Monetary-Fiscal Interactions in the United States

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Abstract

How does the fiscal side of the US government respond to monetary policy, and does it matter? We estimate the response of fiscal variables to monetary shocks and the counterfactual response of macroeconomic aggregates to those shocks under different fiscal rules. Following an interest rate hike, the fiscal authority does not react: spending and transfers remain constant, tax receipts fall along with output, and interest payments and debt increase. Monetary policy would be more contractionary if fiscal policy stabilized debt through spending or taxes, but less contractionary if it used transfers. Indeed, transfer hikes reduce real debt by raising inflation.

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1 Introduction

In many macroeconomic models, the effect of monetary policy sharply depends on how the fiscal side of the government reacts. For instance, in heterogeneous-agent new Keynesian (HANK) models, an interest rate hike increases payments on public debt, thus deteriorating the budget balance. Whether the fiscal authority clears its budget constraint by changing income taxes, transfers, spending, or by issuing more debt shapes the response of output because it shifts the burden of adjustment to different households (Kaplan et al., 2018, Alves et al., 2020). Yet little empirical evidence exists on how Congress responds to the Federal Open Market Committee's (FOMC) decisions and whether that matters.

Our first contribution is to estimate the response of several fiscal variables to monetary policy shocks constructed in the spirit of Romer and Romer (2004). These shocks are interest rate changes purged from forecasts of output, inflation and unemployment prepared by the staff of the Federal Reserve System. Since the FOMC might react to news about future fiscal policy, we also purge rate changes from forecasts of government receipts, expenditures and surpluses. Then, we estimate the effect of those shocks on tax receipts, spending, transfers, interest payments, and real debt at the federal level. Our treatment of the data preserves the budget constraint of the government, thus our results can be transposed into a theoretical model.

We find that, following an exogenous monetary policy tightening, receipts decrease, spending and transfers are constant, and interest payments and debt increase—all of these variables being expressed in real terms. For a 1% point increase in the federal funds rate (FFR) target, tax receipts fall by about 0.2% of trend GDP within two years and bounce back after two more years. Using a database on legislated tax changes (Romer and Romer, 2010), we show that this response is not driven by legislated changes in the tax schedule, but by the endogenous reaction of tax receipts to the fall in output. Perhaps surprisingly, government transfer payments do not exhibit any response. The explanation is simple: most transfers, such as Social Security and Medicare,

are not automatic stabilizers. Unemployment insurance is, but it only accounts for a small share of transfers paid by the federal government. With receipts falling, roughly constant expenditures, and increased interest rate payments, the budget balance deteriorates and feeds an increase in federal debt.

Our second contribution is to estimate the response of the economy to the same monetary contraction under counterfactual rules for fiscal policy. We use the semi-structural method of McKay and Wolf (2023) to construct these counterfactual scenarios: we make some structural assumptions, but we do not rely on a specific model. Their method requires the estimation of the response of the relevant variables to several shock paths for each fiscal instrument. We can then construct the counterfactual scenario by taking the weighted average of the impulse response functions across the various shock paths that best enforces the counterfactual rule. This methodology is immune to the Lucas (1976) critique.

We find that, if fiscal policy stabilizes real debt by cutting spending or increasing taxes, the monetary contraction pushes the economy into a deeper recession. An increase in transfers, on the other hand, can make the recession milder, even though it stabilizes real debt. This surprising result stems from a simple fact, which we are, as far as we know, the first to document: in the data, transfer hikes are expansionary and inflationary enough that they *reduce*—or at least do not increase—real debt: transfers seem to pay for themselves. Thus, the transfer instrument allows the fiscal authority to fight the monetary contraction while stabilizing real debt at the cost of substantial inflation.

Some of our findings are qualitatively consistent with prominent HANK models (Kaplan et al., 2018, Auclert et al., 2020): these models predict that using spending is more contractionary than using taxes, which is more contractionary than letting debt adjust. Our transfer results are not since these models tend to predict that using transfers is more contractionary than using taxes or debt.

Related literature: Kaplan et al. (2018) lament that "there is no empirical evidence that reveals what type of fiscal adjustment is the most likely to occur in practice, following a monetary shock." Still, some papers have touched this question *en passant*. Using vector autoregression (VAR) shocks, Cochrane (1999) finds "not a shred of statistical evidence that federal-funds shocks forecast surpluses." Using a VAR with high-frequency shocks, Sterk and Tenreyro (2018) estimate a response of real debt that is roughly consistent with ours. Using a VAR with recursive identification, Caramp and Silva (2018) find that fiscal revenues over GDP fall after a monetary shock, government purchases are constant and transfers slightly increase. Wolf (2023) applies the McKay-Wolf methodology to estimate the sensitivity of the fiscal multiplier to different monetary policy rules.

2 Reality: Methodology

2.1 Monetary Shock

To identify monetary shocks, we use a variation on the measure developed by Romer and Romer (2004), henceforth RR. They purge rate changes from forecasts of output, inflation and unemployment to remove the component of monetary policy that is endogenous to economic conditions. The forecasts they use, known as the Greenbook forecasts, are prepared before each Federal Open Market Committee (FOMC) meeting by the staff of the Federal Reserve.

It is plausible, however, that the monetary side of the US government should systematically react to the stance of its fiscal side, above and beyond the latter's effect on output, inflation and unemployment. For instance, the FOMC may monetize fiscal deficits, or tighten in the face of those deficits as a show of independence. To mitigate this concern, we add Greenbook forecasts for receipts, expenditures and surplus of the federal government to the list of controls. Thus, we estimate:

$$\begin{aligned}\Delta i_m =& \alpha + \beta i_{m-1} + \sum_{q=-1}^{2} \gamma^q \Delta \tilde{y}_m^q + \sum_{q=-1}^{2} \zeta^q \left(\Delta \tilde{y}_m^q - \Delta \tilde{y}_{m-1}^q \right) \\ &+ \sum_{q=-1}^{2} \eta^q \tilde{\pi}_m^q + \sum_{q=-1}^{2} \theta^q \left(\tilde{\pi}_m^q - \tilde{\pi}_{m-1}^q \right) + \iota \tilde{u}_m^0\end{aligned}$$

$$
\begin{aligned}
&+ \sum_{q=-1}^{2} \kappa^q \Delta \tilde{rec}_m^q + \sum_{q=-1}^{2} \lambda^q \left(\Delta \tilde{rec}_m^q - \Delta \tilde{rec}_{m-1}^q\right) \\
&+ \sum_{q=-1}^{2} \mu^q \Delta \tilde{exp}_m^q + \sum_{q=-1}^{2} \nu^q \left(\Delta \tilde{exp}_m^q - \Delta \tilde{exp}_{m-1}^q\right) \\
&+ \sum_{q=-1}^{2} \pi^q \tilde{srpl}_m^q + \sum_{q=-1}^{2} \rho^q \left(\tilde{srpl}_m^q - \tilde{srpl}_{m-1}^q\right) + \epsilon_m
\end{aligned} \tag{1}
$$

where i_m is the intended federal funds rate in month m, and $\Delta\tilde{y}_m^q$, $\tilde{\pi}_m^q$, $\tilde{u}_m^q$, $\Delta\tilde{rec}_m^q$, $\Delta\tilde{exp}_m^q$ and $\tilde{srpl}_m^q$ are the forecasts for real output growth, inflation, unemployment, receipts growth, expenditures growth and total budget surplus as a share of output in the previous ($q = -1$), current ($q = 0$) and subsequent ($q = 1, 2$) quarters. The residuals obtained after running this regression, $\hat{\epsilon}_m$, are our measure of monetary shocks.

2.2 Variables of Interest

We study the response of 5 fiscal variables—spending, tax receipts, transfers, interest payments, and debt (all in real terms)—and 3 macroeconomic variables—GDP, inflation, and the nominal interest rate. The first 3 fiscal variables are instruments: they can be directly or indirectly controlled by the government. The other 2 endogenously depend on past values of debt, the interest rate, and inflation. The fiscal variables are at the federal level. State and local policy would also be interesting to study, but the narrative shocks that we use to construct the counterfactual have only been developed at the federal level. So, it is more realistic to focus on the latter. Our sample starts in 1947 and stops in 2007 with the arrival of the zero lower bound.

All data series but debt are from the NIPA tables. Debt is from the Flow of Funds. We deflate the nominal series for spending, taxes, transfers, interest payment, debt, and GDP with the GDP deflator. We then de-trend fiscal variables and GDP with the Gordon and Krenn (2010) procedure: (i) regress real GDP on a quadratic trend, (ii) divide real variables by this quadratic trend. Thus, fiscal variables are expressed in percentage of trend GDP.

Compared to the logarithmic transformation, the Gordon-Krenn procedure has an interesting advantage: it preserves the budget constraint of the government.[1] We show in appendix A.3 that the path of debt can be almost exactly deduced from the path of the fiscal variables and inflation. Therefore, our empirical responses are consistent with a well-defined budget constraint for the government. Moreover, we can deduce the response of the deficit without including it in the VAR, simply applying the identity:

$$\text{deficit} = \text{spending} - \text{tax receipts} + \text{transfers} + \text{interest payments}$$

2.3 Specification

Our specification features a vector auto-regression (VAR) with 8 endogenous variables: spending, taxes, transfers, interest payments, debt, GDP, inflation, and the 3-month T-bill rate. The time unit is a quarter. The main competitors of VARs are local projections (LP), which were proposed by Jordà (2005). Recent contributions have shown that both identify the same impulse response function (IRF) in population (Plagborg-Møller and Wolf, 2021) and that VARs have a better bias-variance trade-off (Li et al., 2021). The latter advantage leads us to choose the VARs.

We include the monetary shock series in our VAR, ordered first. We recover the structural shock with a Cholesky decomposition. That is, we assume that the narrative shock, once we control for past values of endogenous variables, is exogenous to current and future macroeconomic conditions. This procedure is recommended by Plagborg-Møller and Wolf (2021), who show that it is equivalent to a local projection where the narrative shock is used as an instrument.

[1] Ramey (2016) also argues in favor of this transformation, albeit on slightly different grounds: when computing a fiscal multiplier, estimates obtained with log-transformed data require a rescaling by the steady state spending to GDP ratio. Such rescaling is unnecessary with the Gordon-Krenn procedure, since it preserves relative levels.

3 Reality: Results

3.1 Main Results

We show the response of our variables to a monetary shock in figure 1. We scale our IRFs such that the point estimate of the response of the nominal interest rate is 1 on impact.

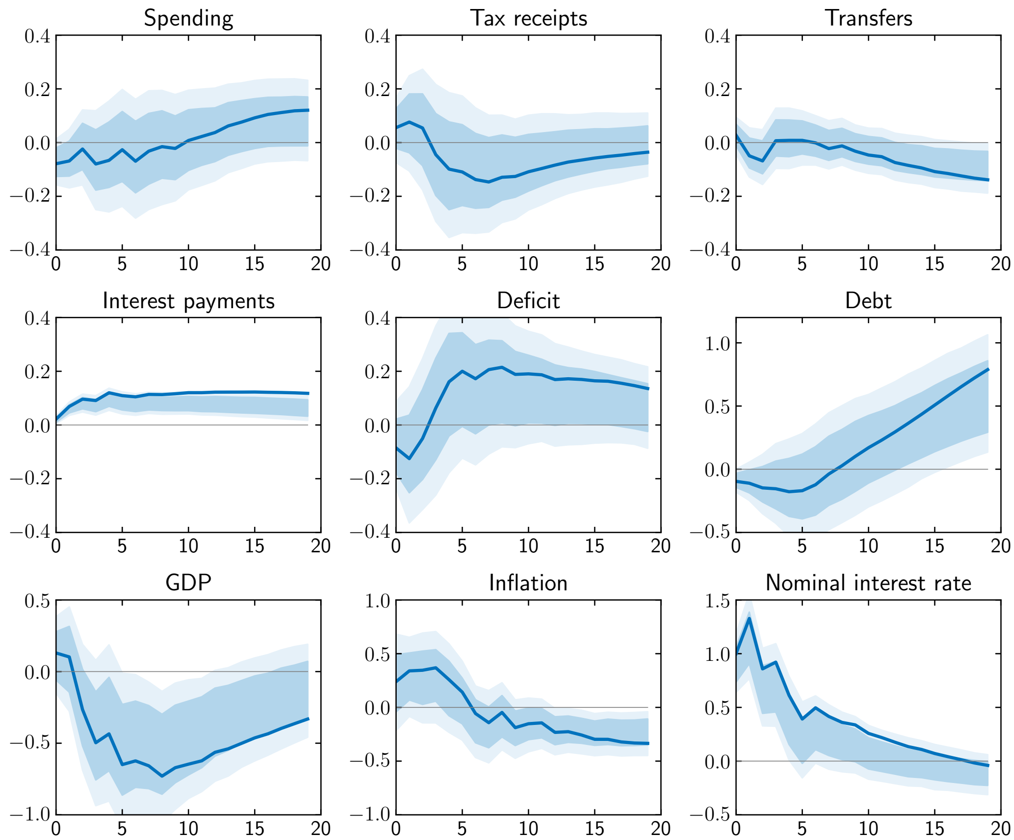
To give context, we first discuss the bottom row, which contains the well-known response of macroeconomic variables to a Romer-Romer monetary shock (Ramey, 2016, Nakamura and Steinsson, 2018). The interest rate jumps on impact. It keeps increasing for one quarter and then slowly reverts towards 0. Real GDP falls in the year that follows the shock, stays low for another year, and starts recovering around the 10th quarter. Inflation falls after a year and stays persistently low for at least 5 years. The magnitude implies that for a 100-basis point rise in the 3-month nominal rate, GDP falls by about 0.75% (compared to trend) at the trough and inflation by 25 percentage points after a year.

The bottom row was context, the top ones are results. Spending and transfers are flat. Tax receipts fall slightly and interest payments increase. The combined effect of these changes is to increase the deficit. After a year, real debt builds up. This build up in real debt is the result of an increase in deficit and the fall in the price level entailed by the monetary shock. A 100-basis point rise in the 3-month nominal rate increases real debt by about 0.5–1% of trend GDP after 5 years.

3.2 Interpretation

Our interpretation of these results is that the fiscal side of the government is mostly inactive in the face of monetary shocks. It leaves spending and transfers unchanged, lets tax receipts fall endogenously as a result of the fall in output and interest payments rise as a consequence of the increase in the interest rate. Debt must adjust to clear the budget constraint. Therefore, a FFR hike leaves the federal government more indebted.

Figure 1: Response to RR monetary shock



Note: VAR includes narrative shocks, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month nominal interest rate. The response of deficit is computed from that of the fiscal variables. The IRFs are scaled such that the point estimate of the response of the nominal interest rate is 1 at time 0. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002). See sections 2 and 4.3 for more details on the methodology.

3.2.1 What Drives Deficit and Debt?

Is the response of real debt driven by deficit or a Fisher effect? In panel A of figure 2, we plot the cumulative response of deficit and inflation, as well as the response of debt that's already plotted in figure 1. The first two lines sum up to the third one, up to a first-order approximation.[2] It turns out most of the response of real debt is accounted for by the cumulative deficit. In appendix figure A.1, we break this down even further: we decompose the cumulative response of deficit into its spending, receipts, transfers, and interest payments components. Most of the increase is due to interest payments, with some contribution from the fall in tax receipts.

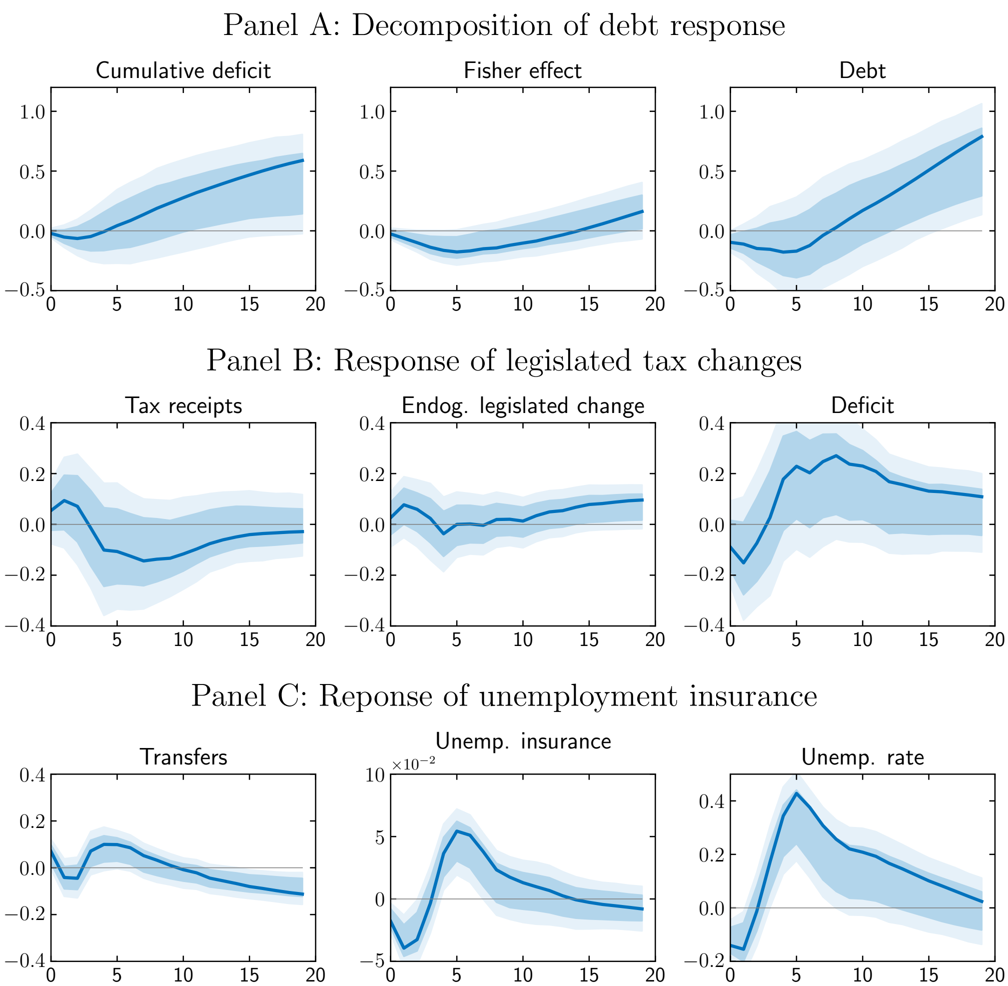
3.2.2 Output-Driven vs. Legislated Changes in Tax Receipts

Is the fall in tax receipts driven by legislated tax changes? Indeed, this fall could be driven by: (i) the contraction in output and tax collection falling for a given tax schedule, (ii) an activist response of Congress in the face of monetary shocks, or (iii) chance correlation. Numbers (i) and (ii), though they highlight different mechanisms, would be valid causal effects of monetary policy. Number (iii) is worrisome in this context: the biggest RR monetary policy shocks occurred in the early Volcker era (Coibion, 2012); at about the same time, Ronald Reagan was presiding over one of the largest tax cuts in US history. Luckily, an informal piece of evidence suggests that the response of receipts is mostly due to number (i): on figure 1, the response of receipts follows that of output. Moreover, the fact that the fall in receipts dissipates after a few years doesn't seem consistent with a change in the tax schedule, which one would expect to last longer.

To investigate this question more formally, we use the database of legislated tax changes created by Romer and Romer (2010). They analyze the narrative

[2] In appendix A.3, we explain in detail the construction of the cumulative responses and show that the approximation is very good. Compared to figure 1, those cumulative responses are divided by 4. Indeed, in keeping with the convention of the national accounts, our quarterly variables and inflation are annualized, so we need to re-scale them so that they're consistent with the response of debt.

Figure 2: Interpretation



Note: In panel A, we study the response of cumulative deficit and inflation implied by the baseline VAR. In panel B, we add exogenous and endogenous legislated tax changes (Romer and Romer, 2010) to the baseline VAR. In panel C, we add unemployment insurance and the unemployment rate. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002). See section 3.2 for more details.

record to quantify changes in the tax schedule, and classify them according to their underlying motivation. They thus distinguish four rationales that can drive a legislated tax change: finance extra spending, fight a recession, remedy an inherited deficit, and spur long-run growth. The first three categories may be endogenous to monetary policy.[3] The latter category is exogenous to monetary policy, but it is a first order of concern for it includes the Reagan tax cuts of 1981.

Our strategy is to add the endogenous legislated changes to the VAR and include the exogenous legislated changes as controls. For the endogenous changes, we use the cumulative changes (expressed as a share of trend GDP). For the exogenous changes, we use the current value and a year of future values of the legislated change. The response of tax receipts stays the same (figure 2, panel B). Since the Reagan tax cuts are part of the controls, this answers the concern that the response of tax receipts is due to chance correlation. As for the endogenous legislated changes, they do not decrease—they increase if anything. Therefore, the fall in tax receipts seems driven by their endogenous response to the fall in output, not by a legislated change in tax rates.

3.2.3 Unresponsive Transfers?

Is the response of transfers plausible? It may seem surprising that transfers do not exhibit a response. Given the contraction in output, one would expect, for instance, a counter-cyclical response of unemployment benefits after the monetary contraction triggers an increase in unemployment. The answer to this puzzle is that most of the transfers that are provided by the federal government should not be expected to be counter-cyclical. In 2007, the three biggest categories, which accounted for 70% of federal transfers, were Social

[3] Romer and Romer (2010) are interested in a different question—what are the effects of tax cuts on output? Hence their assessment of which tax changes are endogenous differs from ours. From their point of view, remedying an inherited deficit is exogenous since it is not driven by economic conditions. From our point of view, an inherited deficit can be the result of past monetary policy actions—the FOMC decides to generate less seigniorage for instance—, hence should be treated as potentially endogenous.

Security, Medicare and Medicaid.[4] There is little reason to expect that old-age, disability and health insurance payments go up in a recession. Programs such as unemployment insurance and food stamps are more likely to be counter-cyclical, but those two only amounted to 4% of the total. To check that our framework implies a plausible response of the counter-cyclical transfers, we add unemployment insurance and the unemployment rate to the VAR and plot the results in panel C of figure 2: consistent with the fall in GDP, both increase after a monetary shock.

4 Counterfactual: Methodology

4.1 The McKay-Wolf (MKW) Method

In this section, we explain a methodology that was recently proposed by McKay and Wolf (2023), henceforth MKW. Readers who are familiar with it can jump to section 4.3.

MKW's method answers a policy counterfactual question thanks to time series regression. This method requires some structural assumptions, but no commitment to a particular model. These assumptions are satisfied by the main models of the macroeconomics literature, such as the real business cycle model or the New Keynesian model, be it with representative or heterogeneous agents.

Consider a macroeconomic model that features non-policy variables, which can be observed or unobserved, and policy instruments. Those variables are linearized around their steady state value. The observed non-policy variables are collected in vector $\mathbf{x}$, the unobserved ones in $\mathbf{w}$, and the policy instruments in $\mathbf{z}$. The vectors $\mathbf{x}$, $\mathbf{w}$, and $\mathbf{z}$ feature the time path, from $t = 0$ to infinity, of each of the variables.[5] The model also features structural and policy shocks,

[4] In appendix table A.4, we break federal transfers down by category.

[5] In practice, an infinite time horizon is truncated at $t = T - 1$ for some finite T. Under such truncation, $\mathbf{x}$, $\mathbf{w}$, and $\mathbf{z}$ become $(n_{\mathbf{x}}T \times 1)$-, $(n_{\mathbf{w}}T \times 1)$-, and $(n_{\mathbf{z}}T \times 1)$-arrays, respectively, where $n_{\mathbf{x}}$, $n_{\mathbf{w}}$, and $n_{\mathbf{z}}$ are the number of observed non-fiscal variables, unobserved variables, and fiscal instruments, respectively.

collected in ε and ν, respectively.

The main theoretical assumption is that the equations that characterize the solution of the model can be separated into a non-policy block and a policy block. Formally, one must be able to write them in the following way:

$$\text{non-policy block:} \qquad \mathcal{H}_w \mathbf{w} + \mathcal{H}_{\mathbf{x}} \mathbf{x} + \mathcal{H}_{\mathbf{z}} \mathbf{z} + \mathcal{H}_\epsilon \varepsilon = \mathbf{0} \tag{2}$$

$$\text{policy block:} \qquad \mathcal{A}_x \mathbf{x} + \mathcal{A}_{\mathbf{z}} \mathbf{z} + \nu = \mathbf{0} \tag{3}$$

Crucially, the elements of the $\mathcal{H}$ matrices are not allowed to depend on the policy rules $\mathcal{A}$. The solution is assumed to be unique. We write it as:

$$\begin{pmatrix} \mathbf{w} \\ \mathbf{x} \\ \mathbf{z} \end{pmatrix} = \underbrace{\begin{pmatrix} \Theta_{w,\varepsilon,\mathcal{A}} & \Theta_{w,\nu,\mathcal{A}} \\ \Theta_{x,\varepsilon,\mathcal{A}} & \Theta_{x,\nu,\mathcal{A}} \\ \Theta_{z,\varepsilon,\mathcal{A}} & \Theta_{z,\nu,\mathcal{A}} \end{pmatrix}}_{=\Theta} \times \begin{pmatrix} \varepsilon \\ \nu \end{pmatrix} \tag{4}$$

Each row of Θ contains the impulse response function (IRF) of the variables of the model to the shocks.

Once again, the workhorses of modern macroeconomics can all be written in this way, once they're linearized. Take, for instance, the representative agent New Keynesian (RANK) model (Galí, 2015, ch. 3), which we augment with government spending:

$$\begin{aligned} \text{NK Phillips curve:} \quad & \pi_t = \beta E_t \pi_{t+1} + \kappa \hat{y}_t + \psi a_t \\ \text{dynamic IS:} \quad & \hat{y}_t = -\frac{1}{\sigma}\left(\hat{\imath}_t - E_t \pi_{t+1}\right) + E_t \hat{y}_{t+1} + s_g \left(\hat{g}_t - E_t \hat{g}_{t+1}\right) \\ \text{Taylor rule:} \quad & \hat{\imath}_t = \phi_\pi \pi_t + \phi_y \hat{y}_t + v_t \\ \text{government spending:} \quad & \hat{g}_t = \rho \hat{g}_{t-1} + w_t \end{aligned}$$

where π is inflation, $\hat{y}$ output, $\hat{g}$ government spending, $\hat{\imath}$ the nominal interest rate — the latter three expressed in deviation from steady state —, a, v and w are technology, monetary and fiscal shocks. Putting π and $\hat{y}$ in $\mathbf{x}$, $\hat{\imath}$ and $\hat{g}$ in $\mathbf{z}$, a in ε, and v and w in ν, one can write this model in the prescribed format.

The rows of the matrices of equation (2), the non-policy block, would feature the Phillips curve and IS equations expressed from time $t = 0$ to infinity, while those of equation (3), the policy block, would have the Taylor and spending rules.

Assume now that we are interested in the effect of a structural shock path ε under some counterfactual policy rule:

$$\hat{\mathcal{A}}_x \mathbf{x} + \hat{\mathcal{A}}_{\mathbf{z}} \mathbf{z} = \mathbf{0} \tag{3'}$$

In the context of the RANK model sketched above, an example would be that we want to study the effect of a natural rate shock under a Taylor rule with different coefficients, or a strict inflation targeting policy. As in MKW, $\mathbf{x}_{\mathcal{A}}(\varepsilon)$ and $\mathbf{x}_{\hat{\mathcal{A}}}(\varepsilon)$ denote the path of the non-policy variables under the prevailing and counterfactual policy rules following shock ε, and $\mathbf{z}_{\mathcal{A}}(\varepsilon)$ and $\mathbf{z}_{\hat{\mathcal{A}}}(\varepsilon)$ denote that of policy variables $\mathbf{z}$.

MKW show that the counterfactual response of endogenous variables can be recovered from the impulse response functions under the *prevailing* policy rule:

$$\mathbf{x}_{\hat{\mathcal{A}}}(\varepsilon) = \mathbf{x}_{\mathcal{A}}(\varepsilon) + \mathbf{\Theta}_{\mathbf{x},\nu,\mathcal{A}} \times \hat{\nu} \tag{5}$$

$$\mathbf{z}_{\hat{\mathcal{A}}}(\varepsilon) = \mathbf{z}_{\mathcal{A}}(\varepsilon) + \mathbf{\Theta}_{\mathbf{z},\nu,\mathcal{A}} \times \hat{\nu} \tag{6}$$

where $\hat{\nu}$ is the unique solution of:

$$\hat{\mathcal{A}}_x \left[\mathbf{x}_{\mathcal{A}}(\varepsilon) + \mathbf{\Theta}_{\mathbf{x},\nu,\mathcal{A}} \times \hat{\nu}\right] + \hat{\mathcal{A}}_z \left[\mathbf{z}_{\mathcal{A}}(\varepsilon) + \mathbf{\Theta}_{\mathbf{z},\nu,\mathcal{A}} \times \hat{\nu}\right] = \mathbf{0} \tag{7}$$

The essence of this result is that a counterfactual policy rule has the same effect as an appropriate sequence of policy shocks that mimics said counterfactual rule.

This result, however, isn't directly implementable, as it requires knowledge of each element of the $\Theta_{x,\nu,\mathcal{A}}$ and $\Theta_{z,\nu,\mathcal{A}}$ matrices. Empirically, that means knowing the response of endogenous variables to each possible shock path! In reality, it is impossible to estimate the response of macroeconomic variables to more than a few of those. To circumvent this difficulty, MKW propose to solve:

$$\min_{\mathbf{s}} || \hat{\mathcal{A}}_x \left(\mathbf{x}_{\mathcal{A}}(\boldsymbol{\varepsilon}) + \boldsymbol{\Omega}_{\mathbf{x},\mathcal{A}} \times \mathbf{s}\right) + \hat{\mathcal{A}}_z \left(\mathbf{z}_{\mathcal{A}}(\boldsymbol{\varepsilon}) + \boldsymbol{\Omega}_{\mathbf{z},\mathcal{A}} \times \mathbf{s}\right) || \tag{8}$$

Each column of $\Omega_{x,\mathcal{A}}$ and $\Omega_{z,\mathcal{A}}$ is the empirical estimate of the IRF of $\mathbf{x}$ and $\mathbf{z}$ to a shock path. The minimization problem consists in choosing weights $\mathbf{s}$ to implement the counterfactual policy rule as well as possible. Note that solving equation (8) does not requirezs)pecifying the full model, only knowledge of the IRF to the structural shocks ($\mathbf{x}_{\mathcal{A}}(\boldsymbol{\varepsilon})$, $\mathbf{z}_{\mathcal{A}}(\boldsymbol{\varepsilon})$) and to a few policy shock paths ($\Omega_{x,\mathcal{A}}$, $\Omega_{z,\mathcal{A}}$).

Summary: the MKW method answers policy counterfactual questions based on time series regressions. It requires only minimal structural assumptions that embed most standard macroeconomic models. It is immune to the Lucas (1976) critique, as economic agents' expectation regarding a future policy change is already reflected in the impulse responses to a policy shock path.

4.2 Application to Fiscal-Monetary Interactions

We are interested in the effect of a monetary shock conditional on various fiscal rules. Note that this is not exactly what the method described above was originally meant to do: MKW are concerned with the effect of a structural shock depending on policy rules; we are concerned with the effect of a shock to a policy instrument (the Federal Funds Rate target) depending on rules for other policy instruments (government spending, taxes, and transfers). It is, however, straightforward to extend the framework to the latter case: one can always write the monetary rule in the non-policy block. The monetary shock then plays the role of the structural shock and the instruments are the typical fiscal instruments of a macroeconomic model: government spending, taxes, and transfers.

How does our approach relate to the theoretical literature on fiscal-monetary interactions? First, we are agnostic about whether monetary and fiscal policies are passive or active (Leeper, 1991). Similarly, the economy could be described by a fiscal theory of the price level as much as by a more conventional New Keynesian framework.[6] On the other hand, we assume that there are no regime switches throughout the sample: the monetary rule must remain constant since we place it in the non-policy block.[7] Thus, we do not nest the models of Bianchi (2013) or Bianchi and Ilut (2017). We do nest, however, the latest generation of models of monetary-fiscal interactions, which feature "shock-specific" rules. This new class of models was recently introduced by Bianchi et al. (2023): they propose a framework where the central bank accommodates unfunded transfer shocks with inflation (Fiscally-led rule), while it does not accommodate other fiscal policy shocks by actively responding to inflation (Monetary-led rule), so that "Monetary-led and Fiscally-led rules coexist in [the] model, and the policy coordination is shock-specific" (p. 5). We formally show in appendix A.4 that our approach can be mapped into this framework.

4.3 Implementation

4.3.1 Fiscal Shocks

We use a variety of fiscal policy shocks. The MKW procedure ideally demands an infinity of those. To approach that ideal, we have extensively surveyed the literature starting from Valerie Ramey's handbook chapter on "Macroeconomic Shocks and Their Propagation" (Ramey, 2016).

Most fiscal shocks fall under two umbrellas: narrative approach and structural identification. The narrative approach relies on a reading of the historical record: the researcher reads official documents to identify the rationale for policy changes. If this rationale is exogenous to the state of the economy, the change is retained as a valid policy shock, rejected otherwise. While there exists many variations, every series of narrative shock stems from a seminal paper: Ramey (2011) for spending, Romer and Romer (2010) for taxes,

[6] See, for example, the model of Cochrane (2023, chapter 5). The non-policy block is equations (A1.51, A1.52, A1.54, A1.56), the policy block equations (A1.53, A1.55, A1.57).

[7] Changes in the fiscal rules over time would be easily handled since they are in the policy block (McKay and Wolf, 2023, appendix A.4).

and Romer and Romer (2016) for transfers. Structural identification relies on a structural vector auto-regression (SVAR). In the simplest case, researchers identify the fiscal shock with a Cholesky decomposition: they regress the fiscal variable on past values of several macroeconomic variables and assume that the residual doesn't respond contemporaneously to those variables. Therefore, said residual is a valid shock to infer the effect of fiscal policy. While the assumption that spending doesn't respond contemporaneously to GDP is plausible, it is clearly dubious for taxes: at given marginal tax rates, tax receipts should be positively correlated with GDP. Hence, more elaborate versions of this scheme control for the contemporaneous response of taxes to macroeconomic variables: this approach was pioneered by Blanchard and Perotti (2002) and perfected by Caldara and Kamps (2017).

For each fiscal instrument, we have at least one narrative and one structural shock series (table 1). We make a quick list here and describe their construction in detail in appendix A.6. We always take the narrative shocks from the reference papers cited above. The spending shocks are Ramey's original series. We use the Romer-Romer legislated tax changes motivated by long-run growth.[8] For transfers, Romer and Romer distinguish long-run from temporary changes in Social Security benefits. We only use the long run changes since temporary changes have no distinguishable effect in quarterly data. For structurally identified shocks, we use the Cholesky identification for spending and the Caldara-Kamps identification for taxes and transfers.[9] Finally, we use one series that does not neatly fall in those two categories: the spending shocks of Ben Zeev and Pappa (2017). They are identified by finding the shock that best explains the next five years of defense spending while being orthogonal to current defense spending.

[8]See section 3.2.2 in the main text for details on their methodology. See also section A.6.3 in the appendix for why we use these shocks instead of later variations introduced by Mertens and Ravn (2012, 2013).

[9]In the baseline, we use a version of Caldara and Kamps's full fiscal rule which controls for the contemporaneous response of fiscal variables to our 3 macroeconomic variables (GDP, inflation, and the interest rate). In appendix A.2, we also show some results for the simple fiscal rule, which only allows for a contemporaneous response to GDP. See appendix A.6 for more details on the Caldara-Kamps methodology.

Table 1: Fiscal shocks

Identification	Description	Source
	Spending	
Narrative	Future changes in military spending constructed by reading the specialized press	Ramey (2011)
Medium-run constraint	Shock that best explains future movements in defense spending while being orthogonal to current defense spending	Ben Zeev and Pappa (2017)
Cholesky	Cholesky identification with spending ordered first	Blanchard and Perotti (2002)
	Taxes	
Narrative	Legislated tax changes motivated by long-run growth	Romer and Romer (2010)
Proxy	Reduced form shock for taxes purged from contemporaneous response to non-fiscal variables (GDP, inflation, nominal interest rate)	Caldara and Kamps (2017)
	Transfers	
Narrative	Long-run transfer legislated changes	Romer and Romer (2016)
Proxy	Reduced form shock for transfers purged from contemporaneous response to non-fiscal variables (GDP, inflation, nominal interest rate)	Our computation based on methodology of Caldara and Kamps (2017)

Note: see appendix A.6 for more details on the construction of these shocks.

4.3.2 Specification

For each of the three fiscal instruments, we follow the procedure described in section 2: we estimate a VAR with the non-structural shocks corresponding to the fiscal instrument ordered first, the 5 fiscal variables, and the 3 macroeconomic variables.

To be internally consistent, we always re-estimate the structural shock within our VAR. For instance, Blanchard and Perotti (2002) identify spending shocks by running a VAR with spending, taxes, and GDP and running a Cholesky decomposition with spending ordered first. So, the identification assumption is that spending doesn't respond contemporaneously to other variables. Since we have more variables in our VAR, we adapt this scheme by ordering spending after the narrative shock, but before the other endogenous variables. Thus, our structural shock is not exactly the same as that of Blanchard and Perotti, even though it is identified in the same spirit.

Notice that estimating impulse response functions jointly can affect the response to the shocks: this is not a problem. Consider, for example, our spending shocks. The Ramey shocks and Ben Zeev-Pappa shocks are ordered first and second. Even though they're constructed in a different way, those shocks both capture future changes in defense spending. As a result, they are highly correlated over the sample (0.58). Unsurprisingly, if one estimates their effect separately, they imply similar responses of government spending, GDP, and other macroeconomic variables (Ramey, 2016, figure 5). In our framework, however, the responses are estimated jointly. The response to a Ben Zeev-Pappa shock is identified through a Cholesky decomposition. Since this shock is ordered second, said response controls for contemporaneous and past values of the Ramey shock. So, our procedure takes out all of the variation captured by the Ramey shock. As a result, the response to a Ben Zeev-Pappa shock that we estimate is not the usual one: as we shall see, spending only increases after 2 years, but that increase is more durable (figure A.3). This feature is desirable: the MKW methodology requires several shocks that move the fiscal instrument over different horizons. Being ordered after the Ramey shock, the BZP one becomes a shock to the long end of defense government spending, controlling for medium-run news. It is useful in the counterfactual as we have one shock that moves spending in the medium run (1–2 years) and one that moves the long run (2–5 years). Finally, the Blanchard-Perotti shock, since it relies on contemporaneous innovations in spending, moves the short run (0–2 years).

5 Counter-Factual: Results

5.1 Response to Fiscal Shocks

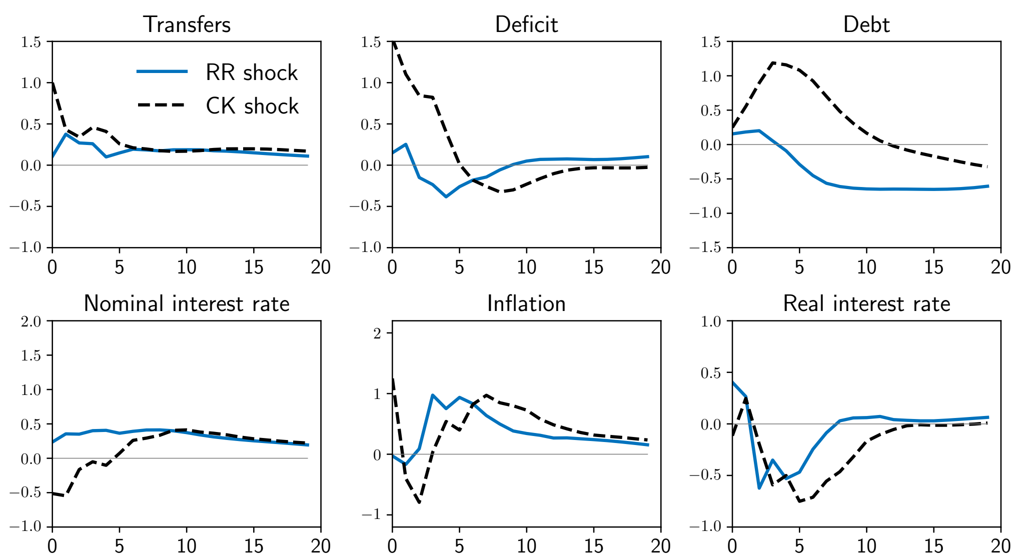
The response of macroeconomic variables to fiscal shocks is not our main focus, so we relegate those to the appendix, figures A.2–A.8. We only comment here on the sometimes counter-intuitive effects of those shocks on deficit and debt.

Spending tends to increase deficit and debt, but the short run effect can be different (figures A.2–A.4). For instance, the Ramey shocks only increase spending after a few quarters, but increase GDP immediately. Ramey argues that this reflects anticipation effects. The implication is that the deficit falls on impact as tax receipts endogenously rise. Moreover, inflation increases, which cuts the real value of debt. As a result, the immediate effect of a Ramey spending hike is to lower the deficit and cut real debt. The Blanchard-Perrotti shocks, since they are more front-loaded, imply more intuitive patterns of deficit and debt.

Tax increases lower the deficit in the short run, but the effect dissipates quickly, perhaps because of a strong Laffer curve effect (figures A.5–A.6). Moreover, tax increases tend to lower inflation, thus raising the real value of debt. On balance, the first effect (short-lived deficit versus increase in the real value of debt) dominates, so that the effect on debt is negative!

Transfer shocks have radical implications (figures 3 and A.7–A.8). Increases in transfers powerfully stimulate GDP, so that tax receipts increase enough to mute or even reverse the effect on the deficit. Besides, they're so inflationary that the real value of debt is lower after 5 years. Those results echo two recent theoretical contributions. Angeletos et al. (2023) show that self-financed increases in transfers are possible in theory. Our results prove that this mechanism is credible empirically. In fact, the point estimates suggest that, not only are transfer hikes self-financed, they leave the government with less debt![10] One reason reality may overcome theory might be that the real interest rate falls on impact. In their model, the central bank is neither accommodating nor fighting the transfer shock. In our sample, it seems to have been accommodating it. As we explained in section 4.3, Bianchi et al. (2023) propose a model with unfunded transfer shocks—shocks to which the central bank responds by allowing inflation to rise. Estimating their model, they argue that unfunded shocks are prevalent in post-WWII data. We show that this mechanism is plausible in a purely empirical framework.

Figure 3: Response of selected variables to transfer shocks



Note: selected results from the VAR with transfer shocks (figures A.7–A.8). This VAR includes the RR transfer shock, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month nominal interest rate.

We emphasize these features because they have received surprisingly little

[10] We investigated the robustness of this result to adding another year of lags in the VAR, using Caldara and Kamps's simple fiscal rule, or putting taxes in front of transfers to identify the CK shock. See figure A.9. We cannot always reject 0, but the point estimate is always negative.

attention in the empirical literature. The papers that proposed these fiscal shocks tend to focus on their macroeconomic consequences, often neglecting their fiscal effects. Exceptions are Mertens and Ravn (2013), who found a muted effect of tax changes on deficit and debt, and Ramey (2016), who noted that narrative tax changes are a weak instrument for tax receipts.

5.2 Counter-Factual Policy: Debt Stabilization

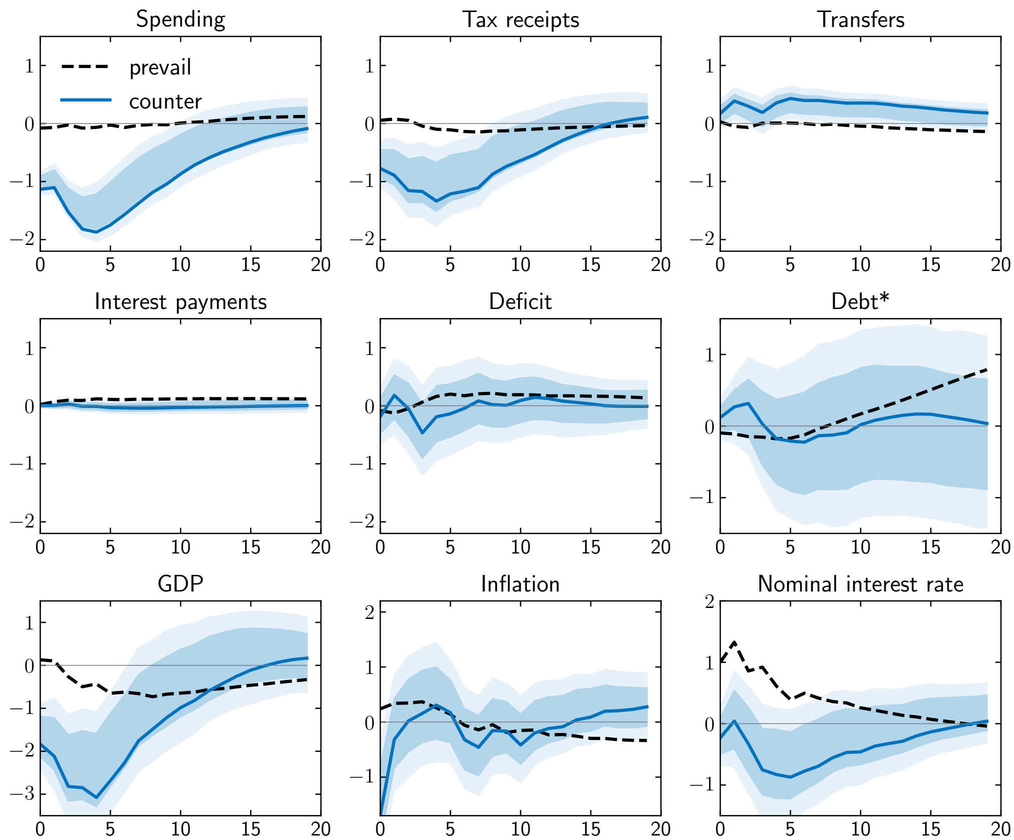
We study the counterfactual response of the economy to a monetary shock, assuming that the federal government stabilizes real debt by changing one of its instruments: spending, taxes, or transfers.

We show the first scenario, a spending cut, in figure 4. The government sharply curtails spending. This spending cut, however, is partly self-defeating: it lowers GDP, which lowers tax receipts, which raises the deficit. So, the government must cut spending more than one-for-one to obtain the desired stabilization. (Since our fiscal variables are expressed as a fraction of trend GDP, the magnitudes on the y-axis can be directly compared across variables.) As a result, this scenario implies a much more pronounced fall in output than the prevailing rule, as well as more deflation in the short run. The nominal interest rate does not even rise anymore: in spite of the contractionary monetary shock, the central bank responds to the fiscal contraction by lowering its nominal interest rate. This helps with debt stabilization as interest payments stay constant.

The second scenario, a tax hike, delivers a similar message (figure 5). The government raises tax rates to run down the deficit and stabilize debt. GDP and inflation fall. This fall is less brutal, but more protracted than with spending.

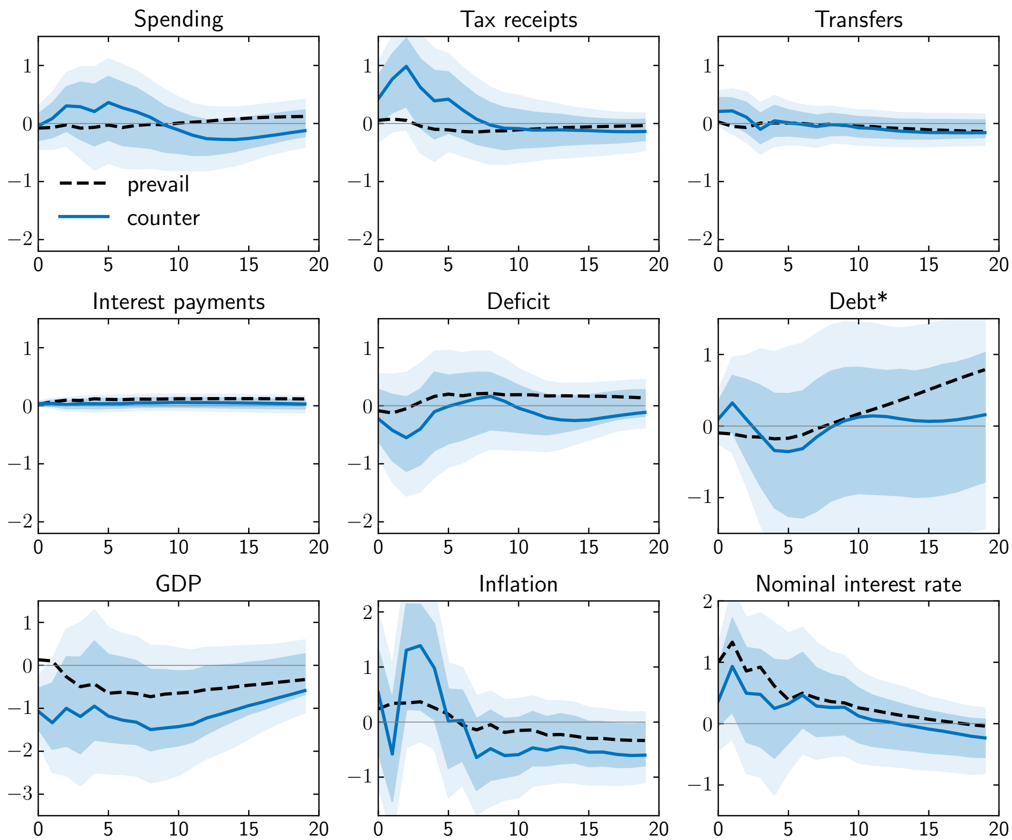
The third scenario, a change in transfers, delivers a surprising insight: the government can stabilize debt with a transfer hike (figure 6)! Transfers increase the deficit, but that effect is dampened by the increase in GDP, which stimulates tax receipts. Moreover, the transfers are very inflationary and they inflate away the debt. Monetary policy is less contractionary than under the

Figure 4: Counter-factual—debt stabilization with spending



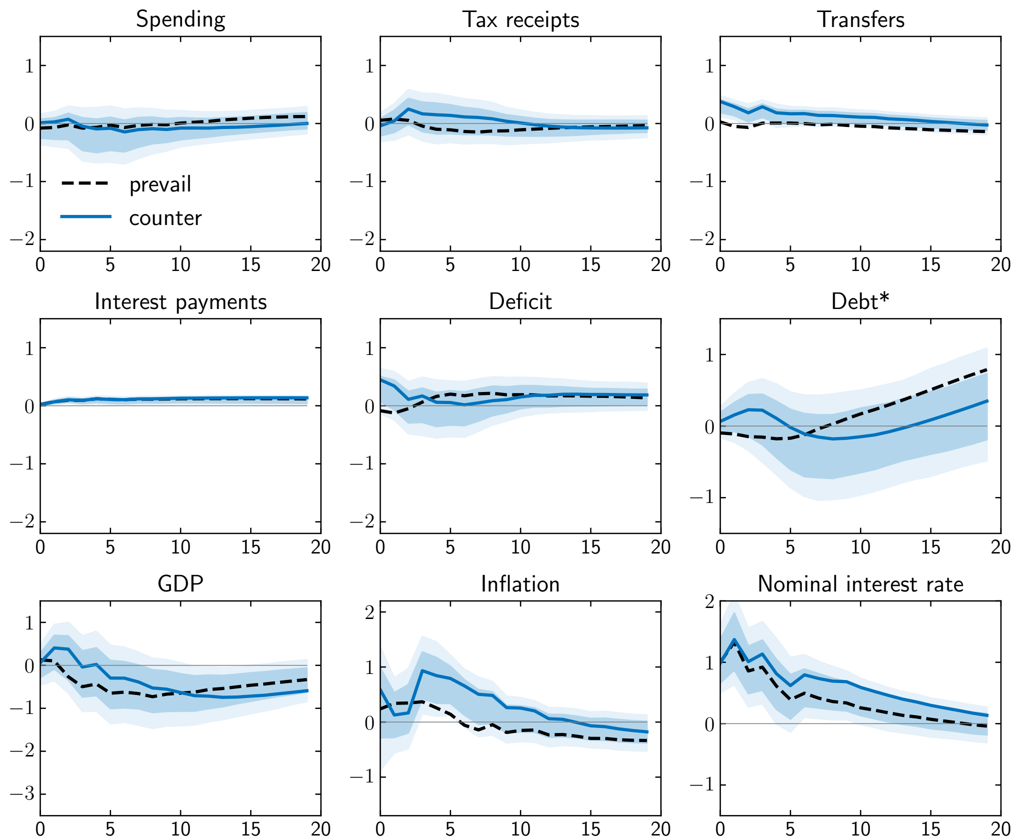
Note: counter-factual response of the economy to a monetary shock if the government stabilizes debt through spending. The broken black line is actual response under the prevailing rule. The blue line and shaded areas are the counter-factual scenario and its 68% (dark) and 90% (light) confidence intervals. The starred variable is the variable that the government tries to stabilize. This counter-factual is constructed with the method of MKW (section 4.1).

Figure 5: Counter-factual—debt stabilization with taxes



Note: counter-factual response of the economy to a monetary shock if the government stabilizes debt through taxes. The broken black line is actual response under the prevailing rule. The blue line and shaded areas are the counter-factual scenario and its 68% (dark) and 90% (light) confidence intervals. The starred variable is the variable that the government tries to stabilize. This counter-factual is constructed with the method of MKW (section 4.1).

Figure 6: Counter-factual—debt stabilization with transfers



Note: counter-factual response of the economy to a monetary shock if the government stabilizes debt through transfers. The broken black line is actual response under the prevailing rule. The blue line and shaded areas are the counter-factual scenario and its 68% (dark) and 90% (light) confidence intervals. The starred variable is the variable that the government tries to stabilize. This counter-factual is constructed with the method of MKW (section 4.1).

prevailing rule.

In the appendix, we look at a different counterfactual rule: deficit stabilization (figures A.16–A.18). The main message is similar for spending and taxes. Stabilizing the deficit with spending requires a significant contraction in output. The effect is more muted if the government uses taxes, but debt is mostly unchanged because of the deflationary effect of tax hikes. We fail to really change the deficit when it comes to transfers. Indeed, our transfer shocks mostly change the deficit in the short run, while the monetary shock raises it in the medium run. This illustrates a limitation of the MKW method: with only two shocks, the counterfactual scenario is not perfectly enforced. This limitation is particularly pronounced when one tries to stabilize a flow instead of a stock. Our debt counterfactual fares better because, in each period, we use the whole cumulative path of past values of deficit and inflation.

5.3 Summary and Takeaway for HANK Models

We summarize our results in table 2 by computing the average response of the main variables over the first 3 years that follow the monetary shock.[11] In reality, GDP falls by 0.46% compared to trend for a shock that increases the real interest rate by 56 basis points. This implies an elasticity of $0.46/0.56 = 0.82$.[12] It may seem surprising that the average response of inflation is positive and insignificant: this result is due to the initial (insignificant) increase in inflation apparent on figure 1. Inflation only starts falling after a year. This is a well-known implication of the Romer-Romer shocks: the price level takes a long time to start falling. If we focus on the second and third years that follow the shock, the average response of inflation is negative (-10 basis points).

As expected from section 5.3, GDP falls more if spending or taxes stabilize debt, less if transfers do. The response of GDP is 4 times larger with spending, 2.5 times with taxes. With transfers, the response is less pronounced: GDP falls by 0.21% compared to trend on average. In the latter case, we should

[11] In tables A.1–A.3, we compute these averages for 1, 2, and 4 years after the shock.

[12] Using a VAR and the original version of the Romer-Romer shocks, Nakamura and Steinsson (2018, table A.1) report an elasticity of 0.7.

Table 2: Monetary policy and fiscal response—3-year average

		Counterfactual		
	Actual	Spending	Taxes	Transfers
	(1)	(2)	(3)	(4)
GDP	-0.46	-1.99	-1.26	-0.21
	(0.20)	(0.62)	(0.72)	(0.37)
	[-0.57,-0.18]	[-2.04,-0.84]	[-1.63,-0.19]	[-0.69,0.06]
Inflation	0.08	-0.26	0.07	0.48
	(0.09)	(0.28)	(0.33)	(0.16)
	[-0.05,0.12]	[-0.44,0.11]	[-0.26,0.39]	[0.18,0.50]
Nominal interest rate	0.60	-0.52	0.36	0.83
	(0.15)	(0.39)	(0.49)	(0.26)
	[0.27,0.55]	[-0.76,0.02]	[-0.08,0.86]	[0.41,0.92]
Real interest rate	0.56	-0.40	0.37	0.39
	(0.14)	(0.37)	(0.49)	(0.25)
	[0.28,0.55]	[-0.67,0.05]	[-0.10,0.85]	[0.11,0.59]

Note: average response over the first 3 years to a Romer-Romer monetary shock, depending on the fiscal response. Column (1) is the actual response described in section 3. Columns (2–4) are the counterfactual responses under the three scenarios described in section 5.3: debt stabilization through spending, taxes, or transfers. They respectively correspond to figures 4, 5, and 6. The number in parenthesis is the standard error. The numbers between brackets are the bounds of the 68% confidence interval.

acknowledge that the confidence intervals overlap. Still, in light of our results, it seems plausible that transfers can stabilize debt at no cost in terms of GDP. This statement doesn't imply that the outcome is achieved at no cost. The second row of the table makes clear how transfers pay for themselves: inflation. We do not make any welfare statement here. Yet, the response of inflation to the transfer policy is a reminder that stabilizing debt and GDP is not necessarily optimal.

Are these results consistent with HANK models? Matching the many impulse response functions that we have estimated in a quantitative heterogeneous-agent model is beyond the scope of this paper. Yet, we can venture an informal comparison with two important models of that literature: Kaplan et al. (2018, table 8) and Auclert et al. (2020, figure 7). Interestingly, both models imply that letting debt adjust—what we call reality—is less destabilizing than using taxes, which is itself less destabilizing than using spending. This qualitative ranking is consistent with our estimates.[13] On the other hand, neither model predicts that transfers stabilize output compared to debt adjustment. This shouldn't come as a surprise: in both models, the government borrows in real debt, which kills the Fisherian channel of transfers. This channel is key to our counterfactual results.

6 Conclusion

In this paper, we estimate the response of fiscal policy to monetary shocks and the response of the economy under counterfactual rules for fiscal policy. In reality, fiscal policy mostly relies on debt to deal with the fiscal consequences of a monetary policy action. This strategy dampens the effect of monetary policy on output compared to debt stabilization through spending or taxes, but it amplifies it compared to debt stabilization through transfers.

[13]The model of Kaplan et al. has no macroeconomic persistence or long-term debt, so any quantitative comparison would be heroic. The model of Auclert et al. achieves persistence through sticky expectations and long-term debt; moreover, it is estimated out of an impulse response function to a Romer-Romer monetary shock. Auclert et al. do not report the average response of output, but eyeballing figure 7 suggests that the response of output if spending (resp. taxes) is used to clear the budget constraint is twice (resp. 1.5 times) larger than if debt adjusts. These ratios would be smaller than we estimate, but potentially within the confidence interval (table 2).

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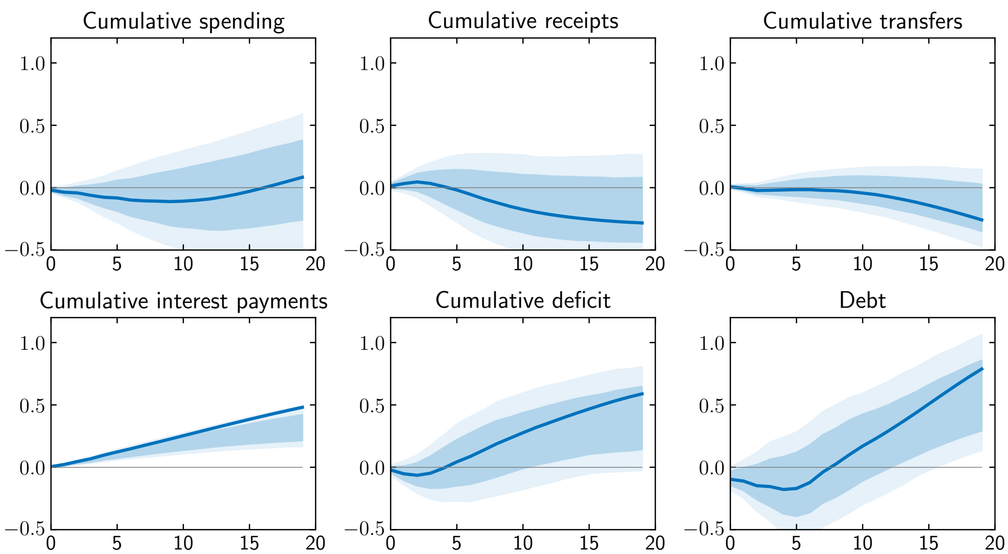
ONLINE APPENDIX

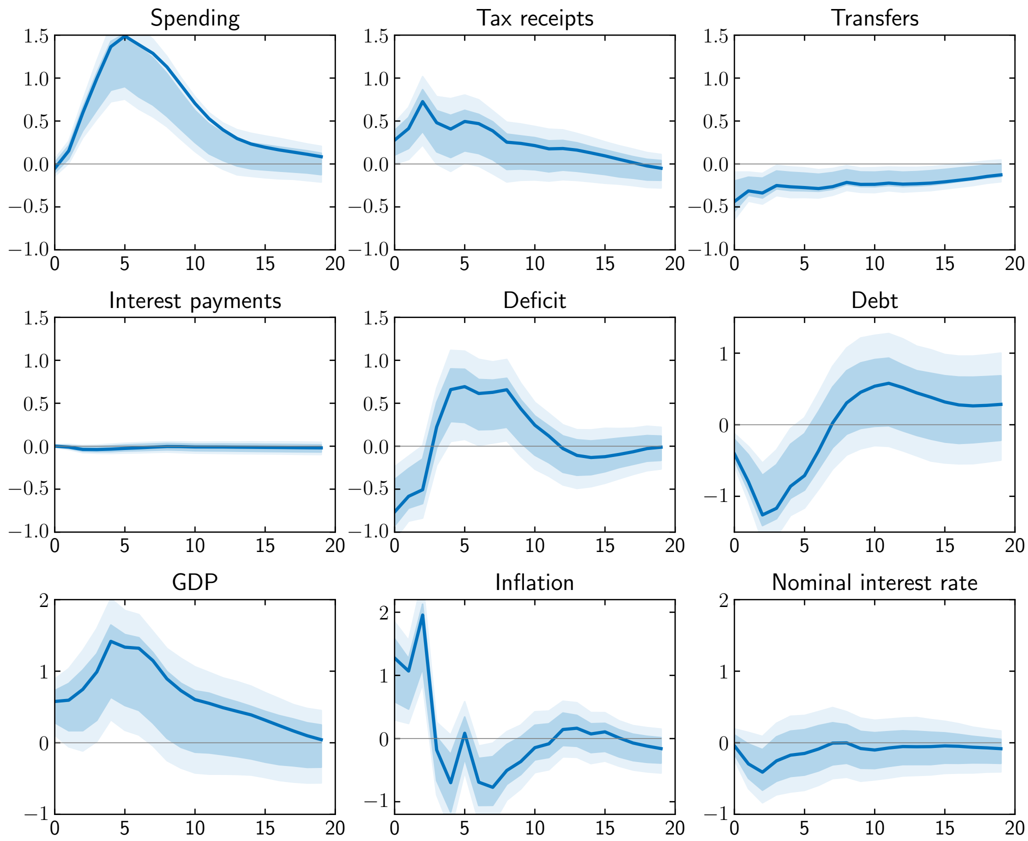
A.1 Additional Figures

Figure A.1: Decomposition of response of deficit to Romer-Romer monetary shock



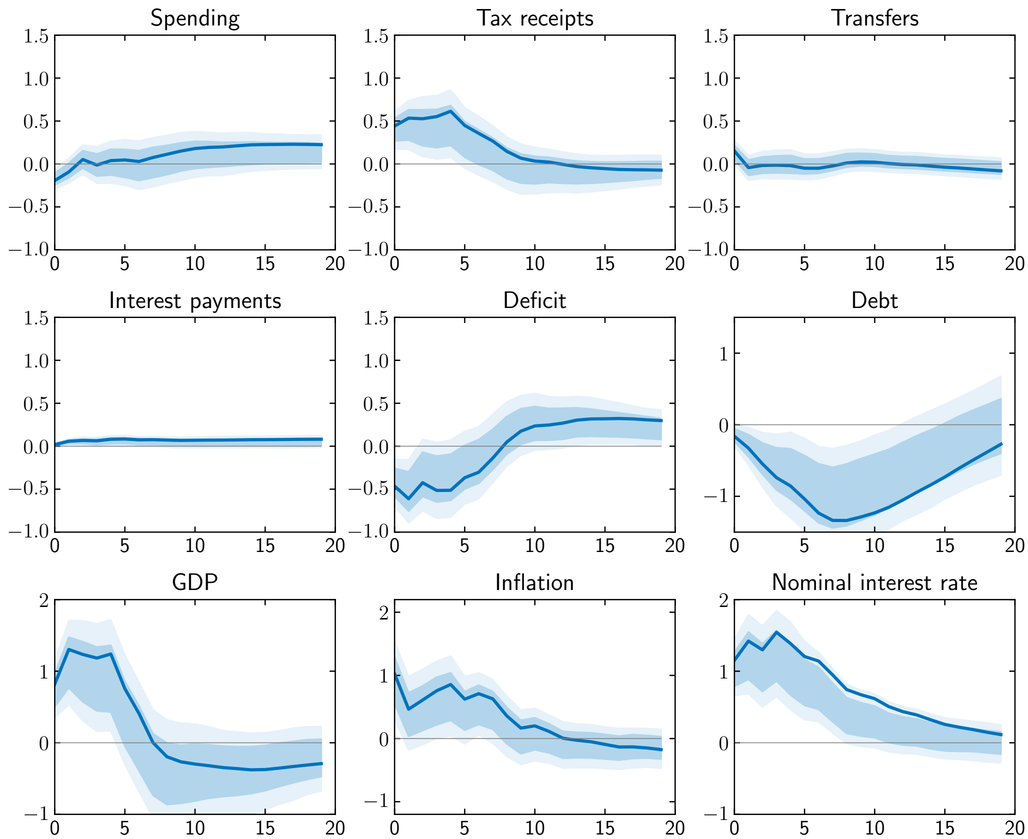
Note: additional result from the baseline VAR (figure 1). This VAR includes the monetary shock, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month interest rate. The last chart is the response of debt as it features in the VAR—it is the same as the debt chart of figure 1. The other charts are the cumulative responses of spending, tax receipts, transfers, interest payments, and the deficit. The first four responses exactly sum to the fifth. These cumulative responses are deduced from equation (A.3), using the coefficients of column (1) of table A.5. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002). See section A.3 for more details.

Figure A.2: Response to Ramey spending shock



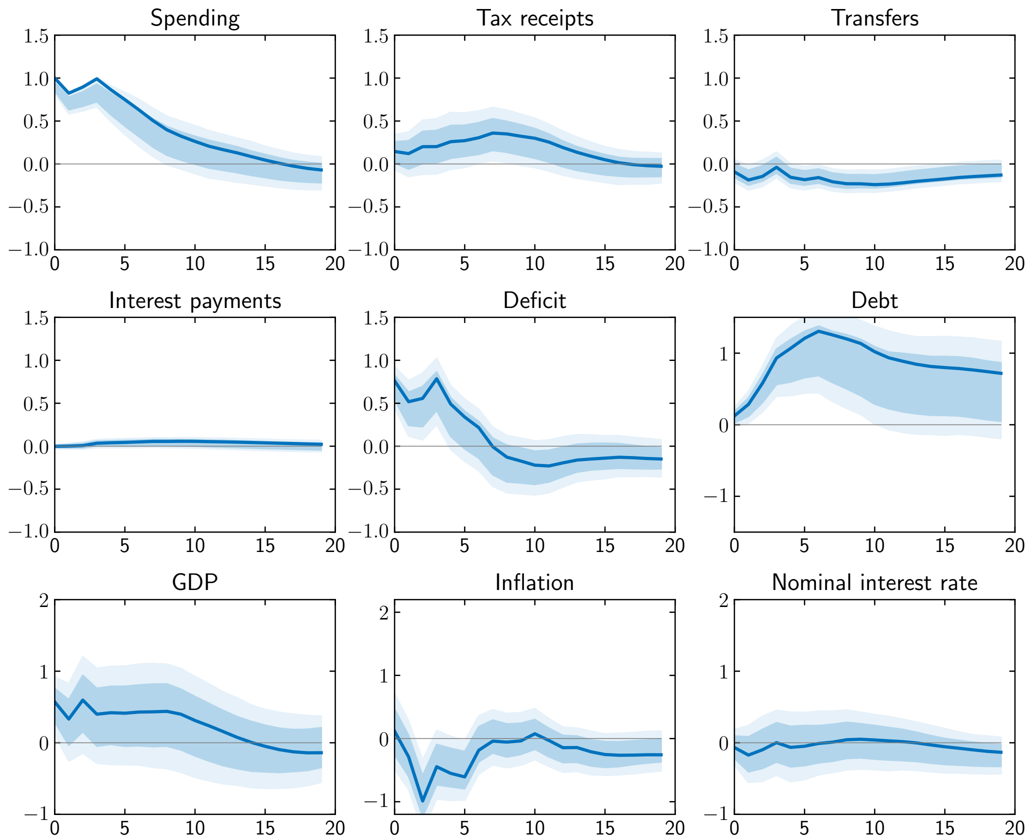
Note: VAR includes narrative shocks, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month nominal interest rate. The response of deficit is computed from that of the fiscal variables. The IRFs are scaled such that the point estimate of the response of spending to the Blanchard-Perroti shock is 1 at time 0. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002). See sections 2 and 4.3 for more details on the methodology.

Figure A.3: Response to Ben Zeev-Pappa spending shock



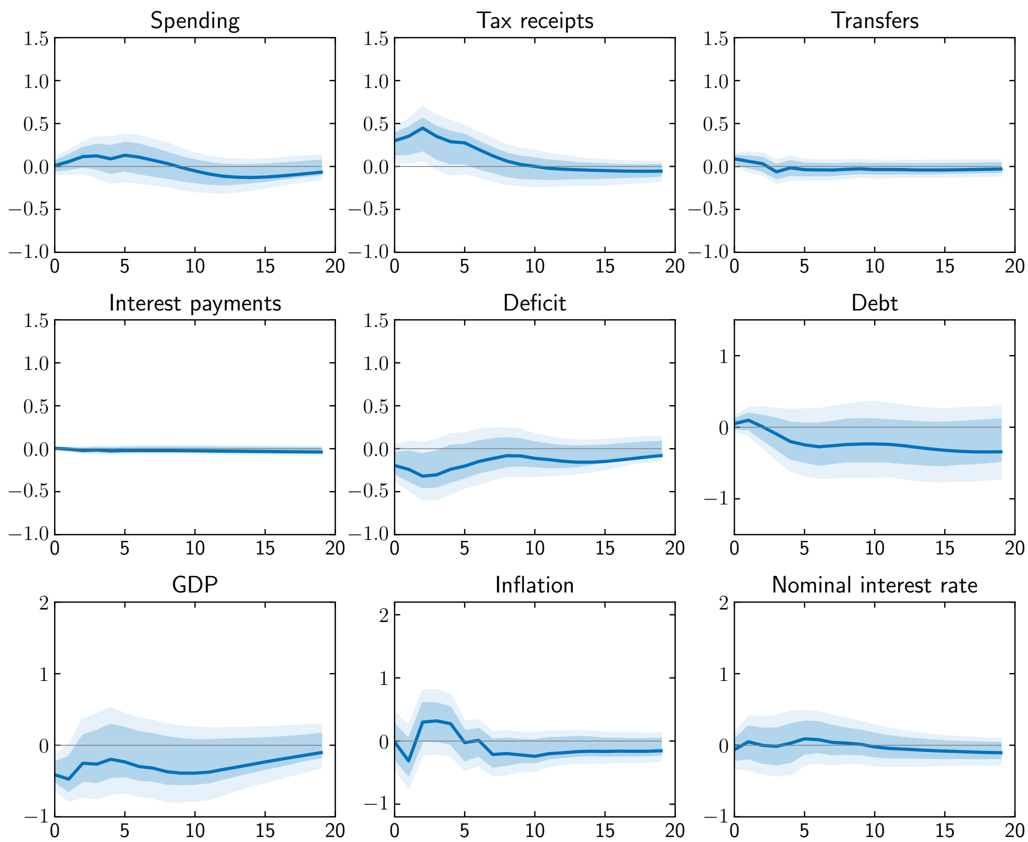
Note: VAR includes narrative shocks, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month nominal interest rate. The response of deficit is computed from that of the fiscal variables. The IRFs are scaled such that the point estimate of the response of spending to the Blanchard-Perroti shock is 1 at time 0. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002). See sections 2 and 4.3 for more details on the methodology.

Figure A.4: Response to Blanchard-Perotti spending shock



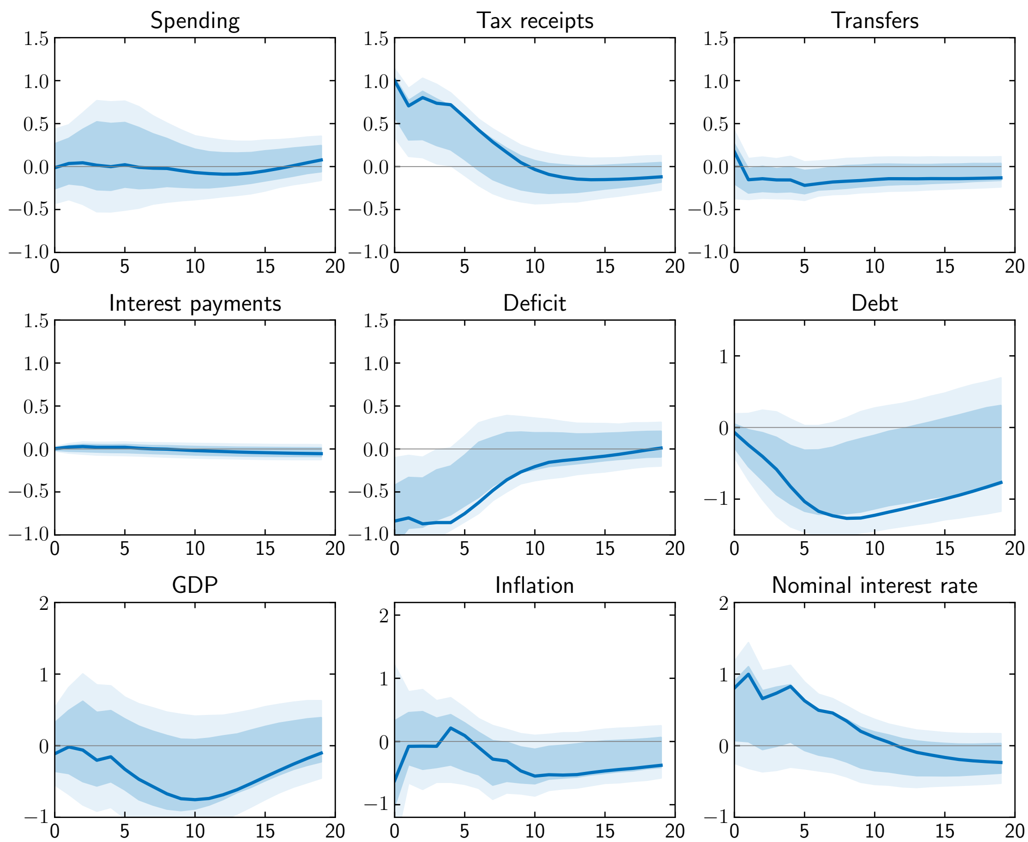
Note: VAR includes narrative shocks, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month nominal interest rate. The response of deficit is computed from that of the fiscal variables. The IRFs are scaled such that the point estimate of the response of spending to the Blanchard-Perroti shock is 1 at time 0. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002). See sections 2 and 4.3 for more details on the methodology.

Figure A.5: Response to Romer-Romer tax shock



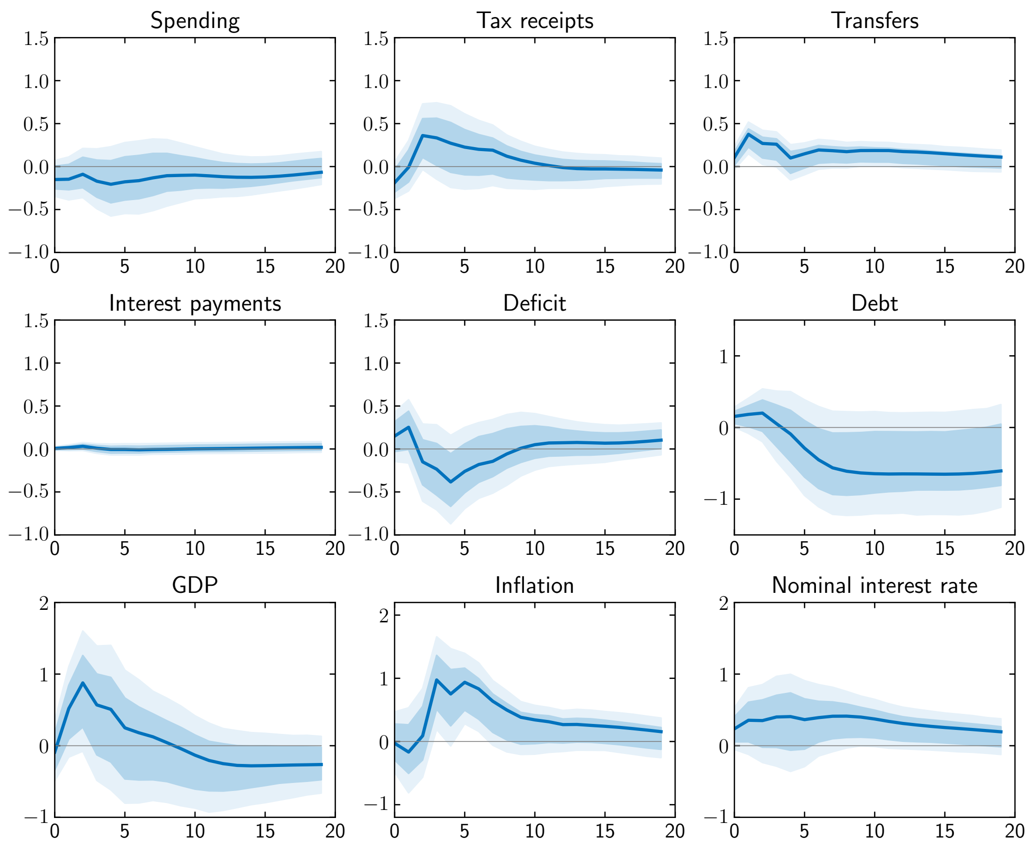
Note: VAR includes narrative shocks, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month nominal interest rate. The response of deficit is computed from that of the fiscal variables. The IRFs are scaled such that the point estimate of the response of taxes to the Caldara-Kamps shock is 1 at time 0. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002). See sections 2 and 4.3 for more details on the methodology.

Figure A.6: Response to Caldara-Kamps tax shock



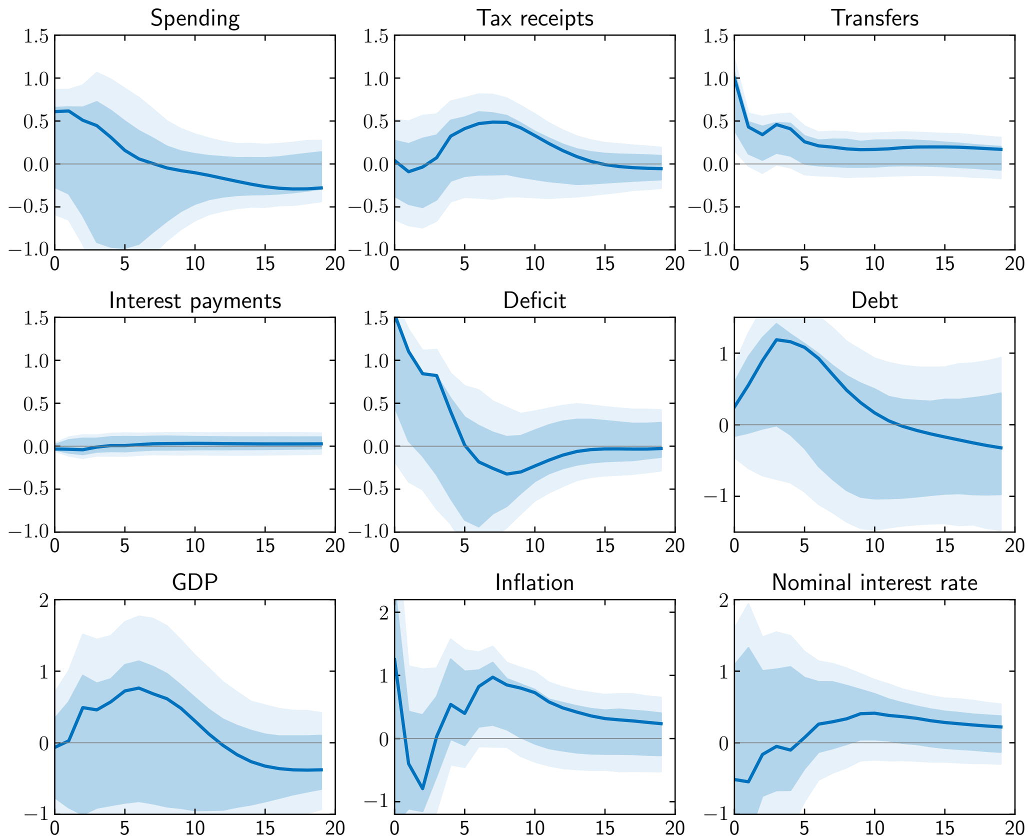
Note: VAR includes narrative shocks, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month nominal interest rate. The response of deficit is computed from that of the fiscal variables. The IRFs are scaled such that the point estimate of the response of taxes to the Caldara-Kamps shock is 1 at time 0. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002). See sections 2 and 4.3 for more details on the methodology.

Figure A.7: Response to Romer-Romer transfer shock



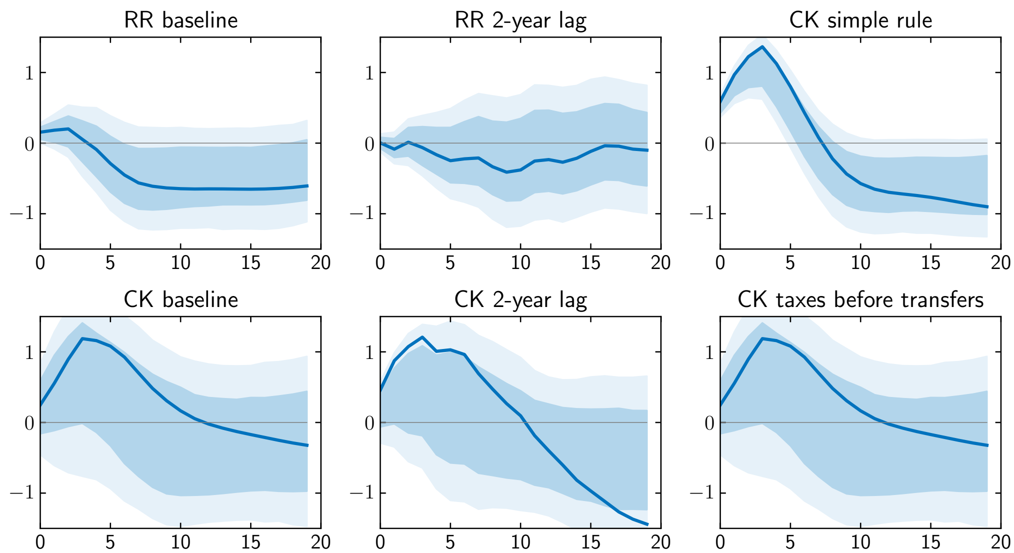
Note: VAR includes narrative shocks, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month nominal interest rate. The response of deficit is computed from that of the fiscal variables. The IRFs are scaled such that the point estimate of the response of transfers to the Caldara-Kamps shock is 1 at time 0. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002). See sections 2 and 4.3 for more details on the methodology.

Figure A.8: Response to Caldara-Kamps transfer shock



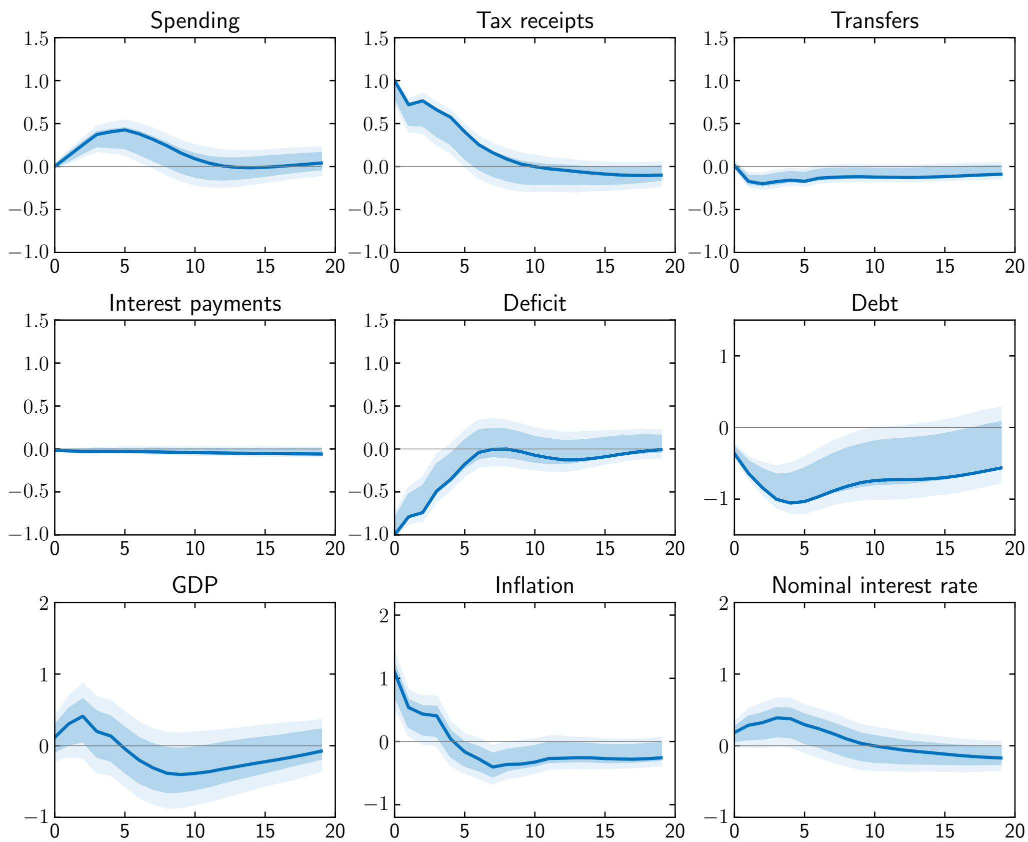
Note: VAR includes narrative shocks, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month nominal interest rate. The response of deficit is computed from that of the fiscal variables. The IRFs are scaled such that the point estimate of the response of transfers to the Caldara-Kamps shock is 1 at time 0. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002). See sections 2 and 4.3 for more details on the methodology.

Figure A.9: Debt response to transfer shocks in various specifications



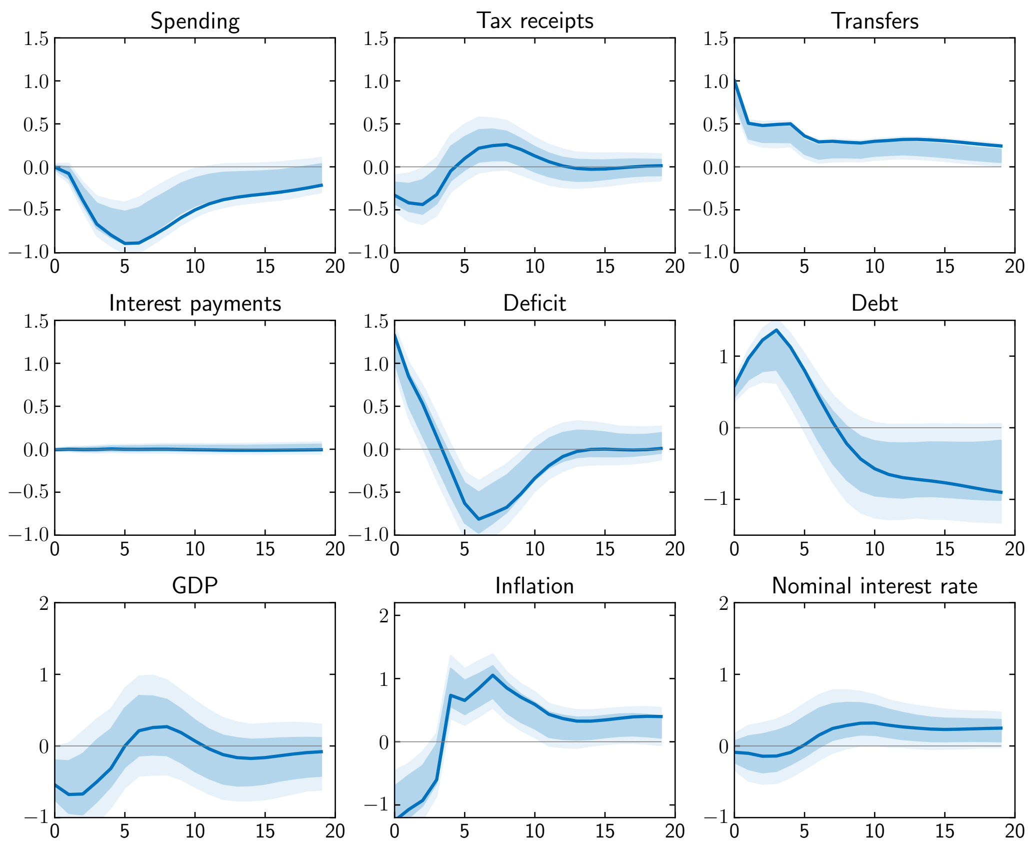
Note: response of real debt in various specifications. "RR baseline" and "CK baseline" correspond to the Romer-Romer and Caldara-Kamps transfer shocks. They are the same as the response of debt in figures A.7 and A.8. In the second column, we include 2 years of lags in the VAR (instead of 1). In the third column, we use Caldara and Kamps's simple fiscal rule and order taxes before transfers—the RR response is the same as in the baseline. See appendix A.6 for details on the Caldara-Kamps identification.

Figure A.10: Response to Caldara-Kamps tax shock with simple fiscal rule



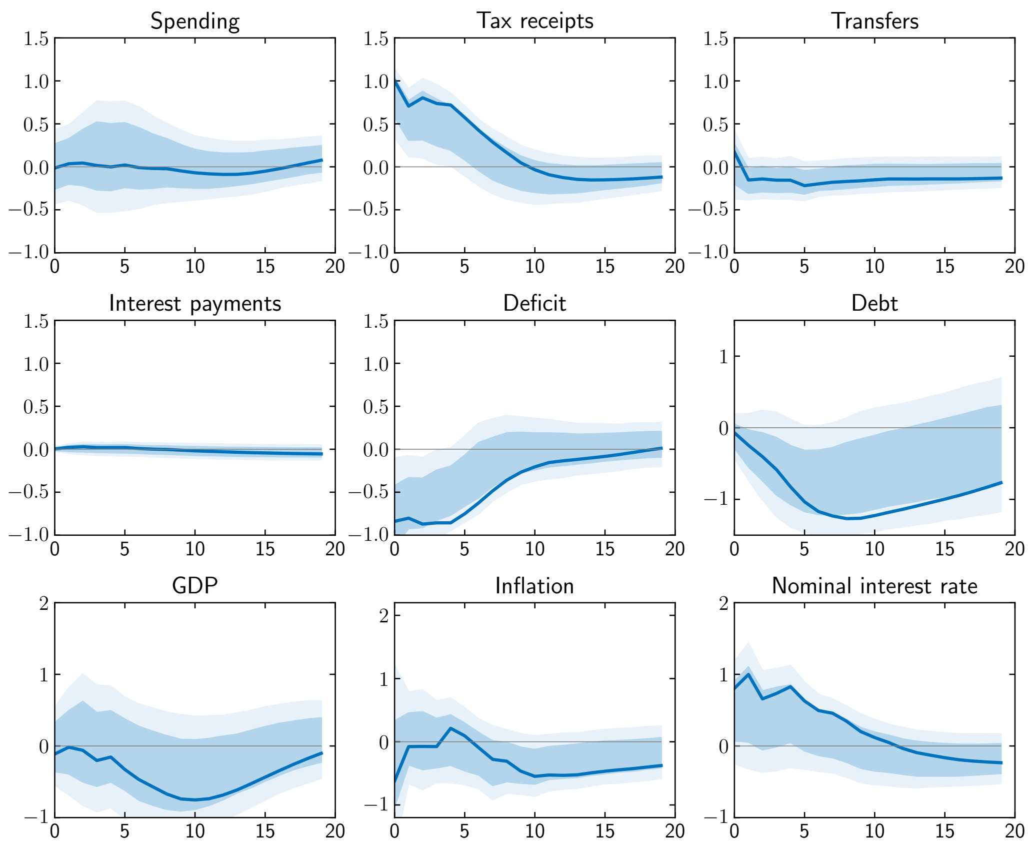
Note: VAR includes narrative shocks, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month nominal interest rate. The response of deficit is computed from that of the fiscal variables. The IRFs are scaled such that the point estimate of the response of taxes to the Caldara-Kamps shock is 1 at time 0. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002). See sections 2 and 4.3 for more details on the methodology.

Figure A.11: Response to Caldara-Kamps transfer shock with simple fiscal rule



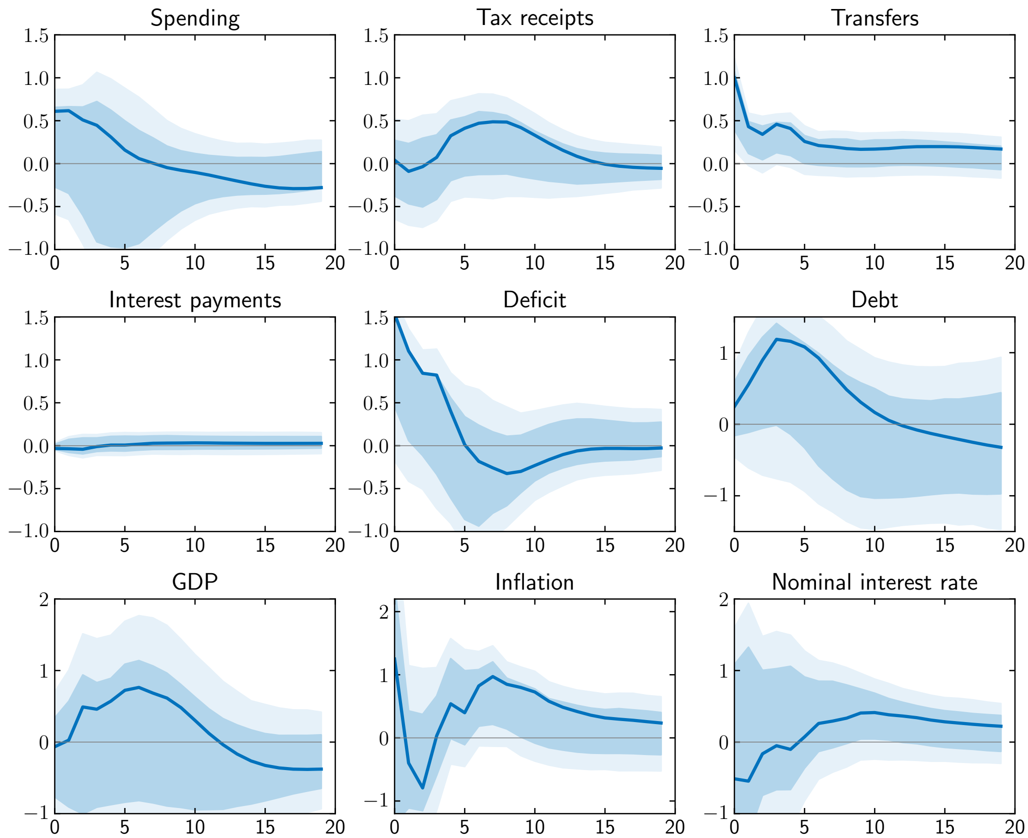
Note: VAR includes narrative shocks, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month nominal interest rate. The response of deficit is computed from that of the fiscal variables. The IRFs are scaled such that the point estimate of the response of taxes to the Caldara-Kamps shock is 1 at time 0. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002). See sections 2 and 4.3 for more details on the methodology.

Figure A.12: Response to Caldara-Kamps tax shock with taxes ordered before transfers



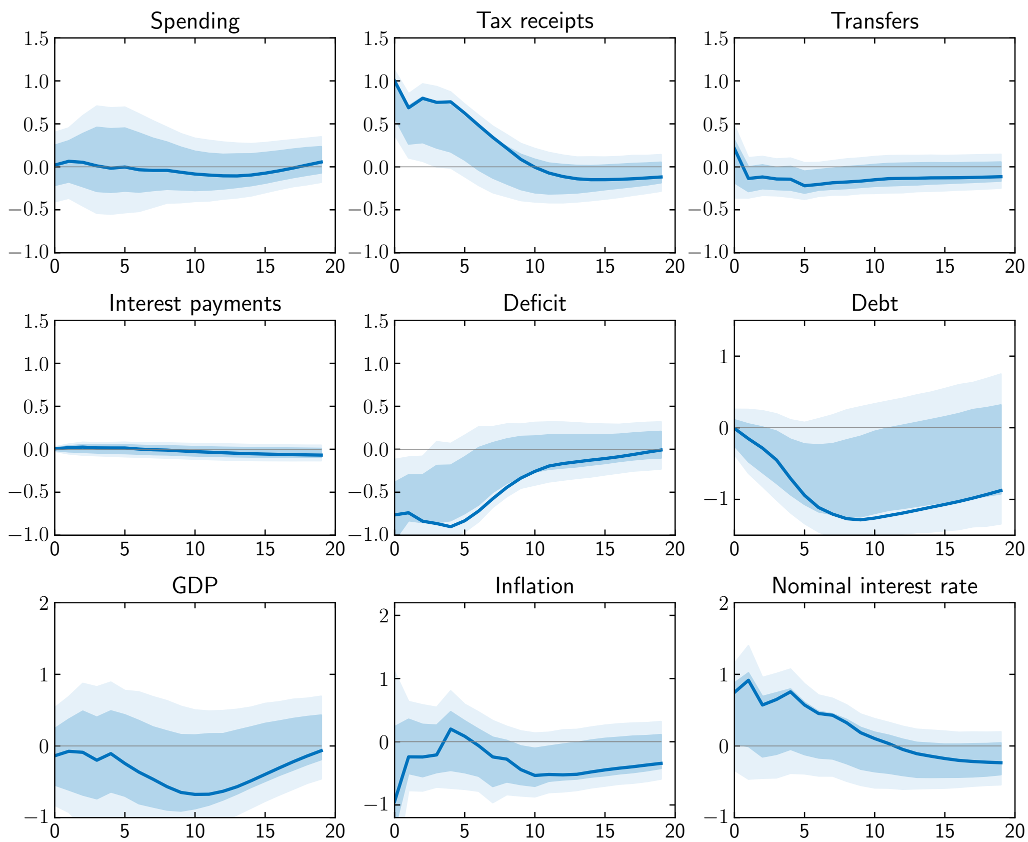
Note: VAR includes narrative shocks, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month nominal interest rate. The response of deficit is computed from that of the fiscal variables. The IRFs are scaled such that the point estimate of the response of taxes to the Caldara-Kamps shock is 1 at time 0. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002). See sections 2 and 4.3 for more details on the methodology.

Figure A.13: Response to Caldara-Kamps transfer shock with taxes ordered before transfers



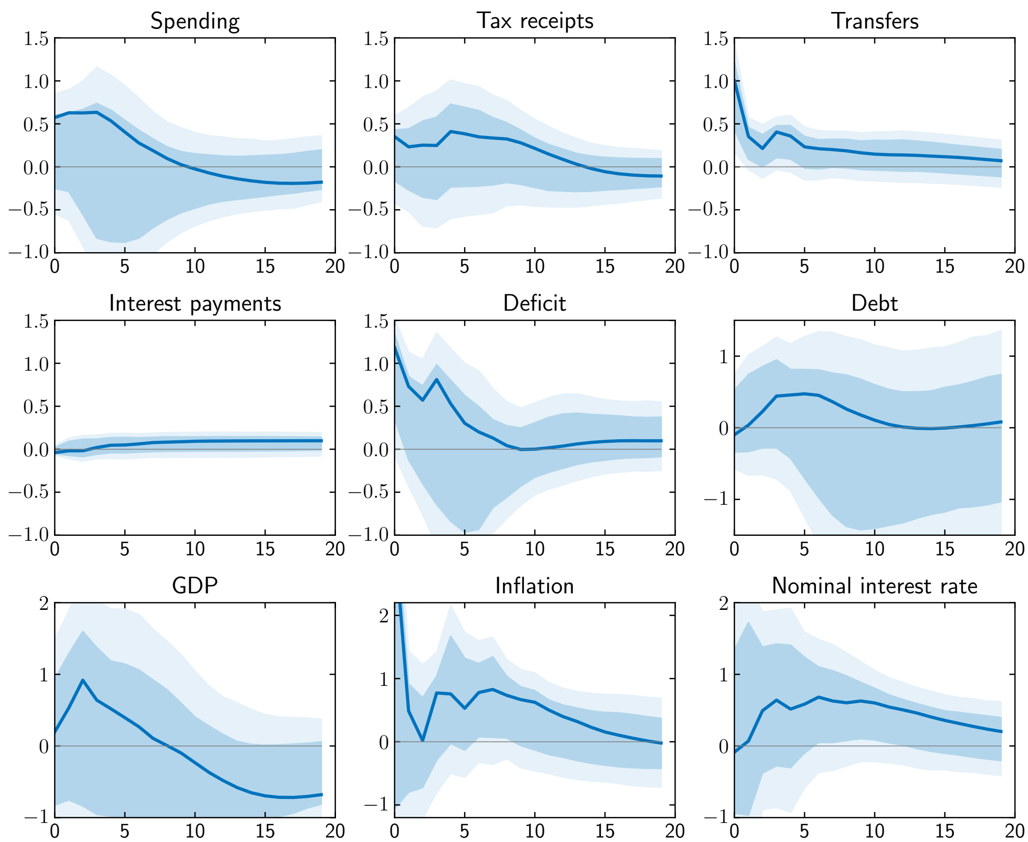
Note: VAR includes narrative shocks, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month nominal interest rate. The response of deficit is computed from that of the fiscal variables. The IRFs are scaled such that the point estimate of the response of transfers to the Caldara-Kamps shock is 1 at time 0. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002). See sections 2 and 4.3 for more details on the methodology.

Figure A.14: Response to Caldara-Kamps tax shock, using their vintage as instrument



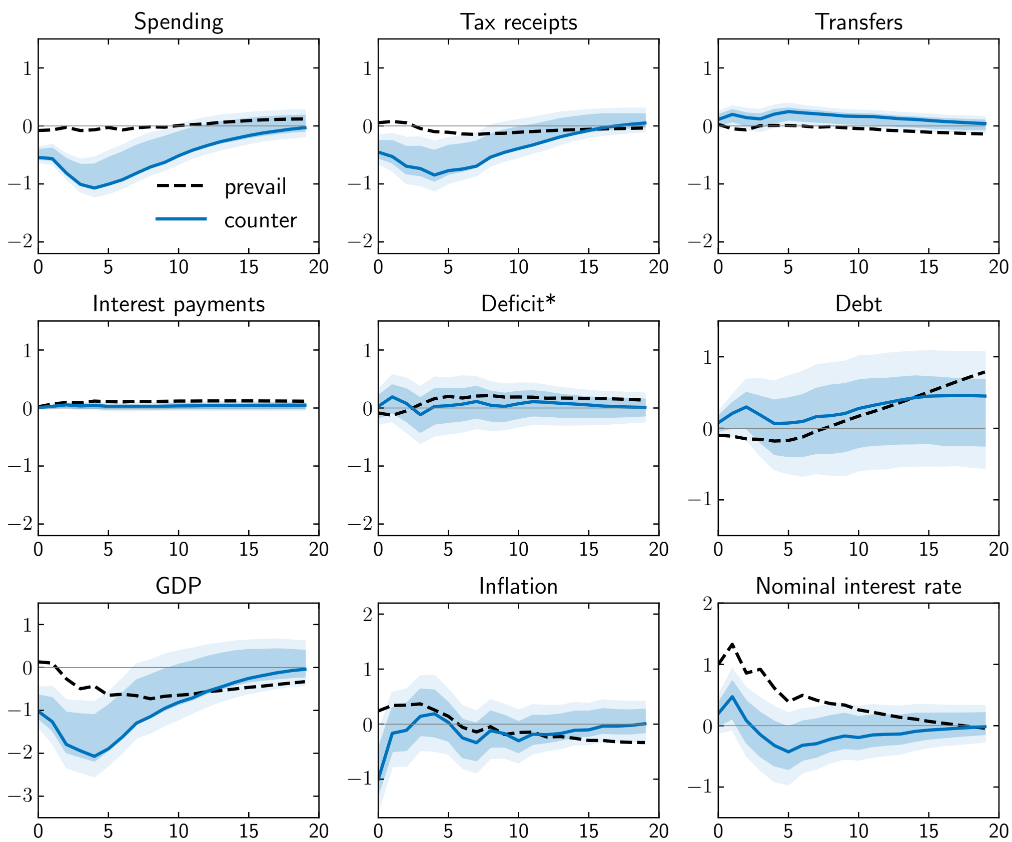
Note: VAR includes narrative shocks, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month nominal interest rate. The response of deficit is computed from that of the fiscal variables. The IRFs are scaled such that the point estimate of the response of taxes to the Caldara-Kamps shock is 1 at time 0. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002). See sections 2 and 4.3 for more details on the methodology.

Figure A.15: Response to Caldara-Kamps transfer shock, using their vintage as instrument



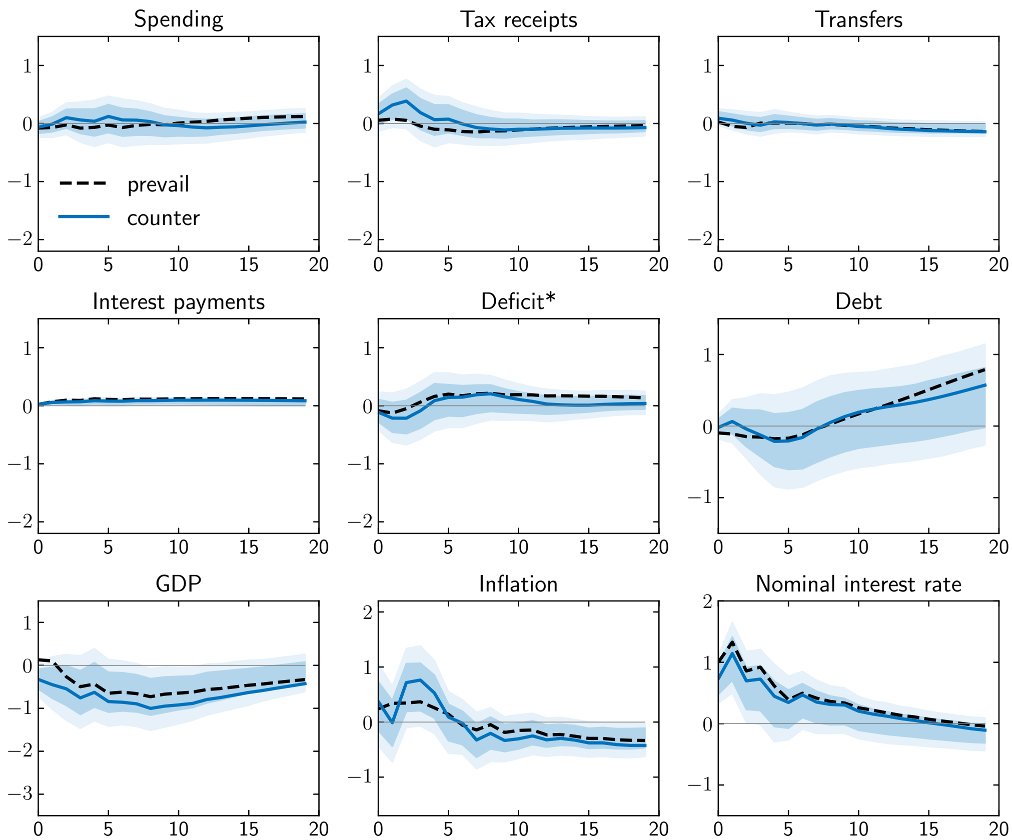
Note: VAR includes narrative shocks, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month nominal interest rate. The response of deficit is computed from that of the fiscal variables. The IRFs are scaled such that the point estimate of the response of transfers to the Caldara-Kamps shock is 1 at time 0. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002). See sections 2 and 4.3 for more details on the methodology.

Figure A.16: Counter-factual—deficit stabilization with spending



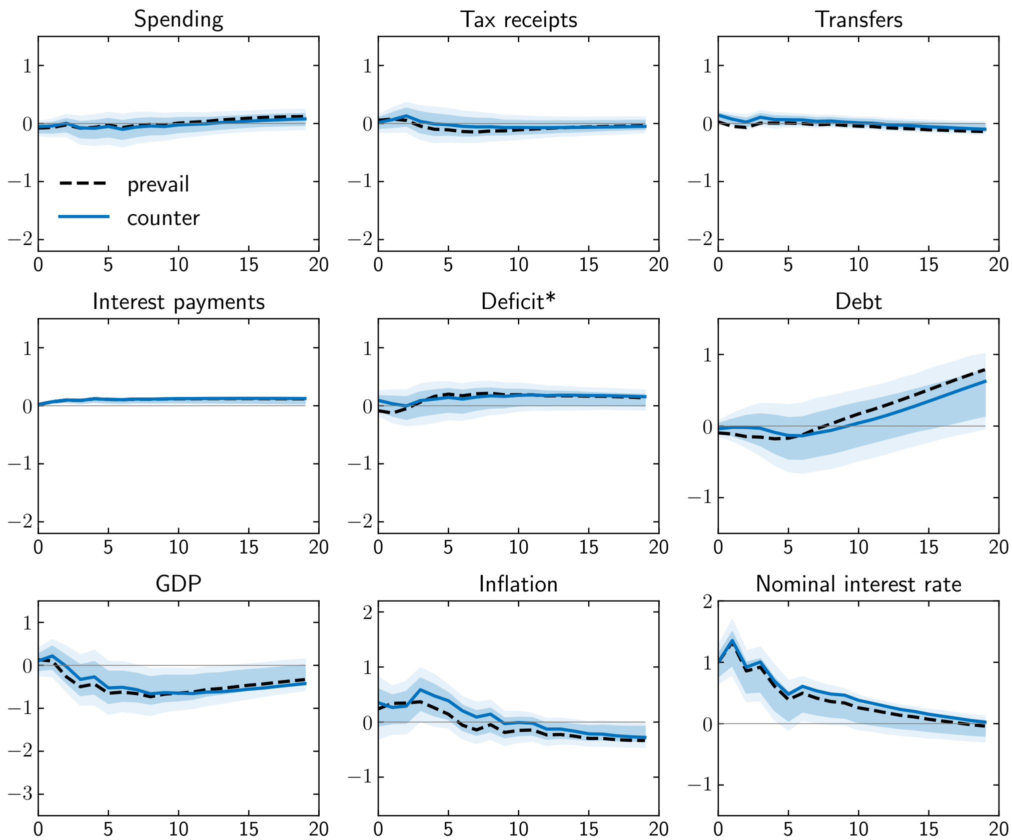
Note: counter-factual response of the economy to a monetary shock if the government stabilizes deficit through spending. The broken black line is actual response under the prevailing rule. The blue line and shaded areas are the counter-factual scenario and its 68% (dark) and 90% (light) confidence intervals. The starred variable is the variable that the government tries to stabilize. This counter-factual is constructed with the method of MKW (section 4.1).

Figure A.17: Counter-factual—deficit stabilization with taxes



Note: counter-factual response of the economy to a monetary shock if the government stabilizes deficit through taxes. The broken black line is actual response under the prevailing rule. The blue line and shaded areas are the counter-factual scenario and its 68% (dark) and 90% (light) confidence intervals. The starred variable is the variable that the government tries to stabilize. This counter-factual is constructed with the method of MKW (section 4.1).

Figure A.18: Counter-factual—deficit stabilization with transfers



Note: counter-factual response of the economy to a monetary shock if the government stabilizes deficit through transfers. The broken black line is actual response under the prevailing rule. The blue line and shaded areas are the counter-factual scenario and its 68% (dark) and 90% (light) confidence intervals. The starred variable is the variable that the government tries to stabilize. This counter-factual is constructed with the method of MKW (section 4.1).

A.2 Additional Tables

Table A.1: Monetary policy and fiscal response—1-year average

		Counterfactual		
	Actual	Spending	Taxes	Transfers
	(1)	(2)	(3)	(4)
GDP	-0.13	-2.40	-1.15	0.20
	(0.21)	(0.62)	(0.78)	(0.40)
	[-0.34,0.09]	[-2.67,-1.44]	[-1.73,-0.23]	[-0.33,0.46]
Inflation	0.32	-0.46	0.66	0.45
	(0.17)	(0.51)	(0.70)	(0.38)
	[0.10,0.45]	[-0.80,0.17]	[-0.13,1.26]	[0.02,0.76]
Nominal interest rate	1.03	-0.32	0.57	1.13
	(0.20)	(0.41)	(0.64)	(0.37)
	[0.66,1.05]	[-0.67,0.16]	[-0.06,1.18]	[0.68,1.42]
Real interest rate	0.70	-0.36	-0.20	0.61
	(0.21)	(0.52)	(0.78)	(0.38)
	[0.38,0.80]	[-0.91,0.11]	[-0.88,0.67]	[0.18,0.94]

Note: average response over the first year to a Romer-Romer monetary shock, depending on the fiscal response. Column (1) is the actual response described in section 3. Columns (2–4) are the counterfactual responses under the three scenarios described in section 5.3: debt stabilization through spending, taxes, or transfers. They respectively correspond to figures 4, 5, and 6. The number in parenthesis is the standard error. The numbers between brackets are the bounds of the 68% confidence interval.

Table A.2: Monetary policy and fiscal response—2-year average

		Counterfactual		
	Actual	Spending	Taxes	Transfers
	(1)	(2)	(3)	(4)
GDP	-0.36	-2.43	-1.17	-0.02
	(0.22)	(0.64)	(0.80)	(0.41)
	[-0.52,-0.09]	[-2.54,-1.26]	[-1.67,-0.09]	[-0.56,0.24]
Inflation	0.19	-0.27	0.38	0.58
	(0.12)	(0.35)	(0.44)	(0.22)
	[0.01,0.24]	[-0.53,0.16]	[-0.13,0.74]	[0.24,0.68]
Nominal interest rate	0.75	-0.55	0.45	0.93
	(0.18)	(0.43)	(0.59)	(0.32)
	[0.39,0.74]	[-0.83,-0.00]	[-0.09,1.05]	[0.48,1.12]
Real interest rate	0.60	-0.48	0.20	0.37
	(0.15)	(0.40)	(0.55)	(0.28)
	[0.33,0.63]	[-0.80,0.00]	[-0.25,0.80]	[0.07,0.63]

Note: average response over the first 2 years to a Romer-Romer monetary shock, depending on the fiscal response. Column (1) is the actual response described in section 3. Columns (2–4) are the counterfactual responses under the three scenarios described in section 5.3: debt stabilization through spending, taxes, or transfers. They respectively correspond to figures 4, 5, and 6. The number in parenthesis is the standard error. The numbers between brackets are the bounds of the 68% confidence interval.

Table A.3: Monetary policy and fiscal response—4-year average

		Counterfactual		
	Actual	Spending	Taxes	Transfers
	(1)	(2)	(3)	(4)
GDP	-0.48	-1.58	-1.21	-0.34
	(0.18)	(0.56)	(0.65)	(0.33)
	[-0.54,-0.18]	[-1.60,-0.51]	[-1.50,-0.22]	[-0.71,-0.05]
Inflation	-0.00	-0.20	-0.07	0.37
	(0.08)	(0.24)	(0.30)	(0.14)
	[-0.11,0.05]	[-0.34,0.15]	[-0.33,0.26]	[0.09,0.38]
Nominal interest rate	0.48	-0.45	0.26	0.72
	(0.13)	(0.34)	(0.40)	(0.21)
	[0.18,0.42]	[-0.61,0.06]	[-0.10,0.66]	[0.34,0.75]
Real interest rate	0.52	-0.37	0.40	0.39
	(0.13)	(0.35)	(0.44)	(0.22)
	[0.24,0.49]	[-0.63,0.04]	[-0.06,0.78]	[0.12,0.55]

Note: average response over the first 4 years to a Romer-Romer monetary shock, depending on the fiscal response. Column (1) is the actual response described in section 3. Columns (2–4) are the counterfactual responses under the three scenarios described in section 5.3: debt stabilization through spending, taxes, or transfers. They respectively correspond to figures 4, 5, and 6. The number in parenthesis is the standard error. The numbers between brackets are the bounds of the 68% confidence interval.

Table A.4: Federal transfers

	1969	1993	2007
Total (billion dollars)	70	792	1758
Social benefits	**66%**	**75%**	**73%**
Social Security	38%	38%	33%
Medicare	10%	19%	24%
Unemployment insurance	3%	4%	2%
Railroad retirement	2%	1%	1%
Pension benefit guaranty	0%	0%	0%
Veterans' life insurance	1%	0%	0%
Workers' compensation	0%	0%	0%
Military medical insurance	0%	0%	0%
Veterans' benefits	8%	2%	2%
Food Stamp Program (FSP)	0%	3%	2%
Black lung benefits	0%	0%	0%
Supplemental Security Income	0%	3%	2%
Refundable tax credits	0%	1%	3%
Other	2%	2%	2%
To the rest of the world	1%	1%	1%
Grants-in-aid to state and local governments	**19%**	**20%**	**20%**
General public service	n.a.	0%	0%
National defense	n.a.	0%	0%
Public order and safety	n.a.	0%	0%
Economic affairs	n.a.	1%	1%
Housing and community services	n.a.	0%	1%
Medicaid	n.a.	10%	11%
Prescription drug plan	n.a.	0%	0%
Other health	n.a.	1%	1%
Recreation and culture	n.a.	0%	0%
Education	n.a.	2%	2%
Income security	n.a.	6%	4%
Other transfers to the rest of the world	**6%**	**3%**	**2%**
Capital transfer payments	**8%**	**3%**	**5%**

Note: based on NIPA tables 3.2, 3.12U and 3.24U. Detailed data on grants-in-aid is unavailable before 1993.

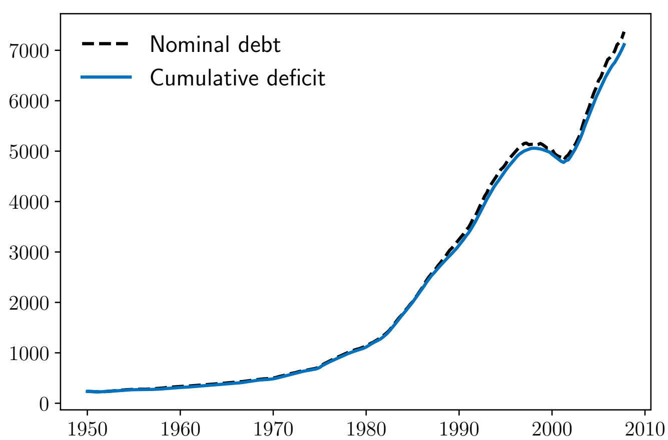
A.3 Budget Constraint

In nominal terms, the law of motion of government debt is given by the following identity:

$$D_t = D_{t-1} + G_t + TR_t - TX_t + INT_t \tag{A.1}$$

where D_t is debt, G_t government spending, TR_t transfers, TX_t taxes, and INT_t interest payments. In practice, this is not perfectly accurate as the NIPA tables, which are the source for the flow variables, and the Flow of Funds, which is the source for governement debt, treat certain items differently.[1] Equation (A.2) is, however, a very good approximation as figure A.19 shows. Using as initial value that of debt at the beginning of the sample, we construct a series by iterating on equation (A.1): the new series is almost indistinguishable from debt according to the Flow of Funds.

Figure A.19: Comparison of debt and cumulative deficit



Note: times series for federal debt and cumulative deficit, expressed in current billion dollars. The cumulative deficit is made equal to debt in the first quarter of 1950.

[1]See Federal Reserve Board (2022, pp. 10–11).

Equation (A.2) can be rewritten with deflated and de-trended quantities:

$$d_t = \frac{d_{t-1}}{\Pi_t \Gamma_t} + g_t + tr_t - tx_t + int_t \tag{A.2}$$

where Π_t is the gross inflation rate, Γ_t the growth rate of the trend and lowercase letters denote the deflated and de-trended variables. Equation (A.2) is exactly implied by equation (A.1), which, as we have seen, is a very good approximation of reality. Equation (A.2), however, is not linear anymore. A linearization in level implies:

$$d_t \approx c + \frac{d_{t-1}}{\Pi^* \Gamma^*} - \frac{d^*}{{\Pi^*}^2 \Gamma^*} \Pi_t - \frac{d^*}{\Pi^* {\Gamma^*}^2} \Gamma_t + g_t + tr_t - tx_t + int_t \tag{A.3}$$

where c is a constant.

Equation (A.3) is not exactly true anymore: it is an approximation. To test its accuracy, we can run a regresson of d_t on the variables that appear on the right-hand side (RHS) of that equation. The results, in table A.5, imply that equation (A.3) is a very good approximation. First, the right-hand side variables explain almost all of the variance in debt: the R-square is above 0.99. Moreover, the coefficients have the sign and magnitude predicted by equation (A.3): those in front of the fiscal variables are approximately equal to 1, while that in front of inflation corresponds to a value of 0.43 for $d_{t-1}/(\Pi_t^2 \Gamma_t)$. The average over the sample is 0.56. Only the coefficient in front of trend growth seems off: its point estimate is 0.94 while the sample average of $d_{t-1}/\left(\Pi_t {\Gamma_t}^2\right)$ is 0.56. The coefficient, however, is very imprecisely estimated. Indeed, there is almost no time variation in trend growth (Γ_t). Consistent with that explanation, dropping Γ_t from the regression has almost no impact on the R-square as column (2) shows.

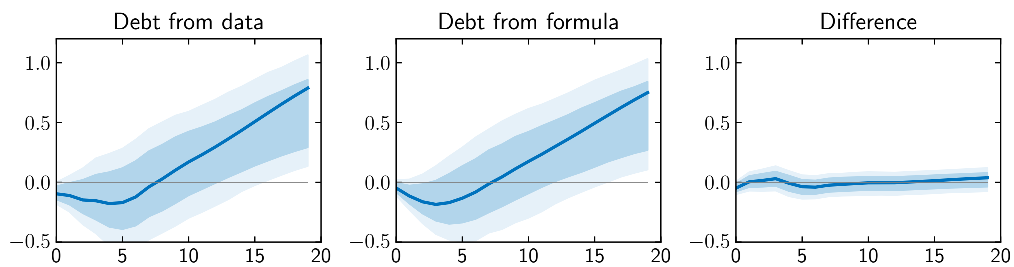
Another way to check the quality of the approximation is to compare the impulse response function of debt directly implied by the VAR—debt being one of the endogenous variables—and that implied by equation (A.3) based on the response of the fiscal variables and inflation. To derive the impulse response function shown in the middle plot, we take the derivative of equation (A.20) with respect to the monetary shock, ϵ_0^M:

$$\frac{dd_t}{d\epsilon_0^M} = 0.986 \times \frac{dd_{t-1}}{d\epsilon_0^M} \underbrace{-0.433 \times \frac{d\Pi_t}{d\epsilon_0^M}}_{\text{Fisher effect}} + \underbrace{\frac{dg_t}{d\epsilon_0^M} + \frac{dtr_t}{d\epsilon_0^M} - \frac{dtx_t}{d\epsilon_0^M} + \frac{dint_t}{d\epsilon_0^M}}_{\text{deficit}}$$

Starting from $t = 0$ and using the fact that $dd_{-1} = 0$, we know everything on the right-hand side from the VAR. This gives us the left-hand side: dd_0. At $t = 1$, we can do the same to obtain dd_1, etc.[2]

We plot the two responses for debt in figure (A.20). The left-hand side plot is the response of the debt variable in the VAR. In the middle plot, we use the response of deficit and inflation and iterate in equation (A.3). We use the coefficients of column (1) in table A.5 in front of d_{t-1} and Π_t. The two plots look exactly the same. We check this in the third plot by plotting the difference between the two lines.

Figure A.20: Response of debt to RR monetary shock



Note: additional result from the baseline VAR (figure 1). This VAR includes the monetary shock, spending, tax receipts, transfers, interest payments, debt, GDP (all in real terms), inflation, and the 3-month interest rate. The left-hand side chart is the response of debt as it features in the VAR—it is the same as the debt chart of figure 1. The middle chart is the response of debt deduced from equation (A.3), using the coefficients of column (1) of table A.5. The right-hand side chart is the difference between the first and second charts. Shaded areas represent 68% (dark) and 90% (light) confidence intervals bootstrapped with 2,000 draws (Runkle, 2002).

[2] Note that we can do this by considering only the deficit or the Fisher effect on the right-hand side. This gives us an additive decomposition of the response of debt into two effects: cumulative deficit and Fisher effect. We show the result of this exercise in the main text (figure 2.A).

Table A.5: Debt check

	(1)	(2)
Lagged debt	0.98	0.98
	(0.00)	(0.00)
	[0.98,0.99]	[0.98,0.99]
Inflation	-0.55	-0.57
	(0.03)	(0.03)
	[-0.61,-0.49]	[-0.62,-0.52]
Trend growth	-0.47	
	(0.41)	
	[-1.27,0.33]	
Spending	1.11	1.11
	(0.04)	(0.04)
	[1.03,1.19]	[1.03,1.19]
Tax receipts	-1.01	-0.97
	(0.05)	(0.04)
	[-1.11,-0.90]	[-1.06,-0.89]
Transfers	1.09	1.17
	(0.07)	(0.03)
	[0.95,1.24]	[1.12,1.23]
Interest payments	1.00	1.02
	(0.08)	(0.08)
	[0.84,1.17]	[0.85,1.18]
R^2	0.9996	0.9996

Note: estimation of equation (A.3). Column (1) includes the trend growth term (Γ_t), while column (2) doesn't. The number in parenthesis is the standard error. The numbers between brackets are the bounds of the 95% confidence interval.

A.4 Unobserved Fiscal Instruments

A.4.1 General Case

In macroeconomic models, tax receipts and transfer payments are often endogenous objects whose rule is not directly controlled by the government. For instance, tax receipts depend on economic activity as well as a collection of tax rates. If unemployment insurance is modeled, transfer payments depend on the unemployment rate as well as the level of unemployment benefits. In these examples, the government directly controls the rule for tax rates and unemployment benefits, not those for tax receipts and expenses on unemployment insurance. Interpreted literally, the MKW would require observing every tax rate or transfer benefit as well as several exogenous shock paths for each of those. In practice, we only observe tax receipts and transfers payments, and we only have two shock paths for each of those.

How can we map our exercise to such a model? Consider a theoretical environment with a collection of (perhaps unobserved) instruments, z_i, $1 \leq i \leq n$. We can think of those as tax rates on various types and brackets of income, or transfer benefits for various situations (poverty, unemployment, retirement...). Suppose, on the other hand, that we observe another variable, $\tilde{x}$, which we seek to stabilize. In our counter-factual exercises, this variable is debt or deficit. It belongs to the non-policy block since it moves endogenously in response to the fiscal instruments and economic fluctuations. The MKW minimization problem, which we reproduce here for convenience, is the following:

$$\min_{\mathbf{s}} || \hat{\mathcal{A}}_x \left(\mathbf{x}_{\mathcal{A}}(\boldsymbol{\varepsilon}) + \boldsymbol{\Omega}_{\mathbf{x},\mathcal{A}} \times \mathbf{s}\right) + \hat{\mathcal{A}}_z \left(\mathbf{z}_{\mathcal{A}}(\boldsymbol{\varepsilon}) + \boldsymbol{\Omega}_{\mathbf{z},\mathcal{A}} \times \mathbf{s}\right) || \tag{8}$$

Each row of the $\hat{\mathcal{A}}_x$ and $\hat{\mathcal{A}}_z$ matrices defines the counter-factual policy rule of one instrument for one time period.

Since equation (8) contains the empirical response of the instruments to the monetary ($\mathbf{z}_{\mathcal{A}}(\boldsymbol{\varepsilon})$) and policy ($\Omega_{z,\mathcal{A}}$) shocks, not observing the instruments would seem damning. We can, however, work around this problem by enforcing a policy rule which exhibits a weighted average of the unobserved instrument combinations that actually happen in response to the non-policy and policy shocks. Formally, let us choose (without loss of generality) the stabilization of $\tilde{x}$ as the policy rule for the first instrument, z_1: $\tilde{x}_t = 0$ for all t. As no instrument appears in this equation, the corresponding rows of the $\hat{\mathcal{A}}_z$ matrix are made of zeros. Hence, we don't need to observe $\mathbf{z}_{\mathcal{A}}(\boldsymbol{\varepsilon})$ and $\Omega_{z,\mathcal{A}} \times \mathbf{s}$ to know the value of the corresponding rows of $\hat{\mathcal{A}}_z\left(\mathbf{z}_{\mathcal{A}}(\boldsymbol{\varepsilon}) + \boldsymbol{\Omega}_{\mathbf{z},\mathcal{A}} \times \mathbf{s}\right)$: that value is simply 0. For the other instruments, we choose the following policy rule:

$$z_{it} = \frac{\mathbf{z}_{\mathcal{A},\mathbf{z_{it}}}(\varepsilon) + \boldsymbol{\Omega}_{\mathbf{z},\mathcal{A},\mathbf{z_{it}}} \times \mathbf{s}}{\mathbf{z}_{\mathcal{A},\mathbf{z_{1t}}}(\varepsilon) + \boldsymbol{\Omega}_{\mathbf{z},\mathcal{A},\mathbf{z_{1t}}} \times \mathbf{s}} \times z_{1,t}, \qquad i > 1 \tag{A.4}$$

where the z_{it} subscript denotes the line that corresponds to the instrument z_i at time t in $\mathbf{z}_{\mathcal{A}}(\boldsymbol{\varepsilon})$ and $\Omega_{z,\mathcal{A}}$. The corresponding row of $\hat{\mathcal{A}}_z$ (which we denote $\hat{\mathcal{A}}_{z_{it}}$) contains $\frac{\mathbf{z}_{\mathcal{A},\mathbf{z_{it}}}(\varepsilon)+\boldsymbol{\Omega}_{\mathbf{z},\mathcal{A},\mathbf{z_{it}}}\times\mathbf{s}}{\mathbf{z}_{\mathcal{A},\mathbf{z_{1t}}}(\varepsilon)+\boldsymbol{\Omega}_{\mathbf{z},\mathcal{A},\mathbf{z_{1t}}}\times\mathbf{s}}$ in the column for z_{1t}, -1 in the column for z_{it}, and 0 in the other columns. So, it is trivial to check that the matrix product between this row and the vector $\mathbf{z}_{\mathcal{A}}(\varepsilon) + \boldsymbol{\Omega}_{\mathbf{z},\mathcal{A}} \times \mathbf{s}$ is 0: $\hat{\mathcal{A}}_{z_{it}}(\mathbf{z}_{\mathcal{A}}(\varepsilon) + \boldsymbol{\Omega}_{\mathbf{z},\mathcal{A}} \times \mathbf{s}) = \mathbf{0}$. Since equation (A.4) does not feature any non-policy variable, the corresponding row of $\hat{\mathcal{A}}_x$ only contains zeros. Therefore, the corresponding row of $\hat{\mathcal{A}}_x\left(\mathbf{x}_{\mathcal{A}}(\boldsymbol{\varepsilon}) + \boldsymbol{\Omega}_{\mathbf{x},\mathcal{A}} \times \mathbf{s}\right) + \hat{\mathcal{A}}_z\left(\mathbf{z}_{\mathcal{A}}(\boldsymbol{\varepsilon}) + \boldsymbol{\Omega}_{\mathbf{z},\mathcal{A}} \times \mathbf{s}\right)$ is also 0 and irrelevant to the minimization problem. As a result, the only rows that matter for the minimization problem are those that correspond to the policy rule for z_{1t} and where the unobserved instruments don't appear, so that we don't need to know $\mathbf{z}_{\mathcal{A}}(\boldsymbol{\varepsilon})$ and $\Omega_{z,\mathcal{A}} \times \mathbf{s}$.

Once again equation (A.4) is not just a mathematical trick. Implicitly, this policy rule enforces a weighted average of the instrument combinations that happen in response to the non-policy shock ($\mathbf{z}_{\mathcal{A}}(\boldsymbol{\varepsilon})$) and to the policy shocks ($\Omega_{z,\mathcal{A}} \times \mathbf{s}$). We don't observe those combinations, but they are the empirically relevant ones.

A.4.2 Application to Bianchi et al. (2023)

As we explained in sections 4.3 and 5.1, Bianchi et al. (2023) propose a model with "shock-specific" monetary rules. The central bank responds actively to funded shocks, while it lets inflation rise in response to unfunded shocks. Their model features a "shadow economy," which registers the path that variables would take if there were only unfunded shocks. This speaks directly to the unobserved instruments we've described in section A.4.1: in the data, we don't observe the shadow economy (by definition); neither do we observe which shocks are funded or unfunded.

Formally, we can map their model into the MKW framework by collecting $\hat{g}$, $\hat{z}^b$, $\hat{z}$, $\hat{\tau}_L$, $\hat{\tau}_K$, and their shadow economy counterparts in the vector of policy variables ($\mathbf{z}$), ζ_g, ζ_z, ζ^M, ζ^F in the vector of policy shocks ($\boldsymbol{\nu}$), the remaining endogenous variables in the vectors of unobserved ($\mathbf{w}$) and observed ($\mathbf{x}$) policy variables, and the remaining shocks in the vector of non-policy shocks ($\boldsymbol{\varepsilon}$). The non-policy block is made of equations (66–83, 89) and their shadow counterparts, while the policy block features equations (84–88, 91–95).[3] Then, the fact that the distinction between funded and unfunded fiscal instruments is unobservable is addressed as in appendix A.4.1, by enforcing the fiscal rule to be a weighted average of the instrument combinations that happen in response to the non-policy and policy shocks.

In light of the Bianchi-Faccini-Melosi model, the transfer results of section 5.1 suggest that transfer shocks are mostly unfunded. If so, our transfer scenario relies on unfunded transfers: the fiscal authority fights the monetary contraction by increasing unfunded expenses. This forces the central bank to let inflation rise in response, thus undoing the monetary contraction.

[3]Since, in our application of the MKW method, the structural shock is a monetary policy shock, the Taylor rule (89) belongs to the non-policy block (see section 4.3). This implies that we cannot handle the effective lower bound as Bianchi et al. do. Indeed, under realistic "informational requirements," the non-policy block must be linear. See McKay and Wolf (2023, appendices A.8–9).

A.5 Sources

The sources are summarized in table A.6. The definition of the fiscal flow variables is:

$$
\begin{aligned}
\text{spending} &= \text{consumption expenditures (line 25)} + \text{subsidies (line 36)} \\
&\quad + \text{gross investment (line 45)} - \text{capital consumption (line 48)} \\
\text{transfers} &= \text{current transfer payments (line 26)} \\
&\quad + \text{capital transfer payments (line 46)} \\
\text{tax receipts} &= \text{total receipts (line 40)}
\end{aligned}
$$

("Line" refers to the line in NIPA table 3.2.)

Table A.6: Data sources

Variable	Definition	Source
FOMC Forecasts	See section 2.1	Croushore and van Norden (2018)
Fiscal shocks	See section 4.3.1	Ramey (2016) and own computations
GDP	GDP in constant 2012 prices	NIPA table 1.1.6
Price index	GDP deflator	NIPA table 1.1.4
Nominal interest rate	3-month T-bill rate	Ramey (2016)
Fiscal flow variables	See appendix A.5	NIPA table 3.2
Federal debt	Total liabilities (FGTLBLQ027S) minus total assets (FGTFASQ027S)	Flow of Funds downloaded from FRED

Note: sources for the data used in the paper.

A.6 Detailed Description of the Shocks

A.6.1 Monetary Shocks

Romer-Romer monetary shocks: see section 2.1.

A.6.2 Spending Shocks

Ramey spending shocks: Ramey (2011) reads periodicals, mainly *Business Week*, to measure the public's expectations of future military spending. The shock is an estimate of the change in the present discounted value of future spending.

Ben Zeev-Pappa spending shocks: Ben Zeev and Pappa (2017) run a VAR with a number of macroeconomic variables, including defense spending. To construct their structural spending shock, "they search for the structural shock that is: (i) contemporaneously orthogonal to [defense] spending; and that (ii) maximally explains the future variation in [defense] spending" over five years (p. 1572).

Blanchard-Perroti spending shocks: Blanchard and Perotti (2002) run a VAR with spending, taxes, and GDP. To identify the spending shock, they assume that spending doesn't respond contemporaneously to taxes or GDP, a so-called Cholesky decomposition of the covariance matrix of the reduced-form shocks. We reproduce their approach in spirit by ordering spending first after the Ramey and Ben Zeev-Pappa shocks in our 10-variable VAR. Hence, our version of the Blanchard-Perroti spending shocks controls for contemporaneous values of the Ramey and Ben Zeev-Pappa ones.

A.6.3 Tax Shocks

Romer-Romer tax shocks: Romer and Romer (2010) read presidential speeches and Congressional reports to assess the motivation of changes in the tax code. They distinguish four motivations: (i) finance extra spending, (ii) fight a recession, (iii) remedy an inherited deficit, and (iv) spur long-run growth. In their exercise, the last two categories are endogenous. Since we are interested in the effect on fiscal variables, (iii) is problematic, so we only use (iv).

Mertens and Ravn revisit these shocks in a series of papers to study anticipations (Mertens and Ravn, 2012), personal versus corporate income taxes (Mertens and Ravn, 2013), or the implied tax multiplier (Mertens and Ravn, 2014). While the distinction between anticipated and unanticipated tax shocks seems promising in the context of the MKW method–it implies different paths for the fiscal instrument—the anticipated tax changes vary so much in their anticipation horizon that trying to estimate their effect based on their announcement date has little statistical power.[4] We also experimented with personal and corporate tax changes, but those have similar implications for deficit and debt hence did not materially affect our ability to implement the desired counterfactual policy. Finally, the Mertens-Ravn "exogenous" series lump together motivations (iii) and (iv) which, once again, is problematic in our context since motivation (iii) (remedying an inherited deficit) is endogenous to fiscal variables. These experiments and limitation led us to settle for the subset of the original Romer-Romer tax shocks described in the previous paragraph.

Caldara-Kamps tax shocks: Caldara and Kamps (2017) run a VAR with some fiscal and macroeconomic variables. Denoting u_t the vector of reduced-form shocks, they assume an invertible mapping A_0 between u_t and the vector of structural shocks e_t:

$$u_t = (A_0^{-1})' e_t \tag{CK5}$$

(CK5) stands for Caldara and Kamps's equation (5). This equation can be rearranged into:

$$u_{p,t} = \psi_0 u_{np,t} + \omega_p e_{p,t} \tag{CK8}$$

where subscripts p and np respectively denote the policy and non-policy vari-

[4]This limitation led Mertens and Ravn to date the shocks at implementation and study the behavior of the economy before said implementation.

ables. Equation (CK8) is a fiscal rule which ties innovations in a policy variable (e.g. taxes) to innovations in non-policy variables (e.g. GDP) and structural policy shocks (e.g. exogenous change in tax rates). To identify the structural policy shock $e_{P,t}$, Caldara and Kamps propose regressing $u_{p,t}$ on instrumental variables for the non-policy variables, thus identifying the systematic component of the fiscal rule. Their non-policy variables are GDP, inflation, and the nominal interest rate. ("Non-policy" here should be interpreted as non-fiscal policy.)

They consider two cases. In the "simple fiscal rule" case, they assume that taxes do not respond contemporaneously to inflation and the interest rate, hence the corresponding rows of ψ_0 are set equal to 0. In the "general fiscal rule" case, they allow taxes to respond to all non-policy variables. As instrumental variables, they use the Fernald (2014) measure of total factor productivity adjusted for factor utilization for GDP, the Hamilton (2003) series of oil price shocks for inflation, and the Romer and Romer (2004) series of monetary policy shocks for the interest rate. In the baseline, we assume the "full fiscal rule." We replace the Hamilton oil price shocks with the more recent series of Känzig (2021)—Hamilton's series are a weak instrument for oil prices (Stock and Watson, 2012)—and the Romer-Romer monetary shocks with those of Gertler and Karadi (2015) to avoid using the Romer-Romer twice. We discuss the Fernald, Känzig, and Gertler-Karadi in detail in section A.6.5. In figures A.10 and A.11, we use the "simple fiscal rule." Finally, the policy shocks, $e_{p,t}$, are identified by orthogonality. The ordering of the non-policy variables does not matter, but the one of the policy variables does. In the baseline, we put spending first, transfers second, and taxes third. That is, we assume that spending does not contemporaneously respond to transfers and taxes, and transfers do not contemporaneously respond to taxes. We swap the ordering of transfers and taxes in figures A.12 and A.13. Note that, like with the Blanchard-Perroti spending shocks, we re-estimate those shocks within our VAR.

A.6.4 Transfer Shocks

Romer-Romer transfer shocks: Romer and Romer (2016) study Social Security increases from 1952 to 1991. Like with tax changes, they read administrative documents to understand what motivated these increases. They argue that most of the increases "occurred somewhat randomly". Until 1974, Social Security payments weren't automatically adjusted for inflation. Until the early 1990s, "substantial variation in inflation and occasional bursts of retroactive payments resulting from idiosyncratic factors, as well as a legislated change in the timing of cost-of-living adjustments, led to irregular and variable benefit changes" (p. 1). They find a few changes made for countercyclical purposes, which they exclude. They distinguish between permanent and temporay changes. We only use the permanent changes as the temporary ones have no power in quarterly data.

Caldara-Kamps transfer shocks: see the discussion of the Caldara-Kamps tax shocks in section A.6.3. Caldara and Kamps did not estimate the effect of transfer shocks. We apply the methodology that they proposed for taxes to transfers.

A.6.5 Instruments for Caldara-Kamps Identification

Fernald TFP shocks: Fernald (2014) estimates total factor productivity, adjusted for utilization. While replicating Caldara and Kamps's (2017) approach, we noticed that the version of the Fernald (2014) series that is in their replication package differs from what can be downloaded from John Fernald's website.[5] Indeed, the Fernald series are updated several times a year and they underwent an important revision in 2014, sometimes threatening the results of earlier papers (Cascaldi-Garcia, 2017). We were unable to understand which version Caldara and Kamps use or whether they applied a transformation. In our baseline, we use the December 2013 vintage from Fernald's website. Sub-

[5] See `www.frbsf.org/economic-research/indicators-data/total-factor-productivity-tfp/` for the latest version or `www.johnfernald.net/TFP` for a version history.

sequent vintages are too weak an instrument to produce meaningful results (see below).[6] In figures A.14–A.15, we show the results if we use the version of the Fernald series that is in Caldara and Kamps's replication package.

Kanzig oil supply news shocks: Känzig (2021) uses the change in the price of oil futures around announcements of the Organization of the Petroleum Exporting Countries (OPEC).

Gertler-Karadi monetary shocks: Gertler and Karadi (2015) use the change in the price federal funds rate futures around FOMC meetings as a measure of monetary shocks. Early contributors to that identification scheme were: Bagliano and Favero (1999), Cochrane and Piazzesi (2002), Faust et al. (2004), Barakchian and Crowe (2013).

Instrument relevance: we assess the relevance of these instruments in table A.7. Following Caldara and Kamps, we use the TFP and oil shocks to instrument GDP and inflation throughout the sample and restrict the estimation of the first stage of the monetary shocks to the period for which the instrument is observable (1988 onward). Like Caldara and Kamps (2017, table 2), we find that oil shocks are a weak instrument for inflation (table A.7.2, columns 1 and 2), while the other two instruments perform well (table A.7.1, column 1 and table A.7.2, column 3). As mentioned in the first paragraph of this section, we prefer the 2013 vintage of Fernald's TFP shocks to the more recent ones as it is a much stronger instrument (table A.7.1, column 1 and 2). We also report the same regression with the version of Fernald's shock that is in Caldara and Kamps's online appendix (table A.7.1, column 3).

[6] Kurmann and Sims (2021) explain that the most consequential innovation in the 2014 revision is a change in the method for de-trending industry hours per worker, upon which the measure for factor utilization is based. As a result of this change, the high-frequency fluctuations become unfiltered, potentially including cyclical measurement errors.

Table A.7.1: Instrument relevance for CK identification—GDP

	(1) GDP	(2) GDP	(3) GDP
		Tax	
Fernald TFP 13	0.0013		
	(0.0001)		
	[0.0010,0.0015]		
Fernald TFP 23		0.0005	
		(0.0001)	
		[0.0002,0.0008]	
Fernald TFP CK			0.0008
			(0.0001)
			[0.0005,0.0010]
Känzig oil	-0.0001	-0.0002	-0.0003
	(0.0004)	(0.0004)	(0.0004)
	[-0.0009,0.0006]	[-0.0011,0.0006]	[-0.0011,0.0005]
F-statistic	45.55	5.63	17.59
		Transfers	
Fernald TFP 13	0.0012		
	(0.0001)		
	[0.0010,0.0015]		
Fernald TFP 23		0.0004	
		(0.0001)	
		[0.0002,0.0007]	
Fernald TFP CK			0.0007
			(0.0001)
			[0.0004,0.0010]
Känzig oil	-0.0002	-0.0003	-0.0004
	(0.0004)	(0.0004)	(0.0004)
	[-0.0009,0.0005]	[-0.0011,0.0006]	[-0.0012,0.0004]
F-statistic	43.48	5.31	15.03

Note: relevance of various instruments for Caldara-Kamps (CK) identification. See section A.6 for more details. The tax and transfer VARs differ only because they don't feature the same narrative shock. The number in parenthesis is the standard error. The numbers between brackets are the bounds of the 95% confidence interval.

Table A.7.2: Instrument relevance for CK identification—inflation and nominal interest rate

	(1) Inflation	(2) Inflation	(3) Nominal i.r.
	Tax		
Fernald TFP 13	-0.0005	-0.0005	
	(0.0002)	(0.0002)	
	[-0.0010,-0.0000]	[-0.0010,-0.0000]	
Känzig oil	0.0003		
	(0.0007)		
	[-0.0010,0.0017]		
Hamilton oil		0.0001	
		(0.0002)	
		[-0.0002,0.0004]	
Gertler-Karadi			0.0149
			(0.0030)
			[0.0090,0.0209]
F-statistic	2.52	2.55	24.86
		Transfers	
Fernald TFP 13	-0.0004	-0.0004	
	(0.0002)	(0.0002)	
	[-0.0009,0.0001]	[-0.0009,0.0001]	
Känzig oil	0.0003		
	(0.0007)		
	[-0.0010,0.0017]		
Hamilton oil		0.0001	
		(0.0002)	
		[-0.0002,0.0004]	
Gertler-Karadi			0.0151
			(0.0030)
			[0.0092,0.0211]
F-statistic	1.62	1.61	25.62

Note: relevance of various instruments for Caldara-Kamps (CK) identification. See section A.6 for more details. The tax and transfer VARs differ only because they don't feature the same narrative shock. The number in parenthesis is the standard error. The numbers between brackets are the bounds of the 95% confidence interval.

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