w &= (mc(1 - \alpha)^{1-\alpha}\alpha^\alpha r_K^{-\alpha})^{\frac{1}{1-\alpha}}, \\
k/L &= (w/r_K)\alpha/(1 - \alpha), \\
\Omega/L &= (k/L)^\alpha - r_K(k/L) - w, \\
y/L &= (k/L)^\alpha - \Omega/L, \\
i/L &= (1 - (1 - \delta)e^{-z})e^z(k/L), \\
c/L &= y/L(1 - s_{gc}) - i/L, \\
z/L &= ((1 - Re^{-z})s_b - s_{gc})(y/L) + \tau_C(c/L) + \tau_L w + \tau_K r_K(k/L), \\
z^N/L &= Z/L, \\
c^N/L &= ((1 - \tau_L)w + z^N/L)/(1 + \tau_C), \\
c^S/L &= (c/L - \mu c^N/L)/(1 - \mu), \\
c^{*S}/L &= c^S/L + \alpha_g s_{gc}(y/L), \\
L &= \left(\frac{w(1 - \tau_L)}{(1 + \tau_C)(1 + \eta^w)} \frac{1}{(1 - \theta e^{-z})(c^{*S}/L)} \right)^{\frac{1}{1+\xi}}.
\end{aligned}$$

Note that the values of $(k, \Omega, y, i, c, z, c^N, c^S)$ are calculated by multiplying L by their corresponding ratios. Additionally, given the value of y , $b = s_b y$ and $g = s_{gc} y$ are obtained.

A.2 Log-linearized equations

We present the equations of the log-linearized model below, starting with those that describe the actual economy block. All variables with a hat symbol represent deviations from their steady-state values.

Production function:

$$\hat{y}_t = \frac{y + \Omega}{y} \left[\alpha \hat{k}_t + (1 - \alpha) \hat{L}_t \right] \quad (\text{A.1})$$

Capital-labor ratio:

$$\hat{r}_{K,t} - \hat{w}_t = \hat{L}_t - \hat{k}_t \quad (\text{A.2})$$

Marginal cost:

$$\hat{m}c_t = \alpha \hat{r}_{K,t} + (1 - \alpha) \hat{w}_t \quad (\text{A.3})$$

Phillips curve:

$$\hat{\pi}_t = \frac{\beta}{1 + \chi_p \beta} \mathbb{E}_t \hat{\pi}_{t+1} + \frac{\chi_p}{1 + \chi_p \beta} \hat{\pi}_{t-1} + \kappa_p \hat{m}c_t + \kappa_p \hat{\eta}_t^p + \kappa_p \hat{u}_t^{NKPC} \quad (\text{A.4})$$

where

$$\kappa_p = \frac{(1 - \beta \omega_p)(1 - \omega_p)}{\omega_p(1 + \beta \chi_p)}$$

Saver household's FOC for consumption:

$$\hat{\lambda}_t^S = \hat{u}_t^b - \frac{\theta}{e^\varkappa - \theta} \hat{u}_t^a - \frac{e^\varkappa}{e^\varkappa - \theta} \hat{c}_t^{*S} + \frac{\theta}{e^\varkappa - \theta} \hat{c}_{t-1}^{*S} - \frac{\tau_C}{1 + \tau_C} \hat{\tau}_{C,t} \quad (\text{A.5})$$

where $\hat{u}_t^a = u_t^a - \varkappa$.

Public/private consumption in utility:

$$\hat{c}_t^{*S} = \frac{c^S}{c^S + \alpha_G g} \hat{c}_t^S + \frac{\alpha_G g}{c^S + \alpha_G g} \hat{g}_t \quad (\text{A.6})$$

Euler equation:

$$\hat{\lambda}_t^S = \hat{r}_{n,t} + \mathbb{E}_t \hat{\lambda}_{t+1}^S - \mathbb{E}_t \hat{\pi}_{t+1} - \mathbb{E}_t \hat{u}_{t+1}^a + \hat{u}_t^{rp} \quad (\text{A.7})$$

Maturity structure of debt:

$$\hat{r}_{n,t} + \hat{P}_t^m = \frac{\rho}{R} \mathbb{E}_t \hat{P}_{t+1}^m - \hat{u}_t^{rp} \quad (\text{A.8})$$

Saver household's FOC for capacity utilization:

$$\hat{r}_{K,t} - \frac{\tau_K}{1 - \tau_K} \hat{\tau}_{K,t} = \frac{\psi}{1 - \psi} \hat{\nu}_t \quad (\text{A.9})$$

Saver household's FOC for capital:

$$\hat{q}_t = \mathbb{E}_t \hat{\pi}_{t+1} - \hat{r}_{n,t} + \beta e^{-\alpha} [(1 - \tau_K) r_K \mathbb{E}_t \hat{r}_{K,t+1} - \tau_K r_K \mathbb{E}_t \hat{\tau}_{K,t+1} + (1 - \delta) \mathbb{E}_t \hat{q}_{t+1}] - \hat{u}_t^{rp} \quad (\text{A.10})$$

Saver household's FOC for investment:

$$\hat{i}_t + \frac{1}{1 + \beta} \hat{u}_t^a - \frac{1}{(1 + \beta) s e^{2\alpha}} \hat{q}_t - \hat{u}_t^i - \frac{\beta}{1 + \beta} \mathbb{E}_t \hat{i}_{t+1} - \frac{\beta}{1 + \beta} \mathbb{E}_t \hat{u}_{t+1}^a = \frac{1}{1 + \beta} \hat{i}_{t-1} \quad (\text{A.11})$$

Effective capital:

$$\hat{k}_t = \hat{\nu}_t + \hat{k}_{t-1} - \hat{u}_t^a \quad (\text{A.12})$$

Law of motion for capital:

$$\hat{k}_t = (1 - \delta) e^{-\alpha} (\hat{k} - \hat{u}_t^a) + [1 - (1 - \delta) e^{-\alpha}] [(1 + \beta) s e^{2\alpha} + \hat{i}_t] \quad (\text{A.13})$$

Hand-to-mouth household's budget constraint:

$$\tau_C c^N \hat{\tau}_{C,t} + (1 + \tau_C) c^N \hat{c}_t^N = (1 - \tau_L) w L (\hat{w}_t + \hat{L}_t) - \tau_L w L \hat{\tau}_{L,t} + z \hat{z}_t \quad (\text{A.14})$$

Wage equation:

$$\begin{aligned} \hat{w}_t = & \frac{1}{1 + \beta} \hat{w}_{t-1} + \frac{\beta}{1 + \beta} \mathbb{E}_t \hat{w}_{t+1} - \kappa_w \left(\hat{w}_t - \xi \hat{L}_t + \hat{\lambda}_t^S - \frac{\tau_L}{1 - \tau_L} \hat{\tau}_{L,t} \right) \\ & + \frac{\chi_w}{1 + \beta} \hat{\pi}_{t-1} - \frac{1 + \beta \chi_w}{1 + \beta} \hat{\pi}_t + \frac{\beta}{1 + \beta} \mathbb{E}_t \hat{\pi}_{t+1} + \frac{\chi}{1 + \beta} \hat{u}_{t-1}^a - \frac{1 + \beta \chi_w - \rho_a \beta}{1 + \beta} \hat{u}_t^a + \kappa_w \hat{\eta}_t^w \end{aligned} \quad (\text{A.15})$$

where

$$\kappa_w \equiv \frac{(1 - \beta \omega_w)(1 - \omega_w)}{\omega_w (1 + \beta) \left(1 + \frac{(1 + \eta_w) \xi}{\eta_w} \right)}$$

Aggregate households' consumption:

$$c \hat{c}_t = c^S (1 - \mu) \hat{c}_t^S + c^N \mu \hat{c}_t^N \quad (\text{A.16})$$

Aggregate resource constraint:

$$y\hat{y}_t = c\hat{c}_t + i\hat{i}_t + g\hat{g}_t + \psi'(1)k\hat{v}_t \quad (\text{A.17})$$

Government budget constraint:

$$\begin{aligned} \frac{b}{y}(\hat{s}_{b,t} + \hat{y}_t) + \tau_K r_K \frac{k}{y}(\hat{\tau}_{K,t} + \hat{r}_K + \hat{k}_t) + \tau_L w \frac{L}{y}(\hat{\tau}_{L,t} + \hat{w}_t + \hat{L}_t) + \tau_C \frac{c}{y} \hat{c}_t \\ = \frac{1}{\beta} \frac{b}{y}(\hat{s}_{b,t-1} + \hat{y}_{t-1} - \hat{\pi}_t - \hat{P}_{t-1}^m - \hat{u}_t^a) + \frac{b}{y} \frac{\rho}{e^\alpha} \hat{P}_t^m + \frac{g}{y} \hat{g}_t + \frac{z}{y} \hat{z}_t \end{aligned} \quad (\text{A.18})$$

Fiscal Rules:

$$\hat{g}_t = \rho_G \hat{g}_{t-1} - (1 - \rho_G) \gamma_G (\hat{s}_{b,t-1} - \hat{s}_{b,t-1}^F) + \hat{u}_t^g \quad (\text{A.19})$$

$$\hat{z}_t^b = \rho_Z \hat{z}_{t-1}^b - (1 - \rho_Z) \gamma_Z (\hat{s}_{b,t-1} - \hat{s}_{b,t-1}^F) + \phi_{zy} \hat{y}_t + \hat{u}_t^z \quad (\text{A.20})$$

$$\hat{z}_t = \hat{z}_t^b + \zeta_t^M + \zeta_t^F \quad (\text{A.21})$$

$$\hat{\tau}_{L,t} = \rho_L \hat{\tau}_{L,t-1} + (1 - \rho_L) \gamma_L (\hat{s}_{b,t-1} - \hat{s}_{b,t-1}^F) \quad (\text{A.22})$$

$$\hat{\tau}_{K,t} = \rho_K \hat{\tau}_{K,t-1} + (1 - \rho_K) \gamma_K (\hat{s}_{b,t-1} - \hat{s}_{b,t-1}^F) \quad (\text{A.23})$$

Monetary Rule:

$$\hat{r}_{n,t} = \rho_r \hat{r}_{n,t-1} + (1 - \rho_r) [\phi_\pi (\hat{\pi}_t - \hat{\pi}_t^F) + \phi_y \hat{y}_t] + \hat{u}_t^m \quad (\text{A.24})$$

The variables with the superscript F in equations (A.19) to (A.24) pertain to the shadow economy. This block mirrors equations (A.1) to (A.18), with each variable \hat{x}_t replaced by \hat{x}_t^F , along with the following additional equations:

$$\hat{g}_t^F = \rho_G \hat{g}_{t-1}^F - (1 - \rho_G) \gamma_G \hat{s}_{b,t-1}^F + \hat{u}_t^g \quad (\text{A.25})$$

$$\hat{z}_t^{b,F} = \rho_Z \hat{z}_{t-1}^{b,F} - (1 - \rho_Z) \gamma_Z \hat{s}_{b,t-1}^F + \phi_{zy} \hat{y}_t^F + \hat{u}_t^z \quad (\text{A.26})$$

$$\hat{z}_t^F = \hat{z}_t^{b,F} + \zeta_t^F \quad (\text{A.27})$$

$$\hat{\tau}_{L,t}^F = \rho_L \hat{\tau}_{L,t-1}^F + (1 - \rho_L) \gamma_L \hat{s}_{b,t-1}^F \quad (\text{A.28})$$

$$\hat{\tau}_{K,t}^F = \rho_K \hat{\tau}_{K,t-1}^F + (1 - \rho_K) \gamma_K \hat{s}_{b,t-1}^F \quad (\text{A.29})$$

$$\hat{r}_{n,t}^F = \rho_r \hat{r}_{n,t-1}^F + (1 - \rho_r) [\phi_\pi \hat{\pi}_t^F + \phi_y \hat{y}_t^F] + \hat{u}_t^m \quad (\text{A.30})$$

There are 48 endogenous variables, including $\{\hat{y}_t, \hat{k}_t, \hat{L}_t, \hat{r}_{K,t}, \hat{w}_t, \hat{m}c_t, \hat{\pi}_t, \hat{\lambda}_t^S, \hat{c}_t^{*S}, \hat{c}_t^S, \hat{r}_{n,t}, \hat{P}_t^m, \hat{\nu}_t, \hat{q}_t, \hat{i}_t, \hat{k}_t, \hat{c}_t^N, \hat{c}_t, \hat{s}_{b,t}, \hat{g}_t, \hat{z}_t^b, \hat{z}_t, \hat{\tau}_{K,t}, \hat{\tau}_{L,t}\}$ along with their counterparts in the shadow economy, governed by 48 equations: (A.1)–(A.18) for the actual and shadow economies, and the policy rules in each regime, (A.19)–(A.30).

The exogenous shocks \hat{u}_t^x , for $x \in \{a, b, m, i, rp, \mu^{NKPC}, g, z\}$, follow AR(1) processes of the form $\hat{u}_t^x = \rho_x \hat{u}_{t-1}^x + \eta_t^x$, $\eta_t^x \sim N(0, \sigma_x^2)$. In addition, $\hat{\eta}_t^p$ and $\hat{\eta}_t^w$ are assumed to be i.i.d. normal shocks with zero mean and standard deviations σ_p and σ_w , respectively.

Appendix B Data and Sources

The observation equations, which link the observed data to the model's variables, are given by:

$$dGDP_t = \hat{y}_t - \hat{y}_{t-1} + 100\boldsymbol{\varkappa} + \hat{u}_t^a + \mu_t^{GDP}$$

$$dC_t = \hat{c}_t - \hat{c}_{t-1} + 100\boldsymbol{\varkappa} + \hat{u}_t^a$$

$$dI_t = \hat{i}_t - \hat{i}_{t-1} + 100\boldsymbol{\varkappa} + \hat{u}_t^a$$

$$dW_t = \hat{w}_t - \hat{w}_{t-1} + 100\boldsymbol{\varkappa} + \hat{u}_t^a$$

$$dZ_t = \hat{z}_t - \hat{z}_{t-1} + 100\boldsymbol{\varkappa} + \hat{u}_t^a$$

$$dG_t = \hat{g}_t - \hat{g}_{t-1} + 100\boldsymbol{\varkappa} + \hat{u}_t^a$$

$$HOURS_t = \hat{l}_t$$

$$CALL_t = 100 \log R + \hat{R}_t$$

$$INF_t = 100 \log \Pi + \hat{\pi}_t$$

$$BY_t = 100 \log s_b + \hat{s}_{b,t} + \mu_t^{by}$$

where the variables on the left-hand side represent the observed data: $dGDP_t, dC_t, dI_t, dW_t, dZ_t, dG_t$ denote the growth rates of real GDP, private consumption, private investment, wages,

government transfer, and government consumption, respectively. $HOURS_t$ is hours worked, $CALL_t$ is the nominal interest rate, INF_t is the inflation rate, and BY_t is the debt-to-GDP ratio. μ_t^{GDP} and μ_t^{by} are the measurement errors of real GDP growth and the debt-to-GDP ratio, respectively.

Data Sources

We construct each time series as follows:

Real GDP, Private Consumption, and Private Investment *Source:* Cabinet Office, National Accounts. Data from 1994:Q1 onward are based on the 2015 benchmark. For periods prior to 1993:Q4, we construct the series by linking data using year-on-year growth rates of the quarterly data. Private investment includes private business investment, private residential investment, and changes in inventories. We deflate the series using the GDP deflator to obtain real values.

Inflation Rate *Source:* Ministry of Internal Affairs and Communications, Consumer Price Index (CPI). We use the tax-adjusted monthly CPI series (excluding fresh food and energy) from January 1990 to December 2019. For periods after January 2020 and before December 1989, we extend the series using year-on-year growth rates of the monthly data. We take the average of the monthly data to obtain the quarterly data and apply seasonal adjustment using the X12 method.

Nominal Interest Rate *Source:* Bank of Japan, Uncollateralized Call Rate; Krippner (2015). For periods prior to June 1985, we use the collateralized call rate as a proxy, following Miyao (2005). We take the average of the monthly data to obtain the quarterly data. When the uncollateralized call rate falls below 0.25% or is lower than the shadow rate, we instead use the shadow rate.

Hours Worked and Nominal Wages *Source:* Ministry of Health, Labour and Welfare, Monthly Labour Survey. We calculate hours worked by dividing the total hours worked index by the number of working days to obtain daily hours. We calculate nominal wages by dividing scheduled cash earnings by daily hours worked. We then convert both series from monthly to quarterly frequency by averaging the monthly data, and we seasonally adjust them using the X12 method. To obtain real values, we deflate the series using the GDP deflator. Finally, daily hours worked are demeaned so that their mean is zero.

Fiscal Variables *Source:* Cabinet Office, National Accounts. We use the 2023 edition of the National Accounts (2015 base, 2008 SNA) and the 2009 edition (2000 base, 1993 SNA). The latest available data extend through 2023:Q4. To construct the following data series, we follow the methodology outlined in Abe, Fueki, and Kaihatsu (2019).

Government Consumption We construct the raw series as the sum of Collective Consumption Expenditure, Gross Fixed Capital Formation (by General Government), Changes in Inventories (by General Government), and Net Purchases of Non-Produced Assets (Natural Resources), minus Net Saving.

Government Transfers We construct the raw series as the sum of Individual Consumption Expenditure, Subsidies (payable), Social Benefits Other Than Social Transfers in Kind (payable), Capital Transfers (payable minus receivable), and Other Current Transfers (payable minus receivable), minus Net Social Contributions (receivable).

We construct the quarterly series for both government consumption and government transfers prior to 1993:Q4 by linking the 2000-base data using year-on-year growth rates of the original quarterly data. For annual values, we link the series using year-on-year growth rates of the original annual data. We apply seasonal adjustment using the X12 method and deflate the series with the GDP deflator to obtain real values.

Debt-to-GDP ratio We use end-of-year values for liabilities. Quarterly values for each calendar year are constructed by linear interpolation.

Appendix C U.S. estimation results

Tables 4 and 5 show the estimation results of the parameters when using the shadow rate instead of forward interest rates for the U.S. data. The estimated values are generally consistent with those in BFM, except that the response coefficient of the capital tax rate to funded debt in the fiscal rule is significantly negative (whereas it is slightly positive in BFM). Compared to BFM, the value of the habit formation parameter is larger. In relation to this, while the persistence parameter of the preference shock is smaller, its standard deviation is substantially larger.

Figure 8 presents the impulse responses of inflation, the real interest rate, and the debt-to-GDP ratio to unfunded and funded transfer shocks, as well as long-run and short-run price markup shocks. Long-run price markup shocks elicit a stronger short-term positive response in inflation in the U.S. than in Japan. Interestingly, funded transfer shocks exert a modest positive effect on inflation.

Figure 9 shows the historical decomposition results for inflation and GDP growth. Similar to BFM, inflation dynamics are mostly explained by unfunded transfer shocks. In contrast,

the contributions of funded transfer shocks and monetary policy shocks are negligible. Other non-policy shocks have exerted deflationary pressures, particularly in recent periods, consistent with the findings in BFM.

| Param. | Description | Prior | | | Posterior | | |
|---------------|------------------------------|-------|------|------|-----------|---------|---------|
| | | Type | Mean | Std. | Mean | 5% | 95% |
| s_b | Debt-to-GDP annualized | N | 2.4 | 0.05 | 2.4509 | 2.3721 | 2.5235 |
| 100κ | SS growth rate | N | 0.5 | 0.05 | 0.3918 | 0.3216 | 0.4483 |
| $100 \ln \Pi$ | SS inflation | N | 0.5 | 0.05 | 0.4815 | 0.3969 | 0.5872 |
| ξ | Inverse Frisch elasticity | G | 2 | 0.25 | 3.1867 | 2.7165 | 3.6077 |
| μ | Share of hand-to-mouth | B | 0.11 | 0.01 | 0.0870 | 0.0759 | 0.0987 |
| ω_w | Wage Calvo param. | B | 0.5 | 0.1 | 0.7466 | 0.7258 | 0.7676 |
| ω_p | Price Calvo param. | B | 0.5 | 0.1 | 0.9188 | 0.9056 | 0.9306 |
| ψ | Capital util. cost | B | 0.5 | 0.1 | 0.3335 | 0.2582 | 0.4097 |
| s | Investment adj. cost | N | 6 | 0.5 | 6.4355 | 5.8050 | 7.0954 |
| χ_w | Wage infl. indexation | B | 0.5 | 0.2 | 0.0944 | 0.0471 | 0.1339 |
| χ_p | Price infl. indexation | B | 0.5 | 0.2 | 0.2416 | 0.1153 | 0.3940 |
| θ | Habits in consumption | B | 0.5 | 0.2 | 0.9900 | 0.9889 | 0.9914 |
| α_G | Subs. private/gov. cons. | N | 0 | 0.1 | -0.1322 | -0.3037 | 0.0143 |
| ϕ_y | Interest response to GDP | N | 0.25 | 0.1 | 0.0024 | -0.0065 | 0.0104 |
| ϕ_π | Interest response to infl. | N | 2 | 0.1 | 1.9729 | 1.8437 | 2.1129 |
| ϕ_{zy} | Transfer response to GDP | G | 0.1 | 0.05 | 0.2132 | 0.0449 | 0.3721 |
| γ_G | Gov. cons. response to debt | N | 0.25 | 0.1 | 0.1650 | 0.1287 | 0.2101 |
| γ_K | Capital tax response to debt | N | 0.25 | 0.1 | -0.1210 | -0.2425 | -0.0208 |
| γ_L | Labor tax response to debt | N | 0.25 | 0.1 | 0.0185 | -0.0679 | 0.1152 |
| γ_Z | Transfer response to debt | N | 0.25 | 0.1 | 0.1430 | 0.0537 | 0.2254 |
| ρ_c | AR coeff. monetary rule | B | 0.5 | 0.1 | 0.7971 | 0.7732 | 0.8210 |
| ρ_G | AR coeff. gov. cons. rule | B | 0.5 | 0.1 | 0.2348 | 0.1368 | 0.3274 |
| ρ_Z | AR coeff. transfers rule | B | 0.5 | 0.1 | 0.3733 | 0.2247 | 0.5641 |

Table 4. Priors and posteriors for the structural parameters: U.S., 1960:Q1-2022:Q3

Appendix D Japanese subsample estimation results

Table 6 reports the estimation results for the structural parameters based on the subsample through 1998:Q4. Compared to the full-sample estimation results, the frequency of wage adjustment is relatively high, with $1 - \omega_w = 0.3218$. The estimated value of $\alpha_G = -0.0290$ is negative—though not statistically significant—indicating that government consumption and private consumption may act as substitutes. The responsiveness of labor income taxes to

| Param. | Description | Type | Prior | | Posterior | | |
|---------------------|------------------------------|------|-------|-------|-----------|---------|---------|
| | | | Mean | Std. | Mean | 5% | 95% |
| ρ_{eG} | AR coeff. gov. cons | B | 0.5 | 0.1 | 0.9250 | 0.8943 | 0.9563 |
| ρ_{eZ}^M | AR coeff. funded trans. | B | 0.995 | 0.001 | 0.9954 | 0.9940 | 0.9968 |
| ρ_{eZ}^F | AR coeff. unfunded trans. | B | 0.995 | 0.001 | 0.9957 | 0.9947 | 0.9972 |
| ρ_z | AR coeff. short-term trans. | B | 0.5 | 0.1 | 0.4670 | 0.3140 | 0.6151 |
| ρ_a | AR coeff. technology | B | 0.5 | 0.1 | 0.1049 | 0.0682 | 0.1575 |
| ρ_b | AR coeff. preference | B | 0.5 | 0.1 | 0.1349 | 0.0851 | 0.1832 |
| ρ_m | AR coeff. mon. policy | B | 0.5 | 0.1 | 0.2640 | 0.2100 | 0.3415 |
| ρ_i | AR coeff. investment | B | 0.5 | 0.1 | 0.9166 | 0.8972 | 0.9354 |
| ρ_{rp} | AR coeff. risk premium | B | 0.5 | 0.1 | 0.8971 | 0.8760 | 0.9238 |
| $\rho_{\mu NKPC}$ | AR coeff. pers. cost push | B | 0.995 | 0.001 | 0.9961 | 0.9950 | 0.9973 |
| σ_G | St.dev. gov. cons. | IG | 0.5 | 0.2 | 2.2630 | 2.0912 | 2.4006 |
| σ_Z^M | St.dev. funded transfers | IG | 0.5 | 0.2 | 5.7942 | 5.3806 | 6.1867 |
| σ_Z^F | St.dev. unfunded transfers | IG | 0.5 | 0.2 | 1.4085 | 1.1106 | 1.6802 |
| σ_z | St.dev. short-term trans. | IG | 0.5 | 0.2 | 0.4715 | 0.2549 | 0.6701 |
| σ_a | St.dev. technology | IG | 0.5 | 0.2 | 2.0066 | 1.8738 | 2.1495 |
| σ_b | St.dev. preference | IG | 0.5 | 0.2 | 82.7600 | 79.2220 | 86.0477 |
| σ_m | St.dev. mon. policy | IG | 0.5 | 0.2 | 0.2255 | 0.2094 | 0.2438 |
| σ_i | St.dev. investment | IG | 0.5 | 0.2 | 0.5150 | 0.4471 | 0.5771 |
| σ_w | St.dev. wage markup | IG | 0.5 | 0.2 | 0.4547 | 0.4200 | 0.4906 |
| σ_p | St.dev. transitory cost push | IG | 0.5 | 0.2 | 0.1725 | 0.1554 | 0.1875 |
| σ_{rp} | St.dev. risk premium | IG | 0.5 | 0.2 | 0.3645 | 0.3028 | 0.4240 |
| $\sigma_{\mu NKPC}$ | St.dev. persistent cost push | IG | 0.5 | 0.2 | 1.8101 | 1.3807 | 2.3455 |
| σ_{GDP}^m | Measur. error GDP | IG | 0.5 | 0.2 | 0.8882 | 0.8355 | 0.9423 |
| σ_{by}^m | Measur. error Debt/GDP | IG | 0.5 | 0.2 | 0.3964 | 0.2569 | 0.5253 |

Table 5. Priors and posteriors for the exogenous shock parameters: U.S., 1960:Q1-2022:Q3

the debt-to-GDP ratio is also modest, with $\gamma_L = 0.2507$. Table 7 presents the results for the shock parameters, estimated using the full sample while holding the structural parameters fixed. These estimates remain broadly consistent with those from the baseline specification.

Figure 10 demonstrates that the shape of the impulse response functions does not change significantly. However, the inflation response to unfunded transfer shocks is somewhat attenuated. This is also reflected in the historical decomposition of inflation in Figure 11, where the contribution of unfunded transfer shocks becomes smaller.

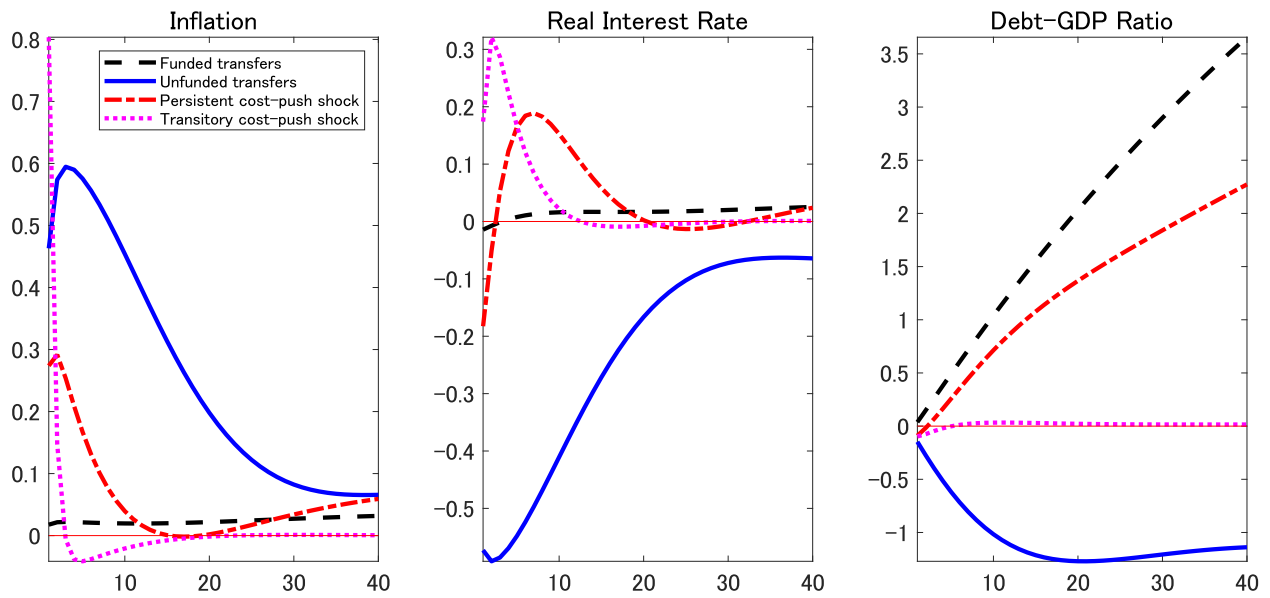
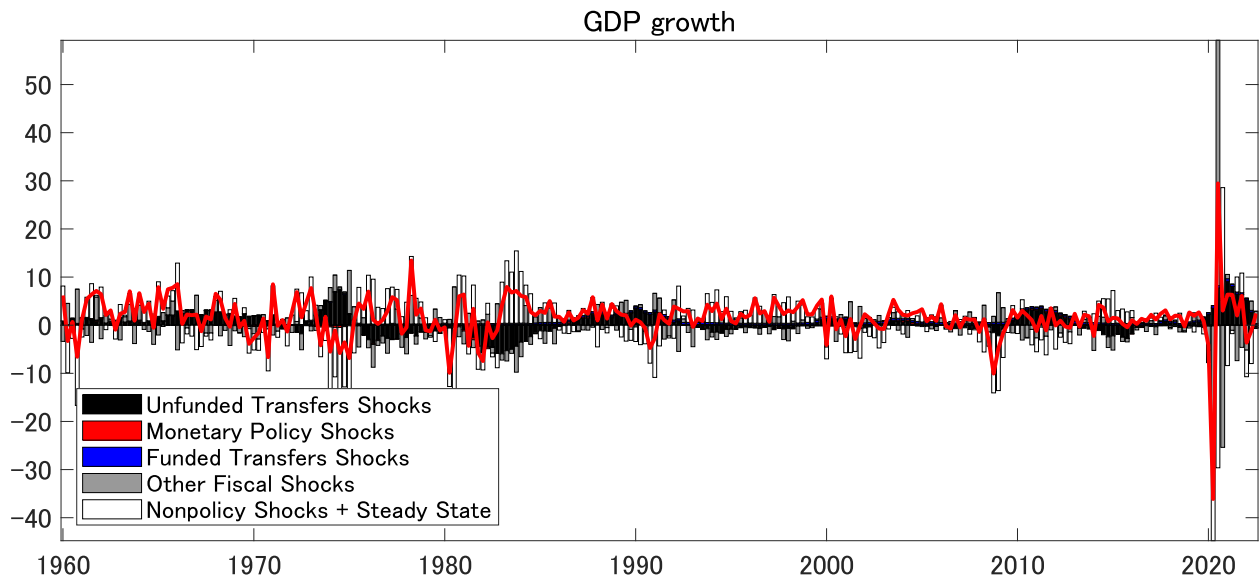
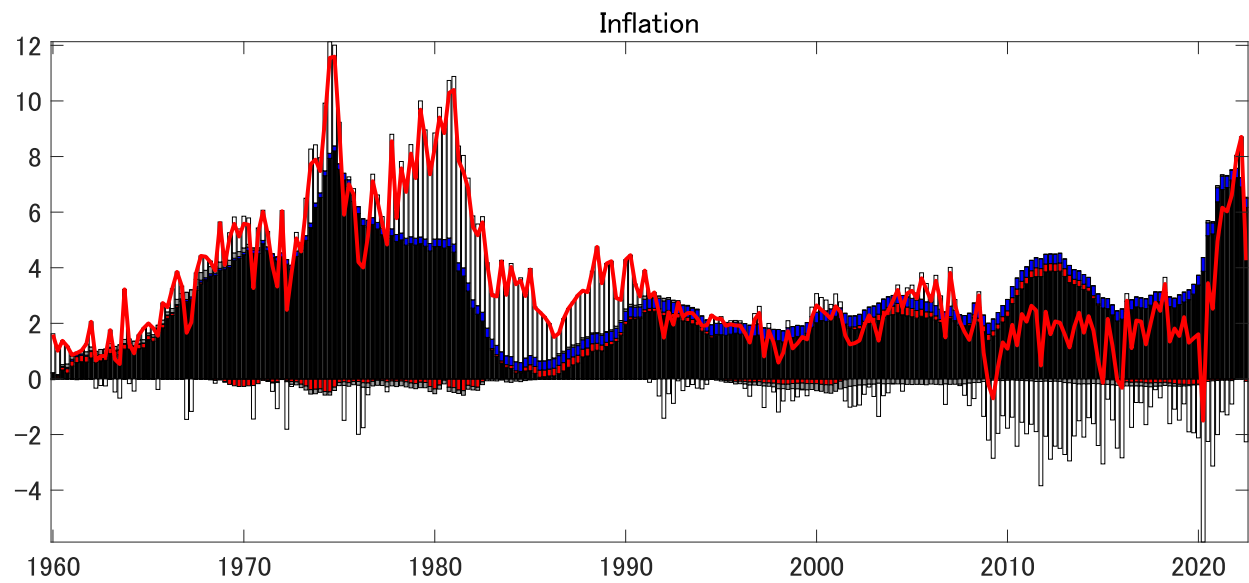


Figure 8. Impulse responses in the medium-scale model: U.S.



Note: Nonpolicy shocks include technology, preference, IST, risk-premium, wage markup, and short-run and long-run price markup shocks. Other policy shocks are transitory transfer and government spending shocks.

Figure 9. Drivers of Inflation and GDP growth: U.S.

| Param. | Description | Prior | | | Posterior | | |
|---------------|----------------------------|-------|------|------|-----------|---------|---------|
| | | Type | Mean | Std. | Mean | 5% | 95% |
| s_b | Debt-to-GDP annualized | N | 2.4 | 0.05 | 2.4625 | 2.3795 | 2.5363 |
| 100κ | SS growth rate | N | 0.5 | 0.05 | 0.4731 | 0.3938 | 0.5558 |
| $100 \ln \Pi$ | SS inflation | N | 0.5 | 0.05 | 0.4955 | 0.4035 | 0.5796 |
| ξ | Inverse Frisch elasticity | G | 2 | 0.25 | 2.2041 | 1.8042 | 2.5644 |
| μ | Share of hand-to-mouth | B | 0.11 | 0.01 | 0.0959 | 0.0814 | 0.1104 |
| ω_w | Wage Calvo param. | B | 0.5 | 0.1 | 0.7281 | 0.6782 | 0.7774 |
| ω_p | Price Calvo param. | B | 0.5 | 0.1 | 0.9255 | 0.9095 | 0.9418 |
| ψ | Capital util. cost | B | 0.5 | 0.1 | 0.5270 | 0.3558 | 0.6957 |
| s | Investment adj. cost | N | 6 | 0.5 | 7.2354 | 6.2811 | 8.1736 |
| χ_w | Wage infl. indexation | B | 0.5 | 0.2 | 0.0423 | 0.0084 | 0.0735 |
| χ_p | Price infl. indexation | B | 0.5 | 0.2 | 0.8667 | 0.7722 | 0.9636 |
| θ | Habits in consumption | B | 0.5 | 0.2 | 0.9562 | 0.9433 | 0.9685 |
| α_G | Subs. private/gov. cons. | N | 0 | 0.1 | -0.0290 | -0.0941 | 0.0340 |
| ϕ_y | Interest response to GDP | N | 0.25 | 0.1 | -0.0975 | -0.1313 | -0.0631 |
| ϕ_π | Interest response to infl. | N | 2 | 0.1 | 1.9103 | 1.7185 | 2.1042 |
| ϕ_{zy} | Transfer response to GDP | G | 0.1 | 0.05 | 0.0927 | 0.0221 | 0.1591 |
| γ_L | Labor tax response to debt | N | 0.25 | 0.1 | 0.2507 | 0.0950 | 0.4134 |
| γ_Z | Transfer response to debt | N | 0.25 | 0.1 | 0.2892 | 0.1498 | 0.4156 |
| ρ_c | AR coeff. monetary rule | B | 0.5 | 0.1 | 0.7947 | 0.7501 | 0.8408 |
| ρ_G | AR coeff. gov. cons. rule | B | 0.5 | 0.1 | 0.5199 | 0.3841 | 0.6537 |
| ρ_Z | AR coeff. transfers rule | B | 0.5 | 0.1 | 0.4994 | 0.3151 | 0.6598 |

Table 6. Priors and posteriors for the structural parameters: Japan, 1981:Q1-1998:Q4 (subsample estimation)

| Param. | Description | Prior | | | Posterior | | |
|-----------------------|------------------------------|-------|-------|-------|-----------|---------|---------|
| | | Type | Mean | Std. | Mean | 5% | 95% |
| ρ_{eG} | AR coeff. gov. cons | B | 0.5 | 0.1 | 0.5869 | 0.5075 | 0.6792 |
| ρ_{eZ}^M | AR coeff. funded trans. | B | 0.995 | 0.001 | 0.9956 | 0.9943 | 0.997 |
| ρ_{eZ}^F | AR coeff. unfunded trans. | B | 0.995 | 0.001 | 0.9969 | 0.9954 | 0.9985 |
| ρ_z | AR coeff. short-term trans. | B | 0.5 | 0.1 | 0.5009 | 0.3383 | 0.6529 |
| ρ_a | AR coeff. technology | B | 0.5 | 0.1 | 0.2846 | 0.2071 | 0.3589 |
| ρ_b | AR coeff. preference | B | 0.5 | 0.1 | 0.1944 | 0.1241 | 0.2661 |
| ρ_m | AR coeff. mon. policy | B | 0.5 | 0.1 | 0.6234 | 0.5447 | 0.6953 |
| ρ_i | AR coeff. investment | B | 0.5 | 0.1 | 0.8272 | 0.7858 | 0.8688 |
| ρ_{rp} | AR coeff. risk premium | B | 0.5 | 0.1 | 0.8913 | 0.8749 | 0.9082 |
| $\rho_{\mu_{NKPC}}$ | AR coeff. pers. cost push | B | 0.995 | 0.001 | 0.9953 | 0.9937 | 0.9967 |
| σ_G | St.dev. gov. cons. | IG | 0.5 | 0.2 | 5.7256 | 5.2576 | 6.2655 |
| σ_Z^M | St.dev. funded transfers | IG | 0.5 | 0.2 | 8.3292 | 7.6379 | 9.1563 |
| σ_Z^F | St.dev. unfunded transfers | IG | 0.5 | 0.2 | 0.5652 | 0.4479 | 0.6880 |
| σ_z | St.dev. short-term trans. | IG | 0.5 | 0.2 | 0.5152 | 0.2492 | 0.7799 |
| σ_a | St.dev. technology | IG | 0.5 | 0.2 | 3.0765 | 2.8101 | 3.3386 |
| σ_b | St.dev. preference | IG | 0.5 | 0.2 | 38.1875 | 33.8604 | 42.6998 |
| σ_m | St.dev. mon. policy | IG | 0.5 | 0.2 | 0.1705 | 0.1527 | 0.1864 |
| σ_i | St.dev. investment | IG | 0.5 | 0.2 | 0.4342 | 0.3462 | 0.5257 |
| σ_w | St.dev. wage markup | IG | 0.5 | 0.2 | 0.3093 | 0.2794 | 0.3410 |
| σ_p | St.dev. transitory cost push | IG | 0.5 | 0.2 | 0.1893 | 0.1712 | 0.2073 |
| σ_{rp} | St.dev. risk premium | IG | 0.5 | 0.2 | 0.4042 | 0.3431 | 0.4612 |
| $\sigma_{\mu_{NKPC}}$ | St.dev. persistent cost push | IG | 0.5 | 0.2 | 0.8377 | 0.6702 | 0.9939 |
| σ_{GDP}^m | Measur. error GDP | IG | 0.5 | 0.2 | 1.6854 | 1.5358 | 1.8210 |
| σ_{by}^m | Measur. error Debt/GDP | IG | 0.5 | 0.2 | 0.3293 | 0.2409 | 0.4233 |

Table 7. Priors and posteriors for the exogenous shock parameters: Japan, 1981:Q1-2023:Q4 (subsample estimation)

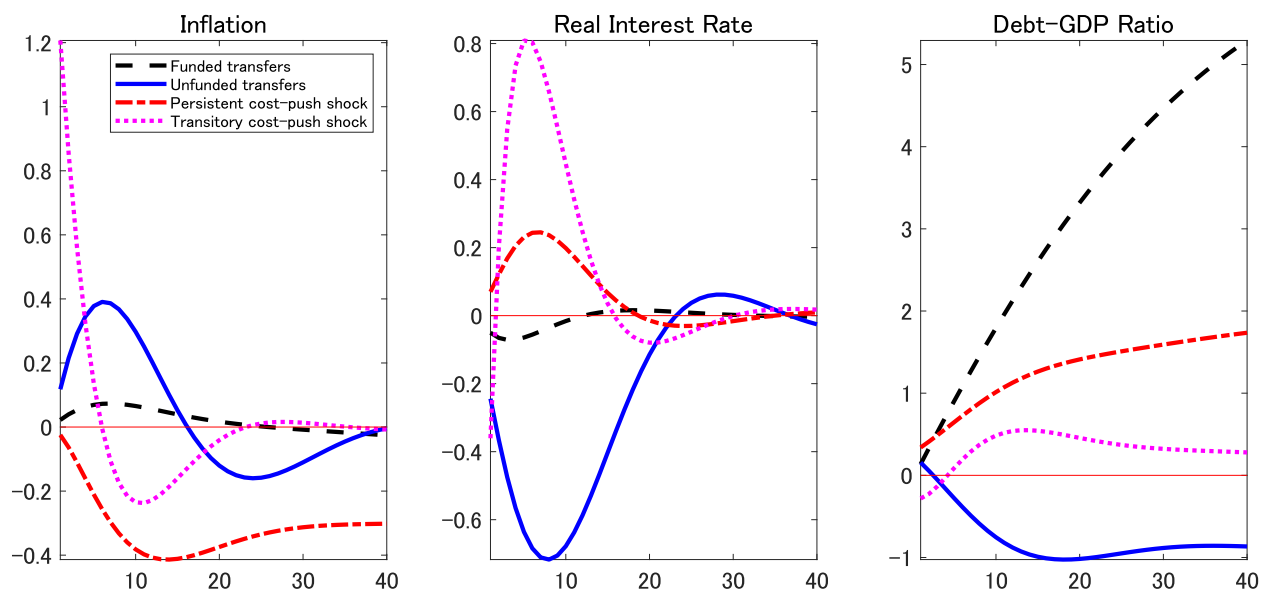
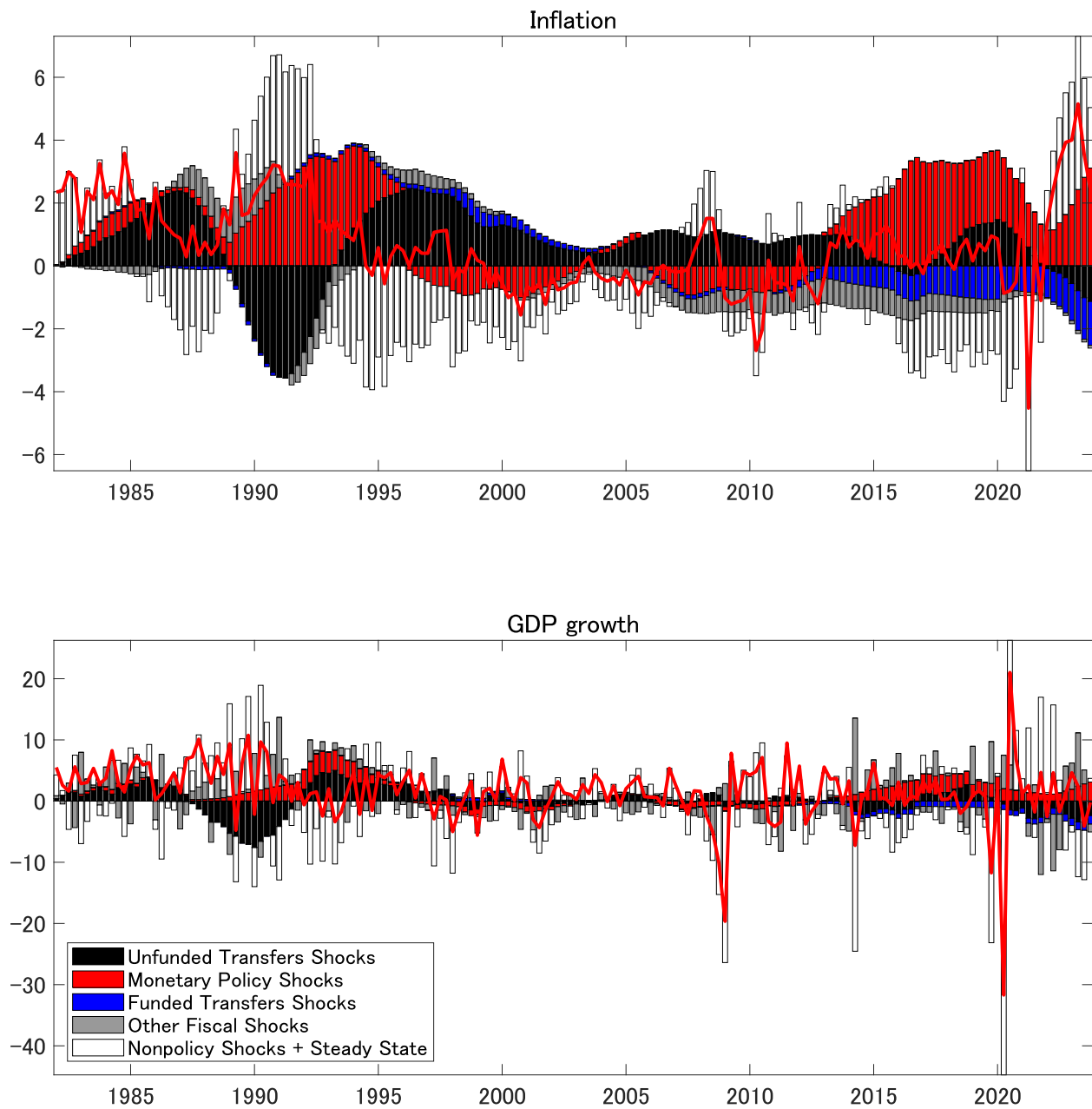


Figure 10. Impulse responses in the medium-scale model: Japan (subsample estimation)



Note: Nonpolicy shocks include technology, preference, IST, risk-premium, wage markup, and short-run and long-run price markup shocks. Other policy shocks are transitory transfer and government spending shocks.

Figure 11. Drivers of Inflation and GDP growth: Japan (subsample estimation)