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The Fiscal Channel of Monetary Policy*

Max Breitenlechner[†] Martin Geiger[‡] Mathias Klein[§]

April 30, 2025

Abstract

This paper empirically quantifies the importance of fiscal policy in shaping the monetary policy transmission mechanism and derives implications for monetary-fiscal interactions. First, we document that a contractionary monetary policy shock, besides lowering output and prices, leads to a pronounced adjustment in fiscal measures and a significant increase in the fiscal deficit. We then construct different structural counterfactuals, in which we shut down the endogenous responses of fiscal measures following a monetary policy shock. The conduct of fiscal policy significantly shapes the monetary transmission mechanism: the impact of a monetary policy shock on prices is more than halved by the endogenous adjustment in public transfers, whereas the tax system significantly reduces the effect on output. We show that changes in the fiscal framework can enhance monetary policy effectiveness.

Keywords: Monetary policy, fiscal channel, monetary fiscal policy interaction, structural counterfactuals, Bayesian proxy structural VAR models.

JEL codes: E32, E52, E63.

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1 Introduction

After inflation rates were relatively close to central banks' target rates during most of the Great Moderation period, since the Coronavirus pandemic and the subsequent Ukraine invasion, inflation rates across the globe are well above target. In response to the elevated price pressure, central banks have increased interest rates intended to reduce aggregate demand and ultimately inflation. At the same time, however, calls for fiscal measures to ease the burden of increasing living costs and to stimulate the economy were immediately voiced by the public.[1] Such expansionary fiscal policy might well counteract the monetary tightening, thereby making monetary policy less effective in fighting inflation (BIS, 2023; Bańkowski et al., 2023; Adrian and Gaspar, 2022). In this paper, we make two important contributions to this debate. First, we empirically quantify the importance of fiscal policy in shaping the monetary policy transmission mechanism. Second, we show how appropriate changes in the fiscal framework can enhance monetary policy effectiveness. Our findings reveal that fiscal policy matters a great deal for the overall macroeconomic impact of monetary policy interventions.

In theory, it is not clear whether and how fiscal policy affects the transmission of monetary policy. As long as Ricardian equivalence holds, the particular path of fiscal measures chosen by the government does not affect the responses to monetary policy (see, e.g., Clarida et al., 1999). In contrast, deviations from Ricardian equivalence through imperfect knowledge or borrowing constrained households imply that the fiscal reaction to the monetary intervention is a key determinant of the overall size of the macroeconomic response (Auclert et al., 2020; Alves et al., 2020; Kaplan et al., 2018; Eusepi and Preston, 2018).[2] Our empirical findings showing that the conduct of fiscal policy is crucial for understanding the overall effects of monetary policy strongly support theoretical predictions based on models in which Ricardian equivalence fails to hold.

As a first step of our analysis, we document that a monetary policy shock, besides affecting real and nominal macroeconomic variables, also significantly affects fiscal variables. We augment a standard monetary vector-autoregressive model of the US with main fiscal measures like tax

[1] For example, the Inflation Reduction Act implemented by the Biden Administration includes a large-scale fiscal stimulus on expenditures related to energy and climate change.

[2] For example, Kaplan et al. (2018) show that in a Heterogeneous Agent New Keynesian (HANK) model, the consequences of monetary policy are intertwined with the fiscal side of the economy. A change in the interest rate affects the intertemporal government budget constraint and generates some form of fiscal response that affects household disposable income. Unlike in models with Ricardian equivalence, the design of this response substantially matters for the overall macroeconomic impact of a monetary shock in a HANK model.

revenues, social transfer payments, discretionary government spending, and the fiscal deficit. To trace out the dynamic impact of exogenous interest rate changes, we estimate a Bayesian proxy structural vector-autoregressive (BPSVAR) model put forward in Arias et al. (2021).

In line with previous literature, we find that an exogenous increase in the interest rate lowers output and prices (see, e.g., Jarociński and Karadi, 2020; Gertler and Karadi, 2015). Most importantly, however, we emphasize a less studied empirical result that is key for understanding the transmission effects of monetary policy shocks. We find that a contractionary monetary intervention triggers a significant decline in tax revenues coupled with a significant increase in social transfer payments and a moderate rise in discretionary spending. The pronounced adjustments in taxes and social transfers are consistent with the mechanics of automatic stabilizers, while the less systematic response of government spending is in line with a more discretionary nature. As a result of lower revenues and higher expenditures, the fiscal deficit considerably increases. The strong impact of monetary policy shocks on fiscal measures motivates our main analysis where we conduct structural counterfactuals to understand how the fiscal channel shapes the transmission of monetary policy, and to depict alternative policy scenarios.

To characterize the fiscal channel of monetary policy, we employ structural counterfactuals along the lines of Antolín-Díaz et al. (2021) and McKay and Wolf (2023). In a first set of counterfactual results, we quantify the importance of the overall fiscal channel for the transmission of monetary policy. To do so, we neutralize the responses of all fiscal measures, namely taxes, transfers, and public spending, simultaneously through appropriately calibrated, consecutive fiscal policy shocks. In addition, we zoom into the different fiscal adjustment channels by shutting down the respective fiscal responses one by one. These counterfactuals help us isolate the mechanisms through which the fiscal channel impacts the monetary policy transmission by exactly neutralizing the endogenous fiscal policy responses. At the same time, they do not necessarily depict feasible policy counterfactuals as described in McKay and Wolf (2023), as it is not clear under which circumstances such scenarios absent endogenous fiscal policy are desirable. We then turn to policy counterfactuals in a narrower sense where we model the decision problem faced by a policy maker in the form of a loss function that incorporates a trade-off between output and price stabilization on the one side and limiting fiscal costs in terms of a higher fiscal deficit on the other side. These counterfactual results give us an indication of the composition of the policy mix of the fiscal response that enhances the effectiveness of monetary policy in the face of a policy trade-off, e.g. as evident in the course of the recent surge in inflation together with subdued growth and elevated public debt levels.

The first set of counterfactual results reveals that the fiscal channel significantly affects how interest rate changes transmit to real and nominal variables. In a counterfactual scenario where we neutralize the responses of all fiscal measures simultaneously, the decline in prices following a contractionary monetary policy shock is more than twice as large compared to the baseline scenario allowing for endogenous fiscal adjustments. In other words, the fiscal channel considerably reduces the deflationary effects of exogenous interest rate hikes. Moreover, the fall in output is also more pronounced when shutting down any endogenous fiscal response. Overall, our results show that the fiscal channel substantially deteriorates the sacrifice ratio implied by the monetary policy output-price trade-off.

When further constructing different counterfactual scenarios where we neutralize each endogenous fiscal response separately, we find that the effects vary across fiscal instruments. For example, when shutting down any endogenous tax revenue response to the monetary policy shock, real GDP falls by more than twice as in the baseline scenario, which allows for an endogenous adjustment in taxes. At the same time, the endogenous tax response has only a limited impact on the monetary transmission into prices. In stark contrast, adjustments through the transfer system have much stronger nominal but limited real effects. Assuming that social transfers do not adjust in response to the contractionary monetary policy shock pertains to an output response that shows only small differences compared to the baseline scenario. However, the fall in prices is more than three times as large when holding transfer payments constant.[3] The effects arising from discretionary public spending are generally small and less systematic. In additional counterfactual exercises we document that (i) the real effects linked to changes in tax revenues primarily materialize through changes in personal consumption and personal income rather than the corporate income tax code, and (ii) the nominal effects in case of changes in social transfer payments are closely linked to changes in firms' unit labor costs.

Based on these insights, and inspired by the recent policy debate, we elaborate on how fiscal policy can be streamlined to enhance monetary policy effectiveness. In particular, we construct two different policy counterfactuals. In the first one, which we call fiscal-activism scenario, the output response to monetary policy shocks is neutralized while the transmission to prices is preserved. In the second policy counterfactual, called constrained-fiscal scenario, the policy

[3]The strong inflationary effects of changes in transfer payments are well in line with recent theoretical contributions highlighting either the role of partly unfunded fiscal debt (Bianchi et al., 2023) or targeted transfers (Kaplan et al., 2023).

maker not only faces a trade-off between output and price stabilization but also intends to limit the deficit implications of the monetary intervention. We follow McKay and Wolf (2023) and implement policy rules approximately using a one-off linear combination of shocks. In our case we use tax revenue, social transfer, and government spending shocks that enforce the desired counterfactual rule as well as possible. This approach involves no ex-post surprises after impact, so that it is immune to the Lucas critique. In addition, we impose the policy rules with a combination of the fiscal shocks occurring over the entire impulse horizon so that the counterfactual is exactly imposed.[4] Independent of the approach, we find that an activist fiscal policy rule that does not impair the transmission to prices is primarily driven by adjusting taxes. In particular, in such an activist fiscal policy scenario taxes fall more strongly in response to a contractionary monetary policy shock compared to the prevailing fiscal framework. The stabilizing effects of lower taxes on output in the face of a monetary tightening calls for a smaller increase in social transfers. However, such a rule comes at the cost of a higher fiscal deficit.[5] Thus, in the constraint scenario, we additionally require a zero-deficit response following the monetary policy shock. The no-deficit target prevents the tax code from easing. As a result, the policy counterfactual is primarily achieved through adjustments in the transfer system and government spending. Which of the two policy scenarios is more desirable depends on the fiscal environment. The fiscal activism scenario results in a further deterioration of the fiscal balance and thus requires a sufficient amount of fiscal space. The constrained scenario is fiscal neutral but relies on strong reductions in government expenditures and thus requires a high degree of flexibility in public spending. However, shifts in government spending are often highly persistent, which might limit the scope for discretionary spending plans (Cox et al., 2024).

Our paper contributes to the topical debate on the interactions between monetary and fiscal policy (Bartsch et al., 2020; BIS, 2023; Beyer et al., 2023; Adrian and Gaspar, 2022), by studying how endogenous fiscal policy shapes the transmission mechanism of monetary policy. Several previous studies have shown that the monetary policy stance significantly influences the size of the government spending multiplier (Klein and Winkler, 2021; Cloyne et al., 2020; Miyamoto et al., 2018; Ramey and Zubairy, 2018). However, there exists much less evidence on the opposite relationship, i.e., how the fiscal stance impacts the way monetary policy affects real

[4]While the first approach requires a particularly responsive, informed and flexible fiscal authority, the policy counterfactual is immune to the Lucas critique by construction. The latter approach provides the most modest policy intervention in terms of the prevalence of fiscal shocks to achieve the counterfactual constraints (Antolín-Díaz et al., 2021).

[5]We complement our analysis by additionally looking at a no-deficit policy in response to monetary policy shocks.

and nominal outcomes. Our paper provides an empirical analysis to fill this gap.[6]

Bouscasse and Hong (2023) also study how fiscal policy responds to monetary policy shocks and they conduct counterfactual analyses to evaluate fiscal deficit implications of the monetary policy transmission. In contrast, we focus on the monetary policy trade-off and study how fiscal policy can be streamlined to alleviate the real costs of deflationary monetary policy actions. Also, note that our results imply a differential endogenous response of fiscal policy due to distinct empirical modelling choices.[7]

The remainder of the paper is organized as follows: Section 2 describes the BPSVAR model, the data, and the proxies used for identification. Section 3 presents our baseline VAR results regarding the impact of monetary policy shocks on macroeconomic variables and fiscal measures as well as the responses to identified fiscal shocks. Section 4 explains the structural counterfactuals. Section 5 presents counterfactual scenarios where we first shut down the endogenous responses of taxes, social transfers, and government spending simultaneously and then one by one, and evaluates the mechanisms at play. In Section 6, we present results of policy counterfactuals under different fiscal policy rules and discuss implications for monetary policy effectiveness. Finally, Section 7 concludes.

2 Methodology

We estimate a Bayesian proxy structural vector-autoregressive (BPSVAR) model that renders the simultaneous evaluation of multiple proxies for monetary and fiscal shocks possible. The structural parameters of the model then allow us to characterize the fiscal channel of US monetary policy in structural counterfactuals as proposed by Antolín-Díaz et al. (2021) and McKay and Wolf (2023), which we detail further below in Section 4.

[6] Kaplan et al. (2018) point out that "Currently, there is no empirical evidence that reveals what type of fiscal adjustment is the most likely to occur in practice, following a monetary shock."

[7] Bouscasse and Hong (2023) identify monetary policy shocks using the narrative Romer and Romer (2004) strategy, whereas we rely on recent developments regarding high-frequency identification and the consideration of potential signalling effects of monetary policy. Importantly, rather than being just a minor difference, identification significantly matters: Our baseline results imply that a contractionary monetary policy shock lowers output and prices. In contrast, Bouscasse and Hong (2023), find that an exogenous increase in the interest rate reduces output but increases prices (the so-called "price puzzle" of monetary policy). Moreover, Bouscasse and Hong (2023) find only small real effects of tax changes which stands in some contrast to our results and existing evidence on the relatively large size of tax multipliers (Mertens and Ravn, 2014; Romer and Romer, 2010).

2.1 The BPSVAR model

To simultaneously identify multiple shocks by multiple instruments within one empirical framework, we consider the BPSVAR by Arias et al. (2021), an efficient algorithm to independently draw from the posterior over the structural parameters of a proxy-SVAR conditional on the exogeneity restrictions and the relevance condition. Let $\boldsymbol{y}_t$ be a $n \times 1$ vector of macroeconomic variables, $\boldsymbol{m}_t$ be a $k \times 1$ vector of instruments (proxies), both observed in time t, then the BPSVAR is given by

$$\widetilde{\boldsymbol{A}}_0 \widetilde{\boldsymbol{y}}_t = \widetilde{\boldsymbol{c}} + \sum_{l=1}^{p} \widetilde{\boldsymbol{A}}_l \widetilde{\boldsymbol{y}}_{t-l} + \widetilde{\boldsymbol{\varepsilon}}_t, \tag{1}$$

where $\widetilde{\boldsymbol{y}}_t' = [\boldsymbol{y}_t', \boldsymbol{m}_t']$ is a $\widetilde{n} \times 1$ vector with $\widetilde{n} = n + k$, $\widetilde{\boldsymbol{c}}$ is a $\widetilde{n} \times 1$ column vector of constants, $\widetilde{\boldsymbol{A}}_l$ are the corresponding $\widetilde{n} \times \widetilde{n}$ coefficient matrixes, and $\widetilde{\boldsymbol{\varepsilon}}_t' = [\boldsymbol{\varepsilon}_t', \boldsymbol{\nu}_t'] \sim N(\boldsymbol{0}, \boldsymbol{I}_{\widetilde{n}})$.

In order to use the proxies $\boldsymbol{m}_t$ as "external instruments" so that they do not directly affect the endogenous variables $\boldsymbol{y}_t$, the corresponding autoregressive coefficients are set to zero,

$$\widetilde{\boldsymbol{A}}_i = \begin{bmatrix} \underset{(n\times n)}{\boldsymbol{A}_i} & \underset{(n\times k)}{\boldsymbol{0}} \\ \underset{(k\times n)}{\boldsymbol{\Gamma}_{i,1}} & \underset{(k\times k)}{\boldsymbol{\Gamma}_{i,2}} \end{bmatrix}, \text{ for } 0 \leq i \leq p. \tag{2}$$

This setup allows us to fit the proxy variables $\boldsymbol{m}_t$ together with the endogenous variables $\boldsymbol{y}_t$ with a single structural model estimated in one step while at the same time accounting for measurement error $\boldsymbol{\nu}_t$.[8]

The k structural shocks of interest $\boldsymbol{\varepsilon}_t^*$ are identified by imposing the standard exogeneity and relevance conditions:

$$E[\boldsymbol{m}_t \boldsymbol{\varepsilon}_t^{o\prime}] = \boldsymbol{0} \tag{3}$$

$$E[\boldsymbol{m}_t \boldsymbol{\varepsilon}_t^{*\prime}] = \boldsymbol{V}, \tag{4}$$

where $\boldsymbol{\varepsilon}_t^o$ indicates $n-k$ unidentified shocks, and $\boldsymbol{V}$ represents a non-singular covariance matrix of the proxy variables and the k identified structural shocks. To achieve exact identification between the multiple proxies and structural shocks in our context we set $\boldsymbol{V}$ to be upper triangular (see also Georgiadis et al., 2024). According to the high-frequency nature we order the monetary policy shock first thereby purging the fiscal shocks from potential endogeneity issues

[8]In contrast, frequentist proxy SVARs are generally estimated in two steps (see, e.g., Mertens and Ravn, 2013; Gertler and Karadi, 2015; Stock and Watson, 2018), which generally complicates inference.

associated with monetary surprises.[9] Arias et al. (2021) show that the exogeneity condition in Equation (3) implies $k \times (n-k)$ additional zero restrictions on the contemporaneous impact matrix $\widetilde{\boldsymbol{A}}_0^{-1}$. Moreover, to improve efficiency we follow Caldara and Herbst (2019) and Arias et al. (2021) and impose a relevance threshold to express a prior belief that the proxy variables are relevant instruments. In particular, similar to Breitenlechner et al. (2022) we require that each of the identified shocks accounts for at least 10% of the variance of the respective proxy variable.

To ensure that the restrictions on $\widetilde{\boldsymbol{A}}_0^{-1}$ as well as on $\widetilde{\boldsymbol{A}}_l$ are simultaneously satisfied, i.e. the estimation identifies the structural shocks $\boldsymbol{\varepsilon}_t^*$, we follow the Bayesian estimation algorithm as described in Arias et al. (2021). Due to the large dimensionality of our system we consider informative priors. Specifically, we opt for a standard Minnesota shrinkage prior, where the tightness and decay hyperparameters are selected hierarchically as described in Giannone et al. (2015).

2.2 Specification and data

Building on a standard monetary VAR specification consisting of measures of output, prices, financial frictions, and a short-term interest rate (see, e.g., Gertler and Karadi, 2015), we additionally consider various fiscal measures. Specifically, we include in $\boldsymbol{y}_t$ real GDP, the GDP deflator, the Gilchrist and Zakrajšek's (2012) excess bond premium (EBP), the one-year treasury bill rate, the fiscal deficit ratio, real tax revenues, real social transfers, and real (discretionary) government spending. The fiscal deficit ratio is constructed as the difference between total government expenditures and receipts as a fraction of nominal GDP. Total government expenditures include interest payments by the government and thus, besides more indirect effects, also capture a direct effect of interest rate changes on public expenditures. As a measure for social transfers we follow Romer and Romer (2016) and use social security benefits to persons paid by the government. Nominal tax revenues and nominal social transfers are converted into real terms by deflating with the GDP price deflator. All variables except the interest rate, the EBP, and the fiscal deficit enter $\boldsymbol{y}_t$ in log levels times 100. In the baseline specification, we set $p = 4$.

We estimate the BPSVAR model on quarterly data ranging from 1983Q1 to 2019Q4. Thus, we exclude the pre-Volcker period as well as the turbulence created by the Coronavirus pandemic

[9] In Appendix B we represent the restrictions in more detail.

potentially impairing sharp identification of the structural parameters.[10] While monetary policy VARs are usually estimated on monthly data, we use quarterly series because the main fiscal measures are only available at a quarterly frequency. We discuss the effects of switching from the monthly to the quarterly frequency below and show that the standard monetary policy transmission mechanism on e.g. prices and output is preserved in quarterly data.

All data except the EBP are taken from the Federal Reserve Bank of St. Louis database, Federal Reserve Economic Data (FRED). Data for the EBP are obtained from the Board of Governors of the Federal Reserve System, who provide the latest estimates of Gilchrist and Zakrajšek's (2012) original EBP series. Table A.1 in the Appendix lists all variables with the corresponding sources and data codes.

2.3 Proxies and identification

To identify monetary policy shocks, we use high-frequency data from Gürkaynak et al. (2022) that contain asset price surprises in a half-hour window around FOMC press releases. These high-frequency changes should capture only the effect of the monetary policy announcement and can be plausibly viewed as exogenous (e.g. Kuttner, 2001; Gürkaynak et al., 2005). In our baseline specification, we use interest rate surprises in the three-month ahead monthly fed funds future rates (see, e.g., Gertler and Karadi, 2015; Jarociński and Karadi, 2020).[11]

While macroeconomic shocks, such as aggregate demand or supply shocks, should not occur systematically within the short time window around monetary policy announcements, several contributions stress that these announcements convey information about the central bank's assessment of the economic situation (e.g. Campbell et al., 2012; Nakamura and Steinsson, 2018; Jarociński and Karadi, 2020). Since a monetary tightening, for instance, is typically a reaction to an improved economic outlook of the central bank, the associated announcement may lead to increased optimism among market participants and, hence, may counteract the effect of the increase in the interest rate.[12] To avoid our policy surprise measure being contaminated by these

[10]A substantial body of work suggests that the transmission mechanism of US monetary policy materially changed following the end of the Volcker disinflation (e.g. Boivin and Giannoni, 2006). Several other studies also detect a change in the fiscal transmission mechanism at the beginning of the 1980s (Bilbiie et al., 2008; Perotti, 2005). Thus, the sample choice has the advantage that we focus on a period in which the monetary-fiscal policy framework was relatively stable.

[11]To capture monetary policy in a broader sense, especially during the more recent period, we also consider an estimation using the first principal component of surprises in interest rate derivatives with maturities up to one year (see, e.g., Nakamura and Steinsson, 2018) in the robustness section (Subsection 3.3).

[12]Alternatively, Bauer and Swanson (2023) argue that these counteracting effects might be rather related to the response of monetary authorities to incoming economic news.

information effects, we follow Jarociński and Karadi (2020) and Jarociński (2022) and use stock market data to obtain a pure policy surprise that is orthogonal to the central bank information surprise (see also Miranda-Agrippino and Ricco, 2021; Andrade and Ferroni, 2021). The main identifying assumption is that a contractionary pure policy shock results in lower stock market prices as it reduces the present value of expected future dividends. Instead, an information shock that is associated with the announcement of higher interest rates results in higher stock prices as market participants adopt a more optimistic outlook. Thus, we impose the restrictions that interest rates and stock prices move in opposite directions following a policy shock, but in the same direction in response to an information shock. The implementation is carried out in the form of rotational sign restrictions as in Jarociński (2022). Along these lines, we obtain a particularly clean monetary policy instrument with an unambiguous economic interpretation.

While monetary policy instruments of the type that we use are well established in the literature, they are typically evaluated using monthly data. However, fiscal measures and proxies that we exploit in our analysis are only available at a quarterly frequency. Thus, in the estimation exercise below, we aggregate the pure monetary policy surprises to the quarterly frequency. To see whether aggregation to the quarterly frequency affects the estimated impulse responses, we compare estimations of otherwise standard monetary VARs with monthly and quarterly frequency in Figure A.1 in the Appendix. It turns out that the main transmission mechanism of the high-frequency surprise is preserved at quarterly frequency as the dynamics of the estimated responses are quite similar.

To construct structural counterfactuals investigating the interactions between monetary and fiscal policy, we have to identify exogenous fiscal interventions on top of the monetary policy shocks. In particular, we construct scenarios that rely on the identification of shocks to tax revenues, transfer payments and government spending.

As an instrument for exogenous changes in US tax revenues, we use the narrative series provided by Mertens and Ravn (2011), which is an extension of the original series by Romer and Romer (2010). To achieve identification the authors exploit the narrative information in official historical documents in two ways. First, they verify that the policy documents do not discuss a desire to respond to current or prospective economic conditions and return growth to normal. Second, within the set of policy changes not motivated by the near-term economic outlook, they focus on tax changes motivated either by a desire to reduce the budget deficit or by raising long-run growth. Thus, the identified tax shocks measure changes in the tax system that are not related to the state of the economy. To properly account for the well-known fiscal foresight problem, we follow Mertens and Ravn (2011) and use only those tax shocks to instrument for exogenous policy changes for which potential anticipation effects are arguably unlikely. More precisely, we omit all tax liability changes that were implemented more than 90 days (one quarter) after becoming law. We combine the original Mertens and Ravn (2011) narrative series which ends in 2006 by the measure provided by Hanson et al. (2021) which extends the series until 2019.

As a proxy for structural shocks to transfer payments, we rely on the narrative series constructed by Romer and Romer (2016). They use documents from the Social Security Administration, Congress, and the executive branch to identify the nature, motivation, timing, and size of benefit increases over several decades. This narrative analysis allows us to focus on increases that raised payments to existing beneficiaries and to exclude the few increases that were explicitly made for countercyclical purposes. In particular, Romer and Romer (2016) classify as exogenous the changes in Social Security benefits to keep up with past inflation, or to increase the insurance provided by the Social Security programs, i.e. ideological motivation of fairness or equity. We combine the original Romer and Romer (2016) narrative series which ends in 1991 by the measure provided by Párraga Rodríguez (2018) which extends the series until 2007.

Finally, we use government spending forecast errors to instrument for exogenous changes in government spending. This approach was also applied by, among others, Ramey (2011) and Auerbach and Gorodnichenko (2012). The underlying idea is that the forecast error captures only those changes in government spending that are not related to aggregate news and thus, are unanticipated by private agents. We extend the series provided by Auerbach and Gorodnichenko (2012), which covers the period 1966-2008 to include the remaining sample years.

Following previous literature employing proxy-VARs, we set the proxies in periods for which the proxies are not available to zero (see, e.g., Paul, 2020; Känzig, 2023). This treatment of missing observations is conservative while we can exploit the full sample to sharpen the estimation of the parameters.

3 VAR results

We first establish our results for the monetary policy shock, and discuss responses of macroeconomic aggregates as well as fiscal measures. As a next step, we discuss the effects of the identified fiscal shocks, i.e. tax, social transfer, and government spending innovations. While this analysis already gives a first intuition on the prevalence and mechanisms of the fiscal channel of monetary policy, we then continue by evaluating the role of the endogenous fiscal responses to monetary policy employing structural counterfactuals à la Antolín-Díaz et al. (2021) and McKay and Wolf (2023).

3.1 Impulse responses to monetary policy shocks

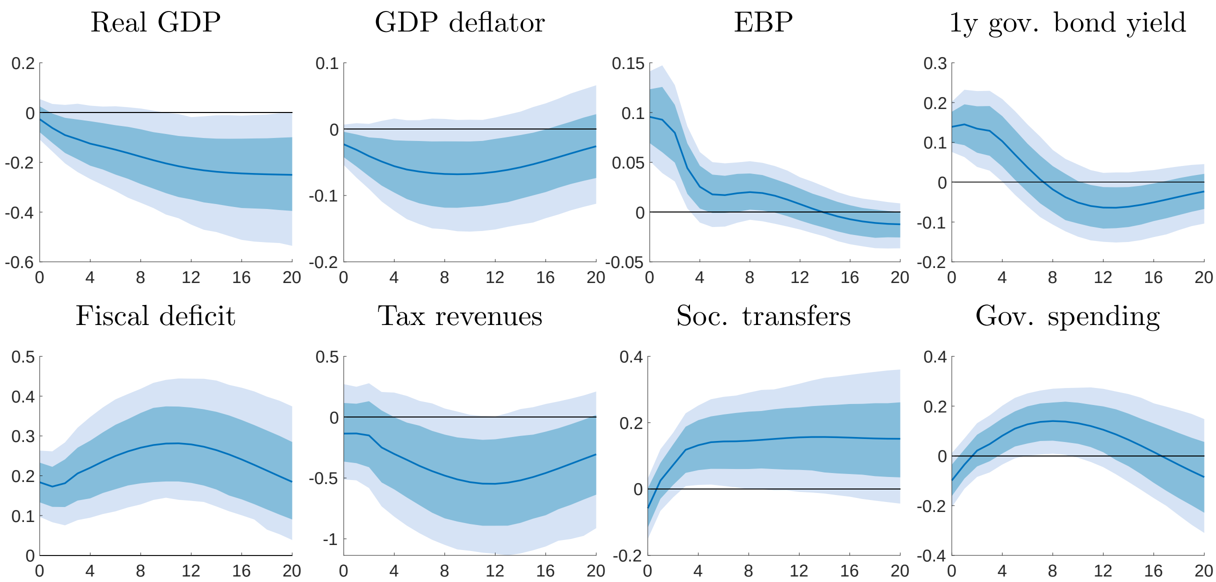
Figure 1 shows the responses to a contractionary monetary policy shock estimated with data ranging from the first quarter of 1983 to the end of 2019. The first row shows the responses of the main macroeconomic variables. The responses of the fiscal measures are shown in the second row. Solid lines show the posterior point-wise median impulse responses and shaded areas correspond to 68% and 90% probability bands. The responses are normalized to a contractionary one standard deviation monetary policy shock in the impact period.

We find that a contractionary monetary policy shock decreases real GDP and the GDP deflator over the medium run. Even though the posterior bands are relatively wide, the mass of the distribution of responses is clearly below zero over most of the impulse horizon. Thus, an exogenous increase in the interest rate lowers output and prices. The one-year treasury bill rate markedly increases on impact and gradually returns to the long-run equilibrium after approximately one year. The response of the excess bond premium (EBP) indicates a sharp and immediate tightening of financial conditions that is particularly pronounced over the first year after the shock sets in. As the interest rate decreases in the medium run, financial conditions ease. The overall aggregate effects are consistent with standard macroeconomic models and well in line with the empirical literature (see, e.g., Ramey, 2016). In particular, the responses show similar dynamics as in Jarociński and Karadi (2020), while they tend to be more pronounced compared to Gertler and Karadi (2015), who do not abstract from the signaling channel of monetary policy. Notably, evaluating the effects of monetary policy on quarterly data turns out to yield similar results in terms of dynamics compared to estimations with monthly data, a frequency which is typically considered in the context of monetary policy.[13]

The second row of Figure 1 shows that a monetary policy shock has a significant impact on fiscal variables. The decline in economic activity induced by the monetary intervention leads to a fall in taxable income and thus lowers tax revenues. Three years after the shock, tax revenues

[13] Figure A.1 in the Appendix provides results from a monthly VAR in which we leave fiscal shocks and variables out of considerations, as they are only available at quarterly frequency. The responses of macroeconomic aggregates are very similar to the ones shown in Figure 1.

Figure 1: Impulse response functions to contractionary monetary policy shocks



Notes: The lines show the posterior point-wise median values of the baseline impulse responses to a contractionary one standard deviation monetary policy shock. The shaded areas represent 68% and 90% centered point-wise probability bands.

are around 0.5% below their pre-shock level. In addition, the economic contraction triggers a significant increase in social transfers. At the end of the impulse horizon, social transfers are elevated by around 0.2%. Through its automatic stabilizing effects, social transfers generally increase (decrease) in economic downturns (expansions). Finally, government consumption expenditures show a mild increase in the medium run after a short-lived decline on impact. Such a moderate rise in (discretionary) public spending following a monetary policy shock is also found by Tenreyro and Thwaites (2016). The rather unsystematic behavior of government spending in response to a monetary policy shock might be explained by the discretionary nature of the series such that business cycle fluctuations should not trigger strong changes in discretionary expenditures. As a result of lower fiscal revenues coupled with higher expenditures in terms of transfers and discretionary spending, the fiscal deficit significantly rises in response to the monetary policy shock. The maximum response is reached three years after the shock with an elevated fiscal deficit of around 0.3 percentage points.[14] This finding is comparable to Sterk and Tenreyro (2018) who find that an expansionary monetary policy shock significantly reduces real public debt.

[14]Our fiscal deficit variable is based on total government expenditures, which on top of social transfers and government spending, includes additional measures that might be sensitive to changes in the interest rate, like interest payments by the government. Therefore, the response of the fiscal deficit captures further dynamics than the difference between the shown responses in tax revenues, social transfers, and government spending.

To summarize, an exogenous monetary policy shock is associated with strong fiscal effects. Revenues decline and expenditures increase, leading to a deterioration of the fiscal balance. The strong impact of monetary policy shocks on fiscal measures motivates our main analysis below where we conduct structural counterfactuals to isolate the fiscal channel in the transmission of monetary policy, and to depict alternative policy scenarios.

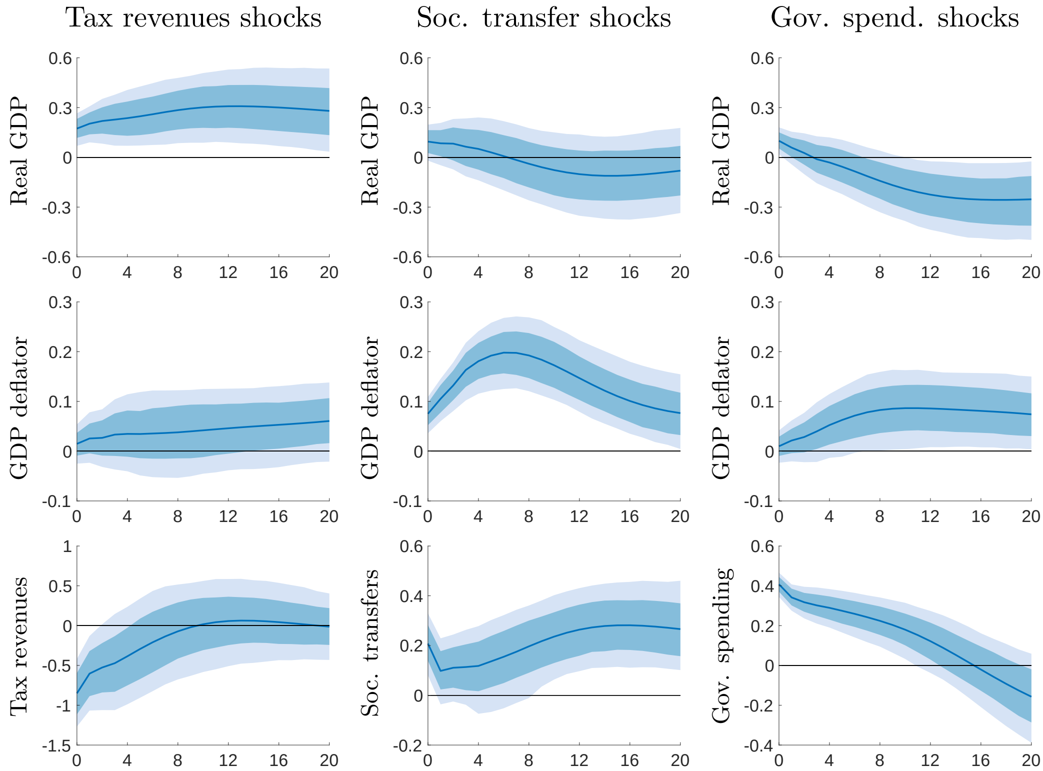
3.2 Impulse responses to fiscal policy shocks

Figure 2 presents for selected variables the estimated impulse responses to the identified fiscal shocks, i.e. the tax, social transfer, and government spending shock. The first column shows the responses to the tax shock, the second column to the transfer shock, and the third column to the spending shock, respectively. The first row presents the respective GDP responses, the second row depicts the price responses and the third row shows the responses of the respective fiscal measure. In the main text, we focus our attention on the central variables of interest, namely output and prices but report the responses of the remaining variables in Figure A.2 in the Appendix. The shocks are normalized to be expansionary and of one standard deviation in size triggering an increase in economic activity on impact. Thus, the responses pertain to an exogenous decline in tax revenues and increases in social transfer payments and government spending.

Overall, the estimated responses are well in line with the findings of previous studies. The tax revenue shock leads to a significant hump-shaped increase in GDP reaching its peak four years after the shock materialized. A similar expansionary impact of exogenous tax reductions is also found by e.g., Mertens and Ravn (2014), Ramey (2016) and Klein and Linnemann (2019). Moreover, the tax cut produces some price pressure with a delayed increase in the GDP deflator of around 0.05% five years after the shock. Mertens and Ravn (2012) and Klein and Linnemann (2019) estimate a comparable muted increase in prices following an exogenous tax reduction.

Compared to the tax shock, an exogenous increase in social transfers is associated with a much more short-lived increase in GDP. The response peaks already three quarters after the shock and becomes negative, albeit not statistically different from zero, in the medium run. Romer and Romer (2016) and Párraga Rodríguez (2018) also find that higher social transfers stimulate output only in the short run. Overall, the result that exogenous tax changes have a stronger impact on economic activity than exogenous changes in transfer payments is well in line with the evidence reported by Romer and Romer (2016). Contrary to the quite limited

Figure 2: Impulse response functions to expansionary fiscal policy shocks



Notes: The lines show the posterior point-wise median values of the baseline impulse responses to an expansionary one standard deviation tax revenue shock (first column), social transfer shock (second column), and government spending shock (third column). The shaded areas represent 68% and 90% centered point-wise probability bands.

real effects of a transfer shock, prices significantly increase following the fiscal stimulus. Two years after the shock, the GDP deflator is 0.2% above its pre-shock level. A similar strong price impact of shocks to social transfer payments is also found by Párraga Rodríguez (2018). Moreover, the particularly strong inflationary effect of positive transfer shocks supports recent theoretical contributions. Bianchi et al. (2023) propose a model with partly unfunded debt. In response to business cycle shocks, the monetary authority controls inflation and the fiscal authority stabilizes debt. However, the central bank accommodates unfunded fiscal shocks, causing persistent movements in inflation. When estimating the model, they find that such fiscal inflation accounts for the bulk of inflation dynamics in post-WWII data. Relatedly, Kaplan et al. (2023) show in a HANK model that an increase in targeted transfers towards poorer households can have strong inflationary effects.

Finally, similar to the transfer shock, the government spending shock induces only a limited and short-lived GDP expansion. GDP significantly increases in the impact period by around 0.1% but then converges back to zero and even turns negative in the medium run. Corsetti et al.

(2012) find a comparable GDP response following an exogenous government spending increase when starting the sample in the early 1980s as we do.[15] Similar to the transfer shock, while leading to only mild real effects, the spending increase also triggers a more pronounced rise in prices. The GDP deflator is up by around 0.1% two years after the spending shock materialized.

The fiscal shocks are associated with endogenous reactions in the other (non-shocked) fiscal measures as can be seen in Figure A.2 in the Appendix. For example, an exogenous tax cut has a delayed positive effect on government spending and leads to an immediate increase in the fiscal deficit. In contrast, an increase in government spending lowers (raises) tax revenues (social transfers) in the medium run, coupled with a deterioration in the fiscal balance. These dynamics are very much in line with the empirical evidence provided in Klein and Linnemann (2019). Somewhat surprisingly, by raising tax revenues and lowering government spending in the short run, an exogenous increase in social transfers has only a muted effect on the fiscal deficit. These endogenous adjustments in fiscal measures are important to keep in mind for our counterfactual analyses. When neutralizing specific fiscal responses like the fall in tax revenues following an exogenous increase in interest rates, this is also associated with indirect effects on government spending and social transfers and vice versa.

In summary, while the tax shock leads to strong real but limited price effects, the transfer and spending shocks are associated with strong price changes but have a muted impact on real economic activity. Given the significant responses of fiscal variables to monetary policy shocks as shown in Figure 1, a natural next step is to analyze the impact of exogenous changes in the interest rate in scenarios where fiscal responses are neutralized. In particular, we proceed to investigate how the transmission of monetary policy shocks changes when the responses of all three fiscal measures, namely taxes, transfers, and government spending are shut down simultaneously. Moreover, we also zoom into the importance of each fiscal instrument by constructing scenarios where we neutralize each of them at a time. The structural counterfactuals presented below provide us with the appropriate framework for investigating these issues.

[15] Also Ramey (2011), Forni and Gambetti (2016) and Bredemeier et al. (2022) find a similar short-lived output expansion following a positive government spending shock when considering a comparable sample period to ours. Moreover, similar to Corsetti et al. (2012) and Forni and Gambetti (2016) our estimates show that after the initial increase, government spending falls below trend in the medium term; a phenomenon they call "spending reversals".

3.3 Robustness

Before we turn to the structural counterfactuals, Figure A.3 in the Appendix documents the robustness of our underlying impulse response functions. First, we consider two alternative approaches to purge the daily high-frequency monetary policy surprises from information effects, namely (i) the "poor-man's approach" by Jarociński and Karadi (2020) in which the surprises are pre-selected depending on whether the policy surprise and the stock market surprise reveal opposite signs, and (ii) the approach by Miranda-Agrippino and Ricco (2021) in which the policy surprises are purged from Greenbook projections. Second, we consider the federal funds rate factor provided by Swanson (2021) purged from information effects as suggested in Miranda-Agrippino and Nenova (2022), and construct the monetary policy proxy based on surprises of interest rate derivatives with maturities up to one year (see, e.g., Nakamura and Steinsson, 2018). Finally, we consider two estimations, in which we either use the original tax proxy measure provided by Mertens and Ravn (2011) or Romer and Romer (2010). Because both series end in 2006, we fill the missing observations with zeros. All these modifications lead to very similar results compared to our baseline model.

4 Structural counterfactuals

Based on the VAR results presented above, we conduct structural counterfactuals to characterize the fiscal adjustments pertaining to the monetary policy shock transmission, as well as to study counterfactual fiscal policy scenarios, as recently put forward by McKay and Wolf (2023). Following Antolín-Díaz et al. (2021), we formalize the counterfactuals as conditional forecasts of the endogenous variables in which we restrict the path of specific variables and shocks.

In a first step of the counterfactual analysis, we replicate the impulse responses of US macroeconomic variables in Figure 1 for counterfactuals in which we neutralize the effects of monetary policy shocks on tax revenues, social transfers, and government spending with a hypothetical sequence of the respective fiscal policy shocks. Specifically, we neutralize all three fiscal measures together allowing us to quantify the overall effect of the fiscal channel. Additionally, we zoom into the different fiscal adjustment channels by separately shutting down the respective fiscal responses. In a second step, we run policy counterfactuals in which we alter the fiscal framework depending on specific rules.

To formalize the counterfactuals, we rewrite the SVAR implied by Equation (1) as an unconditional forecast of the endogenous variables based on information available up to period τ,

$$\boldsymbol{y}_{\tau+1,\tau+h} = \boldsymbol{b}_{\tau+1,\tau+h} + \boldsymbol{\Theta}\boldsymbol{\varepsilon}_{\tau+1,\tau+h}, \tag{5}$$

where $\boldsymbol{y}'_{\tau+1,\tau+h} = [\boldsymbol{y}'_{\tau+1}, \ldots, \boldsymbol{y}'_{\tau+h}]$ stacks the unconditional forecasts of the endogenous variables and $\boldsymbol{\varepsilon}'_{\tau+1,\tau+h} = [\boldsymbol{\varepsilon}'_{\tau+1}, \ldots, \boldsymbol{\varepsilon}'_{\tau+h}]$ the realizations of the future shocks in periods $\tau + 1$ through $\tau + h$. The $nh \times 1$ vector $\boldsymbol{b}_{\tau+1,\tau+h}$ denotes an autoregressive component predetermined by potential initial conditions and past shocks up to $\tau - 1$, and the $nh \times nh$ matrix $\boldsymbol{\Theta}$ is a function of the structural parameters that maps the future shocks into the unconditional forecasts of the endogenous variables.

Antolín-Díaz et al. (2021) provide a general solution to obtain a counterfactual forecast conditional on restrictions on the future path of specific endogenous variables and shocks. Let $\boldsymbol{f}_{\tau+1,\tau+h}$ be a column vector that collects k_o restrictions on the path of endogenous variables and k_s restrictions on the path of future shocks, and define $\boldsymbol{C}' = [\boldsymbol{O}', \boldsymbol{\Theta}^{-1\prime}\boldsymbol{S}']$, where $\boldsymbol{O}$ and $\boldsymbol{S}$ are $k_o \times nh$ and $k_s \times nh$ selection matrices. A structural counterfactual can be expressed as

$$\boldsymbol{C}\overline{\boldsymbol{y}}_{\tau+1,\tau+h} = \boldsymbol{C}\boldsymbol{b}_{\tau+1,\tau+h} + \boldsymbol{C}\boldsymbol{\Theta}\overline{\boldsymbol{\varepsilon}}_{\tau+1,\tau+h} = \boldsymbol{f}_{\tau+1,\tau+h}. \tag{6}$$

Assuming that the economy is in its long-run equilibrium, so that $\boldsymbol{b}_{\tau+1,\tau+h} = \boldsymbol{0}$, the counterfactual path of the future shocks $\overline{\boldsymbol{\varepsilon}}_{\tau+1,\tau+h}$ and of the endogenous variables $\overline{\boldsymbol{y}}_{\tau+1,\tau+h}$ are given by $\overline{\boldsymbol{\varepsilon}}_{\tau+1,\tau+h} = \boldsymbol{D}^*\boldsymbol{f}_{\tau+1,\tau+h}$ and $\overline{\boldsymbol{y}}_{\tau+1,\tau+h} = \boldsymbol{\Theta}\boldsymbol{D}^*\boldsymbol{f}_{\tau+1,\tau+h}$, with $\boldsymbol{D}^*$ being the Moore-Penrose inverse of $\boldsymbol{D} = \boldsymbol{C}\boldsymbol{\Theta}$.

Equation (6), for instance, recovers the baseline impulse responses to the monetary policy shock, as shown in Figure 1, if we do not impose any restrictions on the endogenous variables (i.e. set $\boldsymbol{O}$ to be empty), but restrict all shocks over the entire forecast horizon h to zero, except that the monetary policy shock equals one on impact. These restrictions on the shocks imply that $\boldsymbol{S} = \boldsymbol{I}_{nh}$, and $\boldsymbol{f}_{\tau+1,\tau+h}$ is a $nh \times 1$ vector of zeros with unity in the first entry of the monetary policy shock in $\boldsymbol{\varepsilon}_{\tau+1,\tau+h}$.

To isolate the overall effectiveness of the fiscal channel, the endogenous responses of tax revenues, social transfers, and government spending to monetary policy shocks are simultaneously set to zero over the entire impulse horizon. In this case, the counterfactual is solved by allowing the three fiscal policy shocks to materialize over the impulse horizon. Then, to understand the elements of the fiscal channel pertaining to the different fiscal policy measures, we construct counterfactuals in which we shut down each fiscal measure separately, using only the respective fiscal shock. For example, consider tax revenues: in this case, the tax revenue response to monetary policy shocks is set to zero, while the structural counterfactual is solved for the sequence of tax revenue shocks over the forecasting horizon. In all cases, the solution to Equation (6) is deterministic, and the constraints on tax revenues, social transfers, and government spending are exactly imposed.[16]

In a second set of counterfactuals, we evaluate potential changes in the fiscal framework vis-à-vis monetary policy. In particular, we study hypothetical fiscal policy responses to achieve certain policy objectives with respect to prices, output, and the fiscal deficit. McKay and Wolf (2023) show that such counterfactual policy rules can be recovered by the estimated impulse responses and the respective policy shocks. Moreover, McKay and Wolf (2023) suggest imposing such policy rules using neutralizing shocks only on impact, which renders the counterfactual scenarios immune to the Lucas critique. In order that the counterfactual in Equation (6) recovers the McKay and Wolf (2023) solution, the conditional forecast is restricted to be only driven by shocks in the impact period $\tau + 1$

$$\boldsymbol{C}\overline{\boldsymbol{y}}_{\tau+1,\tau+h} = \boldsymbol{C}\boldsymbol{b}_{\tau+1,\tau+h} + \boldsymbol{C}\boldsymbol{\Theta}\overline{\boldsymbol{\varepsilon}}_{\tau+1} = \boldsymbol{f}_{\tau+1,\tau+h}, \tag{7}$$

where $\boldsymbol{\Theta}$ is now $nh \times n$. Thus, in this case, where the three fiscal policy shocks can only occur on impact to impose the policy counterfactual over a longer horizon, the structural scenario is under-identified and no exact solution exists. McKay and Wolf (2023) approximate the solution 'as well as possible' using the method of least squares, i.e. $\overline{\boldsymbol{\varepsilon}}_{\tau+1} = (\boldsymbol{D}'\boldsymbol{D})^{-1}\boldsymbol{D}'\boldsymbol{f}_{\tau+1,\tau+h}$, where $\boldsymbol{D} = \boldsymbol{C}\boldsymbol{\Theta}$ and the economy is in its long-run equilibrium. The general solution of Antolín-Díaz et al. (2021) provides exactly the same closed-form solution, as the Moore-Penrose inverse $\boldsymbol{D}^* = (\boldsymbol{D}'\boldsymbol{D})^{-1}\boldsymbol{D}'$ (see Corollary 2 in Penrose, 1956).[17]

Additionally, to complement the policy counterfactuals that are imposed with only on-impact shocks, we also show a variant in which neutralizing shocks materialize over the entire forecast-

[16]Note that in this case $\boldsymbol{D}^*$ is full rank, and $\boldsymbol{D}^* = \boldsymbol{D}^{-1}$. The implementation of the individual counterfactual experiments is detailed in Appendix C. McKay and Wolf (2023) show that an alternative way to impose such counterfactuals without ex-post surprises, at least approximately, is to consider a linear combination of offsetting shocks in the impact period. While such an approach is immune to the Lucas critique, it complicates the dissection of the fiscal channel because of the approximation error and the different nature of the offsetting shocks. We turn to the McKay and Wolf (2023) approach below in the context of policy scenarios where we allow for a combination of shocks driving the counterfactual.

[17]In Appendix C we map the minimization problem of McKay and Wolf (2023) into the framework of Antolín-Díaz et al. (2021).

ing horizon to exactly impose the constraints. In this case, the number of neutralizing shocks exceeds the number of restrictions, meaning that the counterfactual is over-identified and multiple solutions exist. The solution implied by the Moore-Penrose inverse minimizes the deviation between the neutralizing shocks and their baseline counterparts. It can be interpreted as the most modest policy intervention to achieve the scenario given the data (see Antolín-Díaz et al., 2021). Below, we refer to the two different implementations of the policy counterfactuals as the most modest intervention and the Lucas critique robust intervention.

5 Neutralizing the endogenous fiscal adjustment

We first study a structural counterfactual where the endogenous responses of all fiscal measures, namely taxes, social transfers, and government spending are shut down simultaneously. By assuming no endogenous reaction in all fiscal measures, these counterfactual responses provide a quantification of the overall importance of the fiscal channel for the transmission of monetary policy shocks. We then zoom into the different fiscal instruments and study the counterfactual impulse responses to a monetary policy shock when the endogenous response of either taxes, social transfers, or government spending is shut down. These restrictions on the future path of observables are imposed by allowing the respective fiscal policy shock to neutralize the endogenous adjustment.[18]

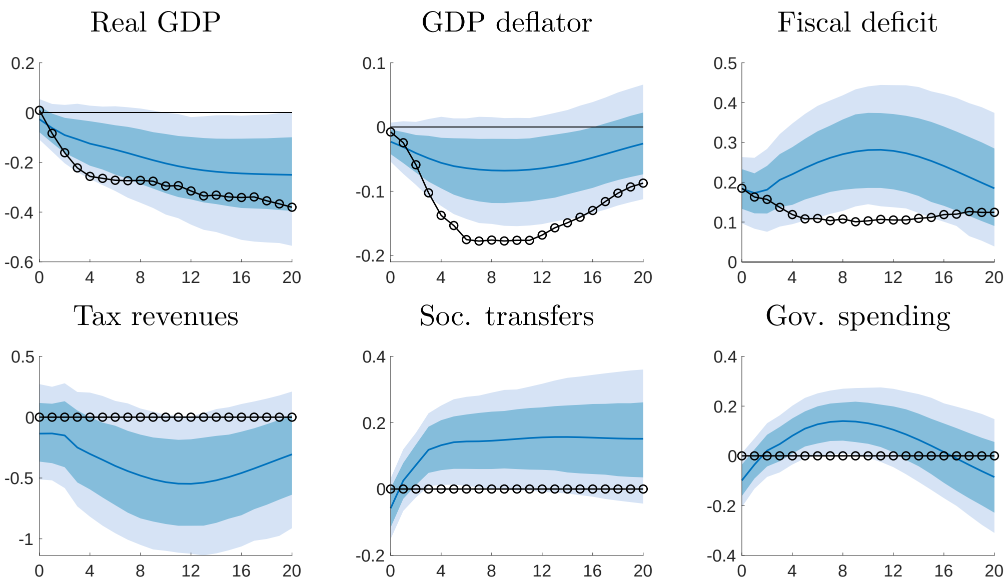
5.1 Counterfactual impulse response functions

Figure 3 shows the effects when assuming no endogenous responses in tax revenues, social transfers, and government spending all together. Thus, instead of a fall in tax revenues, and higher social transfers and government spending as reported in Figure 1, the respective fiscal adjustments are turned off. The lines without markers and shaded areas correspond to the baseline estimates as reported in Figure 1, while lines with markers show the counterfactual responses. The responses of the fiscal measures in the second row of Figure 3 visualize the counterfactual experiment. The responses of tax revenues, social transfers, and government spending are set to zero for the entire impulse horizon.

In the first row of Figure 3, we see the implied counterfactual responses in GDP, prices and the fiscal deficit. The increase in the fiscal deficit following an exogenous increase in the interest rate is substantially reduced. Two years after the shock occurred, the rise in the fiscal deficit is

[18]See Appendix C for the specification of the matrices $\boldsymbol{O}$, $\boldsymbol{S}$, and $\boldsymbol{f}_{\tau+1,\tau+h}$.

Figure 3: Impulse responses and counterfactuals when all fiscal measures are offset



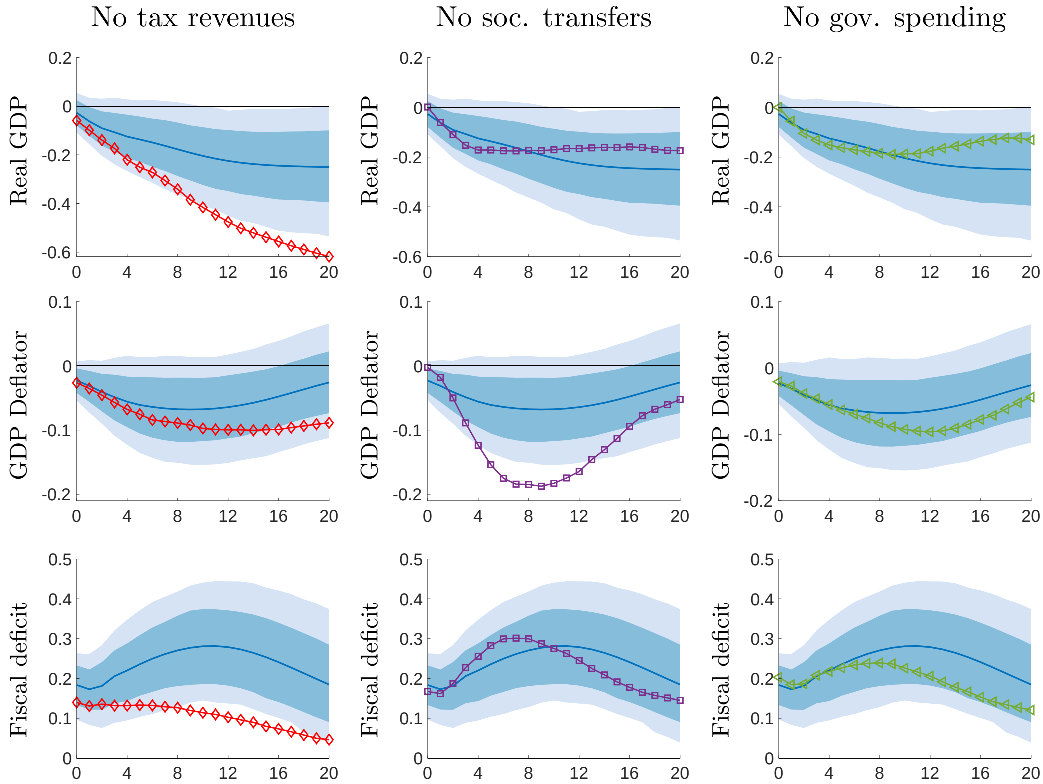
Notes: The lines without markers show the posterior point-wise median values of the baseline impulse responses to a contractionary one standard deviation monetary policy shock. The lines marked with circles depict the counterfactual impulse responses when all endogenous fiscal responses—tax revenues, social transfers, and government spending—are simultaneously neutralized. The shaded areas represent 68% and 90% centered point-wise probability bands for the baseline impulse responses.

more than halved compared to the baseline case with endogenous fiscal adjustments. As noted earlier, the total expenditures variable that enters our fiscal deficit measure includes, on top of social transfers and government spending, other expenditure components that might be affected by changes in the interest rate like, for example, interest payments by the government. This explains why the fiscal deficit also increases in the counterfactual scenario.[19] Besides lower fiscal costs in terms of a limited increase in the fiscal deficit, the counterfactual scenario also implies strong real and nominal consequences. The fall in the GDP deflator is significantly amplified when the fiscal responses are neutralized. While the peak response in prices is less than 0.1% in the baseline case, it more than doubles and becomes less than 0.2% in the counterfactual scenario. Also the fall in GDP is more pronounced in a scenario of no fiscal adjustments. At the end of the impulse horizon, output declines by more than 0.3%, whereas the reduction amounts to around 0.2% in the case with endogenous fiscal reactions.

Figure A.4 in the Appendix reports the implied differences between the baseline and counterfactual impulse responses for GDP, the GDP deflator, and the fiscal deficit. The differences for the

[19]We have verified this line of reasoning by estimating a VAR that includes total government expenditures. Both, in the baseline case with endogenous adjustments in fiscal measures and in the counterfactual scenario, total expenditures increase following the monetary policy shock, although the increase is much limited when assuming no changes in fiscal measures. Results on these estimations are available upon request.

Figure 4: Impulse responses and counterfactuals when individual fiscal measures are offset



Notes: The lines without markers show the posterior point-wise median values of the baseline impulse responses to a contractionary one standard deviation monetary policy shock. The lines with markers depict the counterfactual impulse responses when either the response of tax revenues (first column), social transfers (second column), or government spending (third column) is neutralized. The shaded areas represent 68% and 90% centered point-wise probability bands for the baseline impulse responses.

GDP deflator and the fiscal deficit are significant with the one standard deviation probability bands outside the zero line for most periods of the impulse horizon. The difference for real GDP is less pronounced with the one standard deviation probability bands not encompassing the zero line for a few quarters. To summarize, these results imply that the fiscal channel of monetary policy is quantitatively important. It significantly reduces the deflationary effects of contractionary monetary policy shocks. In addition, the endogenous responses in tax revenues, social transfers, and government spending tend to limit the decline in economic activity following an exogenous increase in the short-term interest rate.

After having investigated the counterfactual responses in a scenario where we shut down the endogenous responses of the separate fiscal measures all together, we now continue and zoom into the implied consequences when shutting down the endogenous response of one of the fiscal measures at a time. The first column of Figure 4 shows the effects when assuming no endogenous response of tax revenues, whereas the second and third columns present the results when assuming unchanged social transfers and government spending, respectively, following the monetary policy shock. As before, the lines without markers and shaded areas correspond to the baseline estimates as reported in Figure 1, while lines with markers show the counterfactual responses.

When shutting down the endogenous response of tax revenues to the monetary policy shock, the effects on output and prices are larger (in absolute terms) compared to the baseline case. The discrepancy is particularly strong for GDP. When not allowing tax revenues to fall following the contractionary monetary intervention, at the end of the impulse horizon GDP declines by around twice as much. Thus, allowing for a temporary decline in tax revenues is quantitatively important to limit the recessionary effects induced by the exogenous increase in the interest rate. A qualitatively similar picture emerges for prices. While the baseline estimates indicate that the GDP deflator is close to zero at the end of the impulse horizon, prices would still be lowered by a bit less than 0.1% when holding tax revenues constant. Holding tax revenues constant also limits the increase in the fiscal deficit. At the end of the impulse horizon, the deficit increase is around 0.05 percentage points, roughly one-fourth of the rise in the fiscal deficit observed in the baseline case.

In a scenario where social transfers do not respond to the monetary policy shock, as shown in the second column of Figure 4, the real effects are quite close to the baseline estimates. This can be explained by the limited impact of exogenous changes in social transfers on real GDP as already shown in Figure 2. In contrast, the effect on prices is quantitatively much more pronounced. Two years after the shock materialized, the baseline estimates show a fall in prices by around 0.05%, whereas prices would fall by around 0.2% when assuming no change in social transfers following the monetary policy shock. Thus, the transfer system considerably dampens the deflationary effects of contractionary monetary policy interventions. There are no systematic differences in the fiscal deficit response between the baseline and the counterfactual scenario. This might seem surprising at first sight but can be explained by the limited impact of social transfer shocks on the fiscal deficit, as discussed in Section 3.

For government spending, the differences between the baseline responses and the counterfactual scenario are more muted. This is due to the mostly insignificant response of government spending to the monetary policy shock (see Figure 1) together with the rather limited impact of exogenous government spending shocks on output and prices (see Figure 2).

These results help our understanding of the importance of the fiscal channel for the transmission of monetary policy shocks as documented in Figure 3. In particular, the stabilizing role of the tax and transfer system considerably reduces the impact of monetary policy interventions on the economy. While endogenous adjustments in the tax system are mainly responsible for the limited impact of monetary policy shocks on output, cyclical movements in transfer payments significantly reduce the impact of monetary policy interventions on prices.

Our findings have important implications for theoretical models. Typically, in models in which Ricardian equivalence holds, the particular path of fiscal measures chosen by the government does not affect the responses to monetary policy (Eusepi and Preston, 2018). In contrast, deviations from Ricardian equivalence through imperfect knowledge or borrowing-constrained households, imply that the fiscal reaction to the monetary expansion is a key determinant of the overall size of the macroeconomic response (Auclert et al., 2020; Alves et al., 2020; Eusepi and Preston, 2018; Kaplan et al., 2018). Our results showing that fiscal policy is crucial for understanding the overall effects of monetary policy strongly support theoretical predictions based on models in which Ricardian equivalence fails.

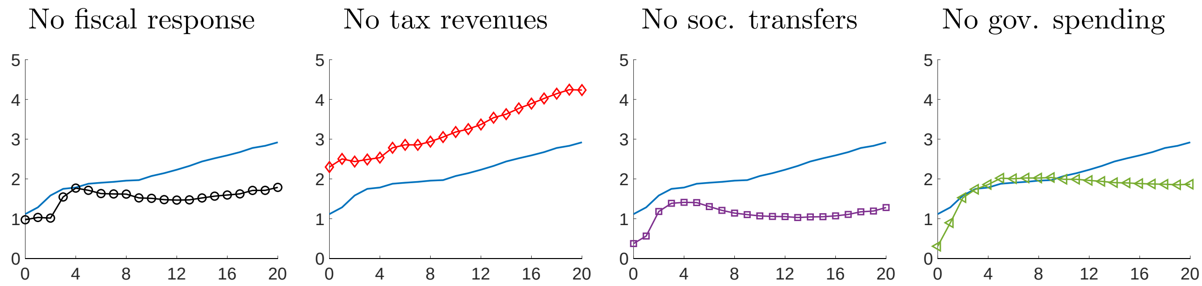
To address possible concerns about the plausibility of our counterfactual exercises with respect to the Lucas critique we report in Figure A.5 the q-divergence proposed by Antolín-Díaz et al. (2021). The q-divergence builds on the Kullback-Leibler divergence and compares the distribution of shocks in the counterfactual scenario to the distribution of shocks implied by the unrestricted impulse responses.[20] The q-divergence transforms the Kullback-Leibler statistic such that values close to 0.5 indicate that the two distributions are similar and unproblematic. In contrast, values close to 1 would indicate that a rather unusual distribution of shocks is necessary to construct the counterfactual, making it likely that economic agents update their beliefs about the structure of the economy. Figure A.5 shows that in each of the three counterfactual scenarios, the distribution of q-values lies very close to 0.5 which implies that the Lucas critique is unlikely to be a major concern for our analysis so far.

5.2 Implications for the monetary policy trade-off

What does the endogenous fiscal policy response following a monetary policy intervention imply for the effectiveness of monetary policy? A useful angle to assess the effectiveness of monetary policy is the sacrifice rate implied by the so-called Phillips curve relationship (Barnichon and

[20] To obtain distributions of the shocks implied by the unconstrained baseline impulse responses and the structural scenarios we follow the calculation of the q-divergence as described in Breitenlechner et al. (2022).

Figure 5: Sacrifice ratios implied by the baseline and counterfactual impulse responses



Notes: The lines without markers show the posterior point-wise median of the sacrifice ratio calculated as the cumulated impulse responses of real GDP divided by the cumulated impulse response of the GDP deflator to a contractionary one standard deviation monetary policy shock. The lines with markers depict the sacrifice ratios implied by the counterfactual impulse responses when either all endogenous fiscal responses are simultaneously neutralized (first column), or when the individual fiscal response of tax revenues (second column), social transfers (third column), or government spending (fourth column) is neutralized separately.

Mesters, 2021). As such, the output-price trade-off is at the core of monetary policy making. Higher interest rates are intended to lower prices at the cost of reducing demand and output while stimulating output through monetary easing fuels inflation. Depending on the central bank's objectives and priorities in terms of price and output stabilization, our results suggest that the effectiveness of monetary policy is significantly influenced by the fiscal framework. We construct the sacrifice ratio of monetary policy as the cumulated real GDP response over the cumulated response in the GDP deflator across the impulse horizon following a monetary policy shock.

Figure 5 shows for the impulse responses displayed in Figures 1, 3 and 4, respectively, the implied sacrifice ratio in percentage terms. As real GDP drops by more than the GDP deflator in the baseline model, the sacrifice ratio is generally above one, as indicated by the solid lines without markers. A lower (higher) value of the sacrifice ratio implies that a smaller (larger) change in output is required to achieve a given change in prices. The lines with markers in Figure 5 refer to the counterfactual scenarios. The left panel belongs to the scenario where we shut down all endogenous fiscal responses as shown in Figure 3. The remaining panels show the counterfactual sacrifice ratios when neutralizing the endogenous response of each of the fiscal instruments separately, as shown in Figure 4. Notably, the sacrifice ratio varies substantially depending on the scenario we consider.

When we neutralize all endogenous fiscal responses simultaneously, the sacrifice ratio becomes smaller compared to a scenario with endogenous fiscal adjustments. While the difference is rather small in the first year of the impulse horizon, it widens in the medium run. Four years after the shock materialized, the sacrifice ratio is almost halved in the counterfactual scenario. This implies that the fiscal channel of monetary policy worsens the monetary policy trade-off. Larger changes in output are required to achieve a given price effect.

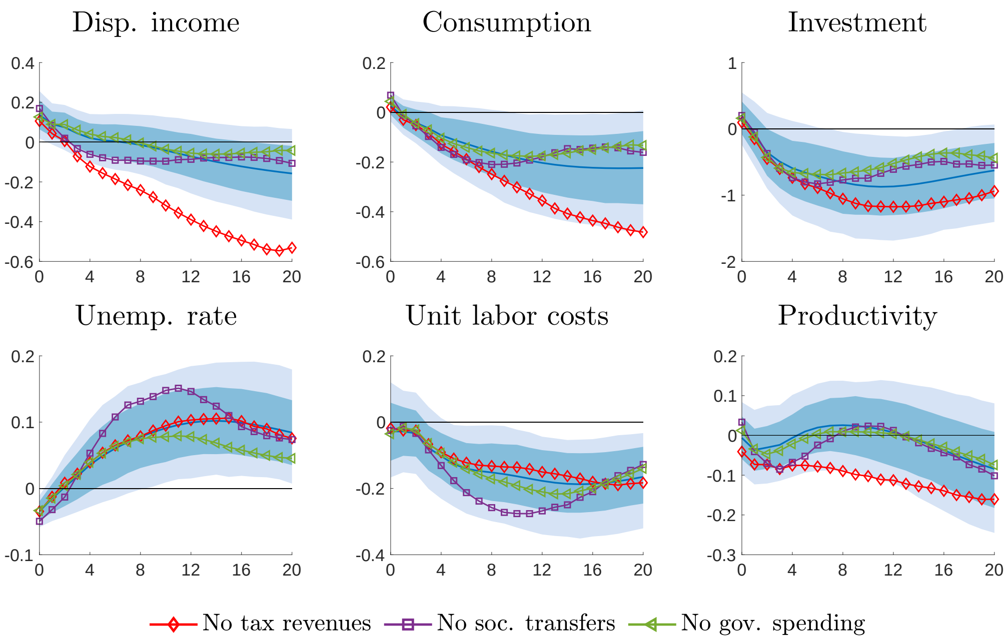
Which fiscal instrument is mainly responsible for lowering the sacrifice ratio? In the scenario in which we shut down the endogenous tax response, as shown in the second panel of Figure 5, the sacrifice ratio increases substantially indicating that a change in prices comes at larger output costs. At the end of the impulse horizon, we observe a hypothetical sacrifice ratio of 4.2 opposed to 2.9. By contrast, neutralizing the reaction of social transfers markedly reduces the sacrifice ratio, presented in the third panel of Figure 5. At the end of the impulse horizon, we observe a hypothetical sacrifice ratio of 1.3. The implications for the sacrifice ratio of the endogenous response of government spending is rather inconclusive (see right panel of Figure 5). As discussed earlier, the fall in tax revenues following a contractionary monetary policy shock strongly limits the real effects of monetary policy interventions without inducing strong price effects. As a result, the sacrifice ratio falls compared to a scenario with constant tax revenues. In stark contrast, the significant increase in transfer payments following an exogenous rise in the interest rate, strongly reduces the impact of monetary policy shocks on prices without entailing strong output effects. As a consequence, the sacrifice ratio increases relative to the no-transfers scenario and thus larger changes in output are required to achieve a given price effect. The lowering of the sacrifice ratio in a scenario without any fiscal adjustments, as shown in the left panel of Figure 5, is mainly driven by adjustments in the transfer system dominating the increase in the ratio through the endogenous tax response.

It is important to note that a lower sacrifice ratio does not need to be preferable in all circumstances. A lower sacrifice ratio implies lower output costs of policy actions to correct off-target inflation which is generally desirable when price stabilization is the central bank's top priority. From this perspective, the endogenous adjustment in taxes enhances the effectiveness of monetary policy. By contrast, to the extent that the social transfer system stabilizes prices, it impairs the transmission of monetary policy to prices making higher rates, and thus higher output costs, necessary to counteract off-target inflation. However, the implications of the sacrifice ratio depend on the priorities of the monetary authority in the face of a policy trade-off. For example, consider the reaction of the central bank to supply shocks which drive output and prices in opposite directions. Depending on the central bank's priorities in terms of output and price stabilization, the monetary authority will raise or lower rates. In case of output stabilization being the top priority, a higher sacrifice ratio and accompanying adjustment in social transfers can be desirable to limit the price effects of higher rates. Moreover, in a scenario where no policy trade-off exists, e.g. in the event of a boom with above-target inflation, a higher sacrifice ratio can be desirable when the output gap is larger than the price gap.

5.3 Inspecting the mechanisms

The previous comparison of actual versus counterfactual impulse response functions already suggests that depending on the fiscal policy instrument, different mechanisms are at play in the endogenous adjustment of fiscal policy after monetary policy shocks. In particular, it appears that the adjustment of taxes rather stabilizes output, while the social transfer system primarily influences prices. In order to better understand the different mechanisms, in the following, we extend our analysis and investigate several important variables that help rationalizing these findings.

Figure 6: Impulse responses and counterfactuals of the unemployment rate, unit labor costs, and productivity



Notes: The lines without markers show the posterior point-wise median values of the baseline impulse responses to a contractionary one standard deviation monetary policy shock. The lines with markers depict the posterior point-wise median values of the counterfactual impulse responses when either the response of tax revenues (diamonds), social transfers (squares), or government spending (triangles) is neutralized separately. The median values of the corresponding q-divergence statistics lie between 0.51 and 0.53. The shaded areas represent 68% and 90% centered point-wise probability bands for the baseline impulse responses.

The first row of Figure 6 shows the actual and counterfactual impulse responses of disposable income, private consumption and investment to monetary policy shocks. In the structural counterfactuals we shut down the endogenous adjustment of taxes, social transfers and government spending by the respective fiscal policy shocks. Clearly, a substantial part of the adverse real effects of the monetary tightening is eased by lowering the tax burden. As a result, consumers sustain their consumption spending, which ultimately cushions the output effects.

Looking at the first row of Figure 6, we see that without an endogenous adjustment in taxes, the counterfactual response in disposable income is substantially stronger and, in the absence of the tax response, the fall in consumption is approximately twice as large as in the baseline while investment expenditures are hardly affected. Similar demand-side adjustments also occur in the responses to monetary policy shocks without a reaction in social transfers, though these effects are generally much less pronounced. Thus, although the transfer system might well limit the fall in consumption expenditures of low-income households with potentially high marginal propensities to consume (Auclert et al., 2020; Kaplan et al., 2018), this effect does not seem to be strong enough to matter much at the aggregate level. Demand-side effects in the transmission of monetary policy shocks through government expenditures appear to be less prominent. In sum, the decomposition of GDP components shows that the real effects in the case of tax revenues primarily materialize through personal consumption expenditures.[21]

The dominant role of private income and spending for understanding the strong output effect of the tax system is also corroborated by a further counterfactual experiment that we run by discriminating between personal and corporate income tax shocks to neutralize the endogenous tax adjustment. In doing so, we rely on the decomposition of narrative (aggregate) tax shocks into changes in personal income and corporate income taxes provided by Mertens and Ravn (2013). Whereas so far, our analysis relied on a measure of aggregate tax revenues, this exercise allows us to zoom into the changes in the tax system by differentiating between personal income and corporate income tax adjustments. Thus, we modify our baseline specification by including real personal (corporate) tax revenues instead of aggregate revenues as endogenous variable in the BPSVAR and using the Mertens and Ravn (2013) proxy to extract exogenous changes in personal (corporate) taxes. The results are shown in Figure A.7 in the Appendix and indicate that the tax channel is predominantly driven by changes in personal income taxes relative to changes in corporate income taxes.

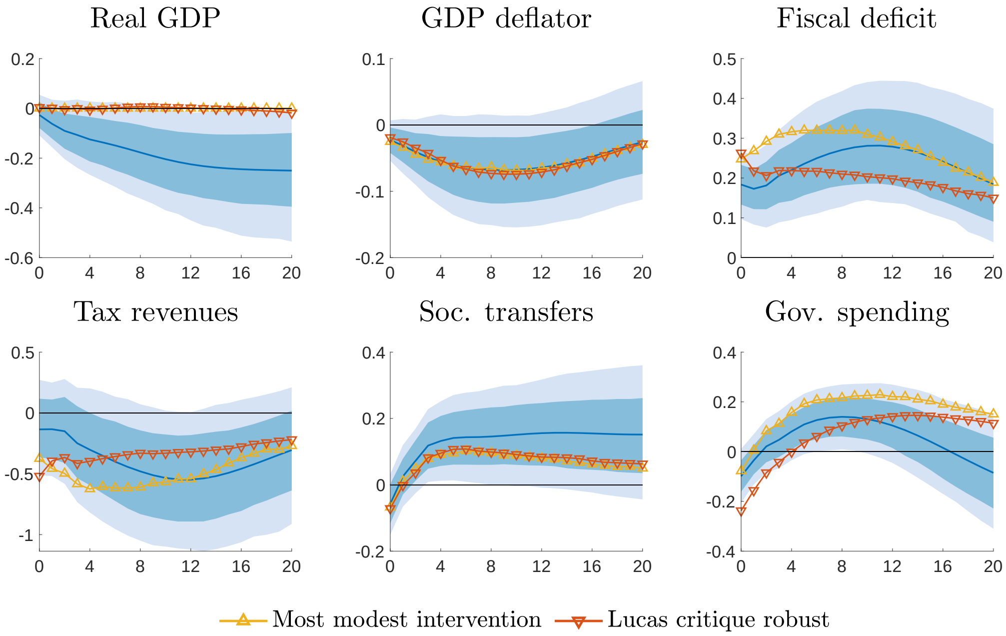
[21]The real effects cannot be explained by trade effects as import and export effects off-set each other (see Figure A.6 in the Appendix, which also shows the responses of the current account and the real effective exchange rat).

Turning to the second row of Figure 6, we intend to better understand the strong price effects of the transfer system as shown in Figure 4, and assess selected labor market variables. We present the responses of the unemployment rate, unit labor costs and labor productivity, respectively. In the baseline scenario, a contractionary monetary policy shock leads to a significant increase in the unemployment rate. Interestingly, when shutting down the endogenous adjustments in taxes and government spending, the resulting counterfactual unemployment responses show only minor differences to the baseline case. However, the transfer system limits the increase in the unemployment rate following exogenous interest rate hikes. At the two-year horizon, the unemployment rate is elevated by around 0.1 percentage points in the baseline, whereas it increases by around 0.15 percentage points in the no-transfers counterfactual. Thus, endogenous adjustments in transfer payments reduce the detrimental labor market effects of contractionary monetary policy shocks. Notably, the transfer system also limits the decline in unit labor costs. Absent the strong increase in transfer payments following the monetary policy shock, unit labor costs fall by a larger magnitude than in the baseline scenario. For the no tax revenues and no government spending scenarios, the differences in the unit labor costs responses, relative to the baseline, are rather limited. The unemployment and unit labor cost responses should be interpreted together. Our results suggest that the endogenous adjustment in transfer payments, by lowering the increase in unemployment, raises the reservation wage of workers and thus, leads to a smaller decline in unit labor costs, relative to the no-social transfers counterfactual. Given that firms' productivity does not change differently in the baseline and counterfactual scenarios, as shown in the right panel of Figure 6, production costs increase. Part of these higher costs might be passed on by firms into higher goods prices. Thus, the strong price effects of the transfer system seem to be related to a supply channel, where higher transfer payments raise unit labor costs and, ultimately, goods prices.

6 Counterfactual policy scenarios

So far, our structural counterfactuals were set up to shut down the overall endogenous fiscal adjustment or each of the different fiscal measures separately. The findings reveal that fiscal measures affect the monetary policy transmission mechanism differently. Based on these results and inspired by recent policy discussions (BIS, 2023; Adrian and Gaspar, 2022; Bartsch et al., 2020), we now take one step further and investigate how potential changes in the prevailing fiscal framework can enhance the effectiveness of monetary policy. That is, we allow for simultaneous changes in the fiscal measures to achieve certain policy goals.

Figure 7: Impulse responses and counterfactual responses in the fiscal-activism scenario



Notes: The lines without markers show the posterior point-wise median values of the baseline impulse responses to a contractionary one standard deviation monetary policy shock. The lines with markers depict the posterior point-wise median values of the counterfactual impulse responses when fiscal policy offsets the effects on real GDP and preserves the baseline effects on the GDP deflator using all three fiscal policy shocks either over the entire impulse horizon (upward-pointing triangles) or only on impact (downward-pointing triangles). The median values of the corresponding q-divergence statistic are 0.52 and 0.52. The shaded areas represent 68% and 90% centered point-wise probability bands for the baseline impulse responses.

In a first step, we render fiscal policy to act more active, thereby aiming to neutralize the output effects of monetary policy shocks while preserving the monetary policy effectiveness with respect to prices. Notably, this first counterfactual policy scenario abstracts from any fiscal deficit considerations. In a second step, we actively take account of the fiscal deficit implications by implementing a policy counterfactual where we manipulate the fiscal responses to reduce the real effects while maintaining the price response and at the same time limit the deterioration of the fiscal balance following a monetary tightening. In the following, we call the first counterfactual the fiscal-activism scenario and the second one the constrained-fiscal scenario.

Consider first the fiscal-activism scenario in which any output effects of monetary policy shocks are neutralized while the impact on prices is preserved. Such a policy scenario implies a sacrifice ratio, as introduced in Section 5.2, of zero, and thus the trade-off of monetary policy between output and price stabilization following exogenous interest rate changes vanishes. Put differently, we are interested in a hypothetical fiscal response to the monetary policy intervention that allows the monetary authority to impact prices while leaving real activity unaffected.[22] A low or zero sacrifice ratio may not be desirable in a demand-driven environment where no policy trade-off exists, as discussed in Section 5.2. However, it may enhance the effectiveness of monetary policy vis-à-vis supply shocks. In particular, such a fiscal-activism scenario could mitigate the real costs of monetary actions in a stagflationary environment, where the monetary policy trade-off is accentuated, as e.g. recently witnessed in the context of high inflation rates together with subdued growth. Also note that whether such a rule is desirable depends on the initial fiscal positions and the arising deficit implications.

Following McKay and Wolf (2023), we express the policy counterfactuals incorporating the monetary policy and fiscal trade-offs by the following loss function:

$$\mathcal{L} = \lambda_\pi \boldsymbol{\overline{\pi}}' \boldsymbol{W} \boldsymbol{\overline{\pi}} + \lambda_y \boldsymbol{y}' \boldsymbol{W} \boldsymbol{y} + \lambda_d \boldsymbol{d}' \boldsymbol{W} \boldsymbol{d}, \tag{8}$$

where $\{\boldsymbol{\overline{\pi}}, y, d\}$ captures the discounted deviation (i) from the baseline response of the GDP deflator to the monetary policy shock, (ii) of GDP from its steady-state, and (iii) of the fiscal deficit from its steady-state, respectively. $\boldsymbol{W} = diag(1, \beta, \beta^2, \ldots)$ with $\beta = 1/1.01$ accounts for the time preferences.

In the fiscal-activism scenario, we set $\lambda_\pi = \lambda_y = 1$ and $\lambda_d = 0$, thus the policymaker acts without any deficit considerations. In the constrained-fiscal scenario, we also account for the fiscal consequences by setting $\lambda_\pi = \lambda_y = \lambda_d = 1$. We allow the policy counterfactuals to be achieved through a combination of adjustments in tax revenues, social transfers, and government spending pertaining to respective fiscal shocks. For the fiscal-activism and the constrained-fiscal scenario, we consider two different approaches, both of them are agnostic about the composition of shocks to achieve the desired output, price, and deficit effects vis-à-vis the monetary policy shock.[23]

Figure 7 shows point-wise median counterfactual responses under the fiscal-activism scenario together with the baseline impulse responses. The red lines with downward-pointing triangle markers show the counterfactual responses in which the fiscal framework adjust on impact only,

[22] It is important to note that our analysis focuses only on aggregate dynamics. Any distributional consequences of monetary policy and the conduct of fiscal-monetary interactions are not considered. Thus, if the monetary authority, besides output and price mandates, also takes particular distributional concerns into account, our analysis should be extended by such dimension.

[23] We present the exact specification of the scenarios in Appendix C.

representing a Lucas critique robust intervention following McKay and Wolf (2023). Orange lines with upward-pointing triangle markers correspond to the fiscal-activism scenario implemented with a combination of successive fiscal policy shocks, representing the most modest intervention (see Antolín-Díaz et al., 2021).

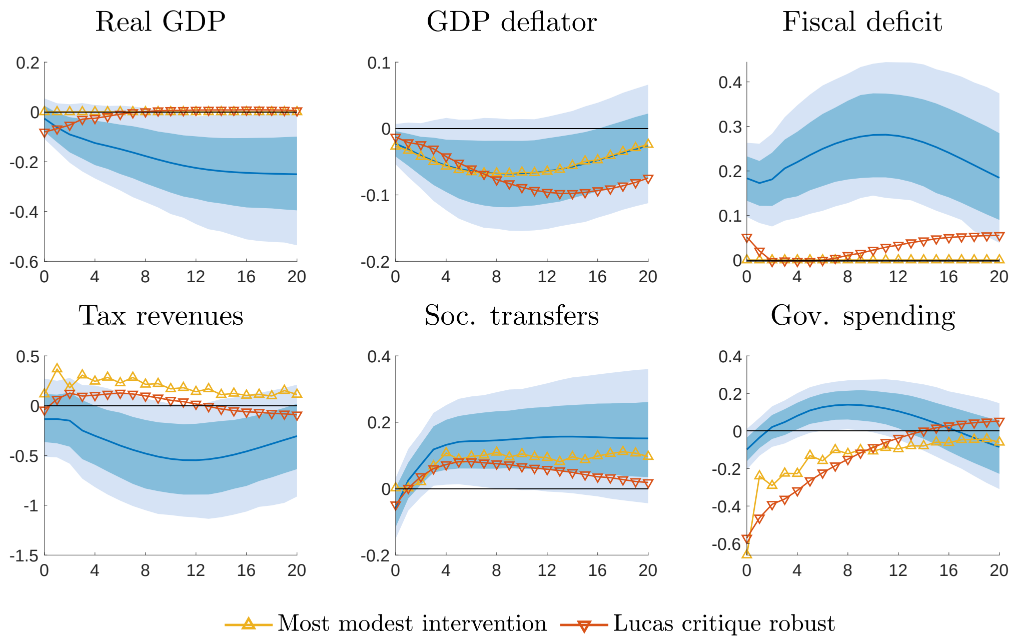
As intended by the scenario, the GDP response to a contractionary monetary policy shock is close to zero for both approaches, whereas the price responses are very similar to the baseline estimates.[24] Which changes in the fiscal framework lead to this outcome? The biggest adjustment takes place on the revenue side. Tax revenues fall much stronger following the exogenous increase in the interest rate than observed in the baseline. In other words, taxes are more cyclical conditional on monetary policy shocks relative to the baseline case. On impact, tax revenues decline by around 0.5% in the Lucas critique robust intervention and by around 0.3% in the most modest intervention, whereas the fall is less than 0.1% in the baseline case. Given the strong real effects of tax revenue shocks as already documented above, this additional fiscal stimulus neutralizes any output effect of the exogenous interest rate increase. In addition, the large real effects of tax revenue changes have only a limited impact on prices. The zero output effect of monetary policy implies that transfer payments, through their automatic stabilization function, increase by less compared to the baseline. In the case of government spending, we see some slight differences between the two approaches. While the Lucas critique robust intervention indicates a stronger decline in discretionary spending relative to the baseline, the most modest intervention implies a stronger increase in government spending over the medium run.

While stabilizing output, the fiscal-activism rule comes with additional fiscal costs. The strong decline in tax revenues coupled with moderate changes in government expenditures leads to a higher fiscal deficit. The on-impact effect is around 2 percentage points in the baseline case but rises to close to 3 percentage points in the counterfactuals. Given the stronger increase (decline) in government spending (tax revenues) in the most modest intervention case, the increase in the fiscal deficit is also more persistent. The strong decline in discretionary public spending in the Lucas critique robust approach results in an elevated fiscal deficit only on impact, while in the medium term, the response is below the baseline. Notably, the fiscal-activism rule does not induce explosive debt dynamics, as both approaches show deficit responses that converge back to steady state.[25]

[24] In Figure A.8 in the Appendix, we also report the prevalence of shocks to impose the scenarios.

[25] Which of the two approaches depicts the mechanics of a change in the fiscal framework more accurately depends on the perspective. For the most modest intervention to withstand the Lucas critique, agents are required to not adjust behavior. This means that they are required to display at least a certain degree of

Figure 8: Impulse responses and counterfactual responses in the constrained-fiscal scenario (fiscal policy offsets the real effects, preserves the nominal effects, and the fiscal deficit is kept constant)



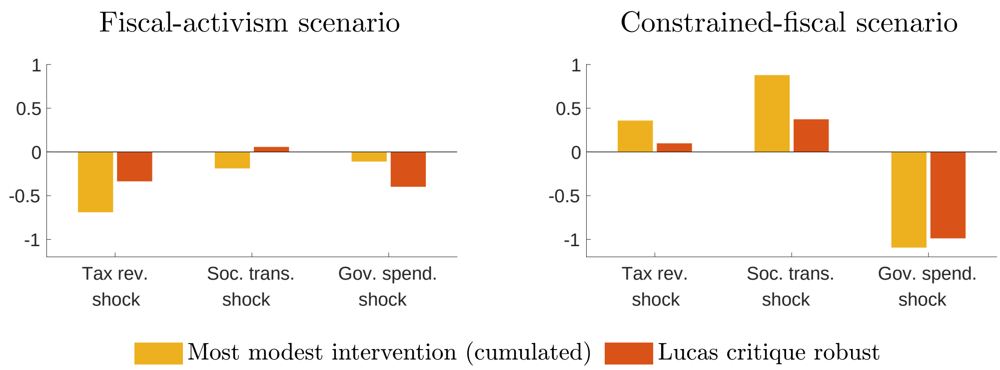
Notes: The lines without markers show the posterior point-wise median values of the baseline impulse responses to a contractionary one standard deviation monetary policy shock. The lines with markers depict the posterior point-wise median values of the counterfactual impulse responses when fiscal policy offsets the effects on real GDP, preserves the nominal effects, and the fiscal deficit is kept constant using all three fiscal policy shocks either over the entire impulse horizon (upward-pointing triangles) or only on impact (downward-pointing triangles). The median values of the corresponding q-divergence statistic are 0.58 and 0.54. The shaded areas represent 68% and 90% centered point-wise probability bands for the baseline impulse responses.

The results shown in Figure 7 indicate that adjustments in the current fiscal framework can enhance the effectiveness of monetary policy but at the cost of a higher fiscal deficit following the monetary intervention. To also account for fiscal deficit considerations, the constrained-fiscal scenario assigns equal weights to all three arguments in the loss function expressed in Equation 8. Figure 8 presents the results of the constrained-fiscal scenario, again for the Lucas critique robust and the most modest intervention. While in the most modest implementation with consecutive neutralizing shocks the scenario is exactly imposed, also the under-identified Lucas critique robust approach a là McKay and Wolf (2023) effectively enforces the scenario. We see that the additional deficit constraint impacts the composition of the fiscal adjustment.

myopia or informational rigidities so that the consecutive adjustment in the fiscal framework does not alter the transmission mechanism. While this appears conceivable, and also note that the q-divergence statistic indicates that the fiscal shocks to impose the scenario are indistinguishable from their unconditional distribution, the implementation à la McKay and Wolf (2023) is (by construction) immune to the Lucas critique. At the same time, this approach requires substantial fiscal flexibility and responsiveness, where relatively large fiscal shocks materialize on impact (see Figure A.8 in the Appendix). By contrast, the policy intervention in the most modest intervention case is smoother and more modest.

In particular, the no-deficit target prevents the tax code from easing. As a result, the policy counterfactual is achieved through adjustments in the transfer system and government spending. To understand how the fiscal framework adjusts in our policy counterfactuals, it helps to look at the prevalence of neutralizing fiscal policy shocks, as shown in Figure 9. The Figure reveals that the constrained-fiscal scenario is mainly driven by adverse government spending and expansionary social transfer shocks. Reducing government spending limits the increase in the fiscal deficit while having only small real effects. On the other side, given that transfer shocks have only a mild impact on the fiscal deficit, the output stabilization is thus achieved by imposing large increases in transfer payments. However, because negative government spending shocks lower social transfer payments as documented in Figure A.2 in the Appendix, aggregate transfer payments increase only by a small amount. The prevalence of the counterfactual shocks further leads to a slight increase in tax revenues.

Figure 9: Neutralizing shocks imposing the policy counterfactuals



Notes: The bars show the posterior point-wise median values of the neutralizing shocks imposing the fiscal-activism scenario (left panel) and constrained-fiscal scenario (right panel). The counterfactual policy rules are imposed using all three fiscal policy shocks either over the entire impulse horizon (left bars) or only on impact (right bars). The left bars represent the cumulated sum of the neutralizing shocks over the impulse horizon. Figures A.8 and A.9 in the Appendix show the neutralizing shocks over the entire impulse horizon with 68% centered point-wise probability bands.

Which one of the two policy scenarios is more desirable depends on the fiscal environment. The fiscal-activism scenario, which is mainly implemented by lowering tax revenues results in a further deterioration of the fiscal balance and thus requires a sufficient amount of fiscal space. The constrained scenario is fiscal neutral but relies on strong reductions in government spending and thus requires a high degree of flexibility in government expenditures. However, shifts in government spending are often highly persistent, which might limit the scope for discretionary spending plans (Cox et al., 2024).

In the Appendix, we also report the results of an additional scenario where we implement a counterfactual of a binding fiscal deficit rule that neutralizes any fiscal deficit implication of monetary policy shocks without imposing any restrictions on the real and nominal effects (see Figures A.10 and A.11). Notably, this no-fiscal deficit scenario is in stark contrast to the observed pattern documented in Figure 1 where the fiscal balance is significantly affected by monetary policy shocks. Independent of the approach chosen, we find that implementing a no-deficit rule significantly amplifies the adverse effects of contractionary monetary policy shocks in the short run: output and prices decline much stronger compared to the baseline case.

7 Conclusion

The counterfactual exercises reveal that the fiscal channel significantly affects the transmission of monetary policy shocks to prices and output. In addition, the way through which fiscal adjustment affects the transmission depends on the type of the fiscal response. Lower tax revenues precipitated by the monetary policy tightening significantly dampen the output response. Absent of an endogenous adjustment of tax revenues, the impact of a monetary policy shock on output is more than doubled emphasizing the role of adjustments in taxes as effective automatic stabilizers. The endogenous response in government spending and social transfer is less relevant for the transmission of monetary policy to output but significantly affects the transmission to prices.

Our results have important policy implications for the calibration of the fiscal reaction to monetary actions. Depending on the instruments through which a potential change in the fiscal framework is implemented—primarily through the revenue or the expenditure side of the public sector—the effects on the transmission of monetary policy to prices and output will differ. We show how changes in the fiscal framework can enhance monetary policy effectiveness.

References

Adrian, T., Gaspar, V., 2022. How fiscal restraint can help fight inflation. IMF Blog November 21.

Alves, F., Kaplan, G., Moll, B., Violante, G.L., 2020. A further look at the propagation of monetary policy shocks in HANK. Journal of Money, Credit and Banking 52, 521–559.

Andrade, P., Ferroni, F., 2021. Delphic and Odyssean monetary policy shocks: Evidence from the euro area. Journal of Monetary Economics 117, 816–832.

Antolín-Díaz, J., Petrella, I., Rubio-Ramírez, J.F., 2021. Structural scenario analysis with SVARs. Journal of Monetary Economics 117, 798–815.

Arias, J.E., Rubio-Ramírez, J.F., Waggoner, D.F., 2021. Inference in Bayesian Proxy-SVARs. Journal of Econometrics 225, 88–106.

Auclert, A., Rognlie, M., Straub, L., 2020. Micro jumps, macro humps: Monetary policy and business cycles in an estimated HANK model. Technical Report 26647. National Bureau of Economic Research.

Auerbach, A.J., Gorodnichenko, Y., 2012. Measuring the output responses to fiscal policy. American Economic Journal: Economic Policy 4, 1–27.

Barnichon, R., Mesters, G., 2021. The Phillips multiplier. Journal of Monetary Economics 117, 689–705.

Bartsch, E., Bénassy-Quéré, A., Corsetti, G., Debrun, X., 2020. It's all in the mix: How monetary and fiscal policies can work or fail together. Geneva Report on the World Economy, No 23, ICMB and CEPR.

Bauer, M.D., Swanson, E.T., 2023. An alternative explanation for the "Fed information effect". American Economic Review 113, 664–700.

Bańkowski, K., Bouabdallah, O., Checherita-Westphal, C., Freier, M., Jacquinot, P., Muggenthaler, P., 2023. Fiscal policy and high inflation. Economic Bulletin Articles 2.

Beyer, R.C.M., Duttagupta, R., Fotiou, A., Honjo, M.K., Horton, M.M.A., Jakab, Z., Nguyen, V., Portillo, M.R.A., Lindé, J., Suphaphiphat, M.N., Zen, M.L., 2023. Shared problem, shared solution: Benefits from fiscal-monetary interactions in the euro area. Working Papers 2023/149. International Monetary Fund.

Bianchi, F., Faccini, R., Melosi, L., 2023. A fiscal theory of persistent inflation. Quarterly Journal of Economics 138, 2127–2179.

Bilbiie, F.O., Meier, A., Müller, G.J., 2008. What accounts for the changes in U.S. fiscal policy transmission? Journal of Money, Credit and Banking 40, 1439–1470.

BIS, 2023. Annual economic report. Basel.

Boivin, J., Giannoni, M.P., 2006. Has monetary policy become more effective? Review of Economics and Statistics 88, 445–462.

Bouscasse, P., Hong, S., 2023. Monetary-fiscal interactions in the United States. Unpublished.

Bredemeier, C., Juessen, F., Schabert, A., 2022. Why are fiscal multipliers moderate even under monetary accommodation? European Economic Review 141, 103970.

Breitenlechner, M., Georgiadis, G., Schumann, B., 2022. What goes around comes around: How large are spillbacks from US monetary policy? Journal of Monetary Economics 131, 45–60.

Caldara, D., Herbst, E., 2019. Monetary policy, real activity, and credit spreads: Evidence from Bayesian Proxy SVARs. American Economic Journal: Macroeconomics 11, 157–92.

Caldara, D., Kamps, C., 2017. The analytics of SVARs: A unified framework to measure fiscal multipliers. Review of Economic Studies 84, 1015–1040.

Campbell, J.R., Evans, C.L., Fisher, J.D., Justiniano, A., Calomiris, C.W., Woodford, M., 2012. Macroeconomic effects of Federal Reserve forward guidance. Brookings Papers on Economic Activity 42, 1–80.

Clarida, R., Gali, J., Gertler, M., 1999. The science of monetary policy: A new keynesian perspective. Journal of Economic Literature 37, 1661–1707.

Cloyne, J.S., Jordà, Ò., Taylor, A.M., 2020. Decomposing the fiscal multiplier. Working Paper 26939. National Bureau of Economic Research.

Corsetti, G., Meier, A., Müller, G.J., 2012. Fiscal stimulus with spending reversals. Review of Economics and Statistics 94, 878–895.

Cox, L., Müller, G.J., Pastén, E., Schoenle, R., Weber, M., 2024. Big G. Journal of Political Economy 132, 3260–3297.

Eusepi, S., Preston, B., 2018. Fiscal foundations of inflation: Imperfect knowledge. American Economic Review 108, 2551–89.

Favara, G., Gilchrist, S., Lewis, K.F., Zakrajšek, E., 2016. Updating the recession risk and the excess bond premium. FEDS Notes. Washington: Board of Governors of the Federal Reserve System.

Forni, M., Gambetti, L., 2016. Government spending shocks in open economy VARs. Journal of International Economics 99, 68–84.

Georgiadis, G., Müller, G.J., Schumann, B., 2024. Global risk and the dollar. Journal of Monetary Economics , 103549.

Gertler, M., Karadi, P., 2015. Monetary policy surprises, credit costs, and economic activity. American Economic Journal: Macroeconomics 7, 44–76.

Giannone, D., Lenza, M., Primiceri, G.E., 2015. Prior selection for vector autoregressions. Review of Economics and Statistics 97, 436–451.

Gilchrist, S., Zakrajšek, E., 2012. Credit spreads and business cycle fluctuations. American Economic Review 102, 1692–1720.

Gürkaynak, R., Karasoy-Can, H.G., LEE, S.S., 2022. Stock market's assessment of monetary policy transmission: The cash flow effect. Journal of Finance 77, 2375–2421.

Gürkaynak, R.S., Sack, B., Swanson, E.T., 2005. Do actions speak louder than words? The response of asset prices to monetary policy actions and statements. International Journal of Central Banking 1, 55–93.

Hanson, M., Hauser, D., Priftis, R., 2021. Fiscal spillovers: The case of US corporate and personal income taxes. Working Paper 21-41. Bank of Canada.

Jarociński, M., Karadi, P., 2020. Deconstructing monetary policy surprises—the role of information shocks. American Economic Journal: Macroeconomics 12, 1–43.

Jarociński, M., 2022. Central bank information effects and transatlantic spillovers. Journal of International Economics 139, 103683.

Känzig, D.R., 2023. The unequal economic consequences of carbon pricing. Working Paper 31221. National Bureau of Economic Research.

Kaplan, G., Moll, B., Violante, G.L., 2018. Monetary policy according to HANK. American Economic Review 108, 697–743.

Kaplan, G., Nikolakoudis, G., Violante, G.L., 2023. Price level and inflation dynamics in heterogeneous agent economies. Working Paper 31433. National Bureau of Economic Research.

Klein, M., Linnemann, L., 2019. Tax and spending shocks in the open economy: Are the deficits twins? European Economic Review 120, 103300.

Klein, M., Winkler, R., 2021. The government spending multiplier at the zero lower bound: International evidence from historical data. Journal of Applied Econometrics 36, 744–759.

Kuttner, K.N., 2001. Monetary policy surprises and interest rates: Evidence from the Fed funds futures market. Journal of Monetary Economics 47, 523–544.

McKay, A., Wolf, C.K., 2023. What can time-series regressions tell us about policy counterfactuals? Econometrica 91, 1695–1725.

Mertens, K., Ravn, M., 2011. Understanding the aggregate effects of anticipated and unanticipated tax policy shocks. Review of Economic Dynamics 14, 27–54.

Mertens, K., Ravn, M.O., 2012. Empirical evidence on the aggregate effects of anticipated and unanticipated US tax policy shocks. American Economic Journal: Economic Policy 4, 145–81.

Mertens, K., Ravn, M.O., 2013. The dynamic effects of personal and corporate income tax changes in the United States. American Economic Review 103, 1212–47.

Mertens, K., Ravn, M.O., 2014. A reconciliation of SVAR and narrative estimates of tax multipliers. Journal of Monetary Economics 68, S1–S19.

Miranda-Agrippino, S., Nenova, T., 2022. A tale of two global monetary policies. Journal of International Economics 136, 103606.

Miranda-Agrippino, S., Ricco, G., 2021. The transmission of monetary policy shocks. American Economic Journal: Macroeconomics 13, 74–107.

Miyamoto, W., Nguyen, T.L., Sergeyev, D., 2018. Government spending multipliers under the zero lower bound: Evidence from Japan. American Economic Journal: Macroeconomics 10, 247–77.

Nakamura, E., Steinsson, J., 2018. High-frequency identification of monetary non-neutrality: The information effect. Quarterly Journal of Economics 133, 1283–1330.

Paul, P., 2020. The time-varying effect of monetary policy on asset prices. Review of Economics and Statistics 102, 690–704.

Penrose, R., 1956. On best approximate solutions of linear matrix equations. Mathematical Proceedings of the Cambridge Philosophical Society 52, 17–19.

Perotti, R., 2005. Estimating the effects of fiscal policy in OECD countries. Working Paper 4842. Centre for Economic Policy Research.

Párraga Rodríguez, S., 2018. The dynamic effects of public expenditure shocks in the United States. Journal of Macroeconomics 56, 340–360.

Ramey, V.A., 2011. Identifying government spending shocks: It's all in the timing. Quarterly Journal of Economics 126, 1–50.

Ramey, V.A., 2016. Macroeconomic shocks and their propagation, in: Handbook of Macroeconomics. Elsevier. volume 2, pp. 71–162.

Ramey, V.A., Zubairy, S., 2018. Government spending multipliers in good times and in bad: Evidence from US historical data. Journal of Political Economy 126, 850–901.

Romer, C.D., Romer, D.H., 2004. A new measure of monetary shocks: Derivation and implications. American Economic Review 94, 1055–1084.

Romer, C.D., Romer, D.H., 2010. The macroeconomic effects of tax changes: Estimates based on a new measure of fiscal shocks. American Economic Review 100, 763–801.

Romer, C.D., Romer, D.H., 2016. Transfer payments and the macroeconomy: The effects of social security benefit increases, 1952-1991. American Economic Journal: Macroeconomics 8, 1–42.

Sterk, V., Tenreyro, S., 2018. The transmission of monetary policy through redistributions and durable purchases. Journal of Monetary Economics 99, 124–137.

Stock, J.H., Watson, M.W., 2018. Identification and estimation of dynamic causal effects in macroeconomics using external instruments. Economic Journal 128, 917–948.

Swanson, E.T., 2021. Measuring the effects of Federal Reserve forward guidance and asset purchases on financial markets. Journal of Monetary Economics 118, 32–53.

Tenreyro, S., Thwaites, G., 2016. Pushing on a string: US monetary policy is less powerful in recessions. American Economic Journal: Macroeconomics 8, 43–74.

Waggoner, D.F., Zha, T., 2003. A Gibbs sampler for structural vector autoregressions. Journal of Economic Dynamics and Control 28, 349–366.

Appendix

A Additional tables and figures

Table A.1: Data description

Variables	Description	Source	Code
Real GDP	Real gross domestic product (quarterly, seasonally adjusted, billions of chained 2012 Dollars)	FRED[1]	GDPC1
Nominal GDP	Gross domestic product (quarterly, seasonally adjusted, billions of Dollars)	FRED	GDP
GDP deflator	Gross domestic product: chain-type price index (index 2012=100, quarterly, seasonally adjusted)	FRED	GDPCTPI
EBP	Favara et al.'s (2016) updated EBP series (quarterly average, not seasonally adjusted)	Web[2]	ebp
IP	Industrial production index (index 2012=100, monthly, seasonally adjusted)	FRED	INDPRO
CPI	Consumer price index for all urban consumers: all items in US city average (index 1982-1984=100, monthly, seasonally adjusted)	FRED	CPIAUCSL
1y gov. bond yield	1-year treasury constant maturity rate (percent, quarterly average, not seasonally adjusted)	FRED	GS1
Gov. spending	Real government spending (quarterly, seasonally adjusted, billions of 2012 Dollars)	FRED	GCEC1
Tax revenues	Federal government total receipts (quarterly, seasonally adjusted, billions of Dollars)	FRED	W018RC1Q027SBEA
Fiscal expenditures	Federal government total expenditures (quarterly, seasonally adjusted, billions of Dollars)	FRED	W019RCQ027SBEA
Fiscal deficit	(Fiscal expenditures-tax revenues)/nominal GDP		
Soc. transfers	Government social benefits to persons - Social Security[3] (quarterly, billions of Dollars)	FRED	W823RC1
Pers. tax revenues	Personal current taxes plus contributions for government social insurance Federal government current tax receipts, quarterly, seasonally adjusted, billions of Dollars) deflated with the GDP deflator	FRED	(A074RC1Q027SBEA+ W780RC1Q027SBEA)/ GDPCTPI
Corp. tax revenues	Taxes on corporate income minus Federal Reserve Bank income (quarterly, seasonally adjusted, billions of Dollars) deflated with the GDP deflator	FRED	(B075RC1Q027SBEA− B677RC1Q027SBEA)/ GDPCTPI
Interest rate surprise	High frequency policy surprises (changes in the three month ahead federal funds future rate, measured 30 min around FOMC announcements)	Gürkaynak et al. (2022)	FF4
Target factor surprise	Swanson's (2021) federal funds rate factor	Swanson (2021)	
Tax shock proxy	Extended Mertens and Ravn's (2011) narrative tax shocks accounted for anticipation effects	Caldara and Kamps (2017)	
Mertens and Ravn (2011) tax proxy	Mertens and Ravn's (2011) narrative tax shock accounted for anticipation effects	Mertens and Ravn (2011)	
Romer and Romer (2010) tax proxy	Romer and Romer's (2010) narrative tax shock	Romer and Romer (2010)	
Soc. transfer proxy	Extended Romer and Romer's (2016) narrative transfer shock	Párraga Rodríguez (2018)	
Gov. spending proxy	Forecast error government spending	Auerbach and Gorodnichenko (2012)[4]	
Pers. inc. tax proxy	Narrative personal income tax shock	Mertens and Ravn (2013)	
Corp. inc. tax proxy	Narrative corporate income tax shock	Mertens and Ravn (2013)	
Investment	Real gross private domestic investment (quarterly, seasonally adjusted, billions of chained 2017 Dollars)	FRED	GPDIC1
Consumption	Real personal consumption expenditures (quarterly, seasonally adjusted, billions of chained 2017 Dollars)	FRED	PCECC96
Imports	Real Imports of Goods and Services (quarterly, seasonally adjusted, billions of chained 2017 Dollars)	FRED	IMPGSC1
Exports	Real Exports of Goods and Services (quarterly, seasonally adjusted, billions of chained 2017 Dollars)	FRED	EXPGSC1

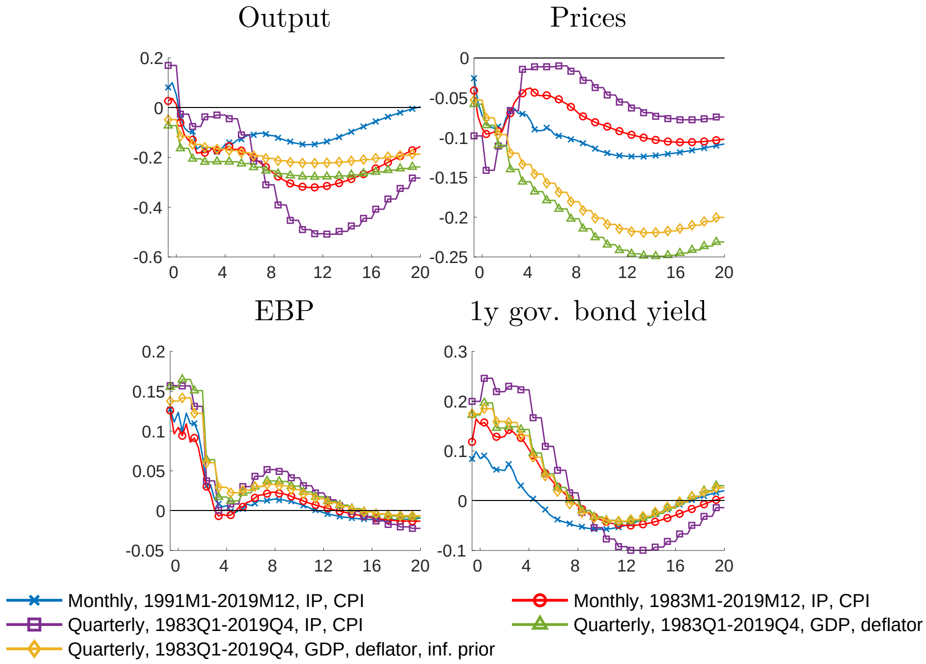
Notes: [1]Federal Reserve Economic Data ; [2]available at `https://doi.org/10.17016/2380-7172.1836`; [3]seasonally adjusted using the standard X12-ARIMA method, developed by the US Bureau of the Census; [4]extended up to the end of our sample in 2019Q4.

Table A.1: Data description (continued)

Variables	Description	Source	Code
Current account	NIPA's Balance on Current Account (quarterly, seasonally adjusted, billions of Dollars) divided by nominal GDP	FRED	NETFI/GDP
Real eff. exch. rate	Real narrow effective exchange rate for United States (quarterly average, index 2020=100, not seasonally adjusted)[3]	FRED	RNUSBIS
Disp. income	Real Disposable Personal Income (quarterly average, seasonally adjusted, billions of chained 2017 Dollars)	FRED	DSPIC96
Private savings	Gross Private Saving (quarterly, seasonally adjusted, billions of Dollars) deflated with the GDP deflator	FRED	GPSAVE/GDPCTPI
Unemp. rate	Unemployment rate (quarterly average, seasonally adjusted, percent)	FRED	UNRATE
Unit labor costs	Unit labor costs for all workers (nonfarm business sector, quarterly, index 2017=100, seasonally adjusted)	FRED	ULCNFB
Productivity	Labor productivity for all workers (nonfarm business sector, output per hour, quarterly, index 2017=100, seasonally adjusted)	FRED	OPHNFB

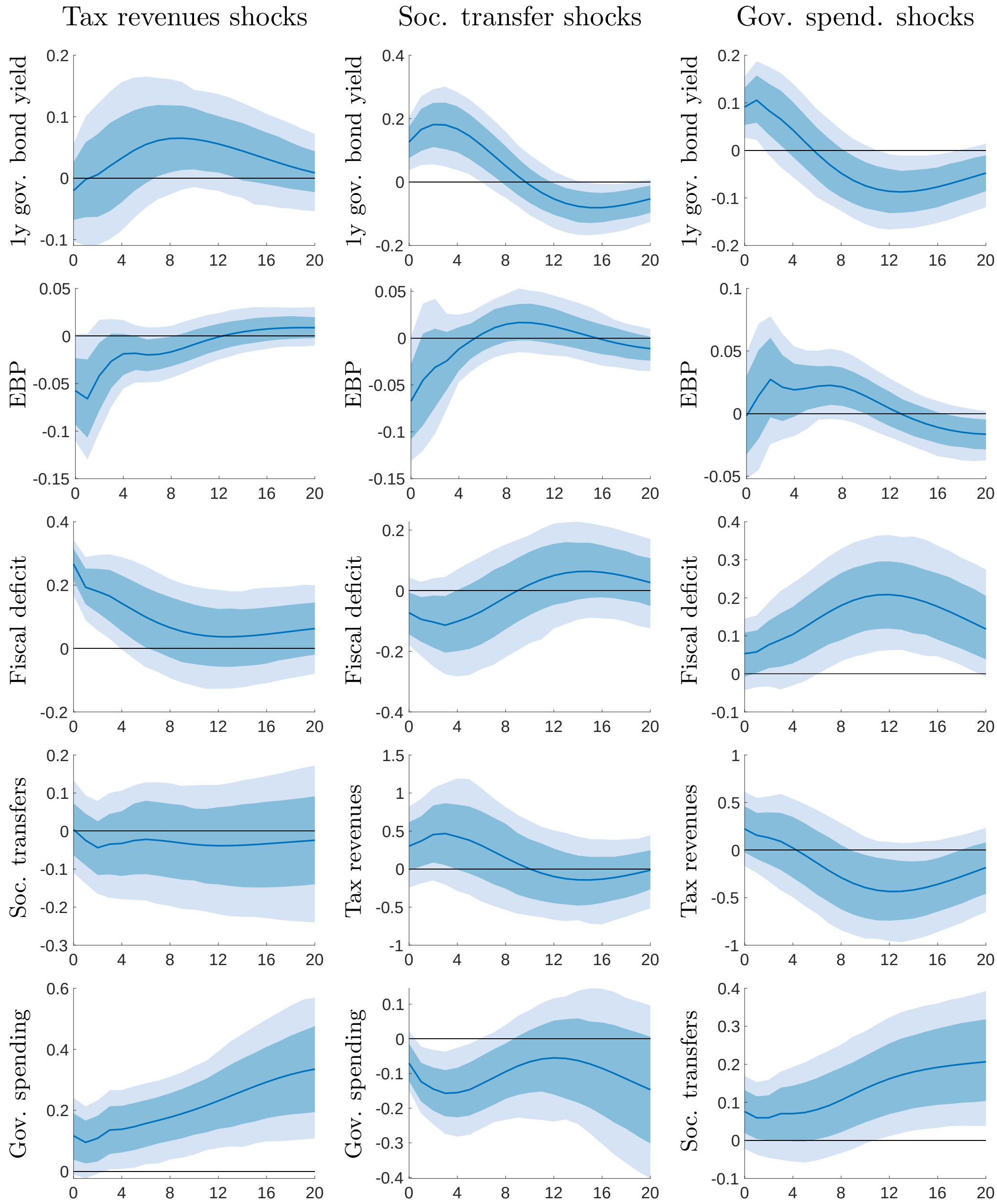
Notes: [1]Federal Reserve Economic Data ; [2]available at `https://doi.org/10.17016/2380-7172.1836`; [3]seasonally adjusted using the standard X12-ARIMA method, developed by the US Bureau of the Census; [4]extended up to the end of our sample in 2019Q4.

Figure A.1: Impulse response functions to a contractionary monetary policy shocks from different data frequencies and sample periods



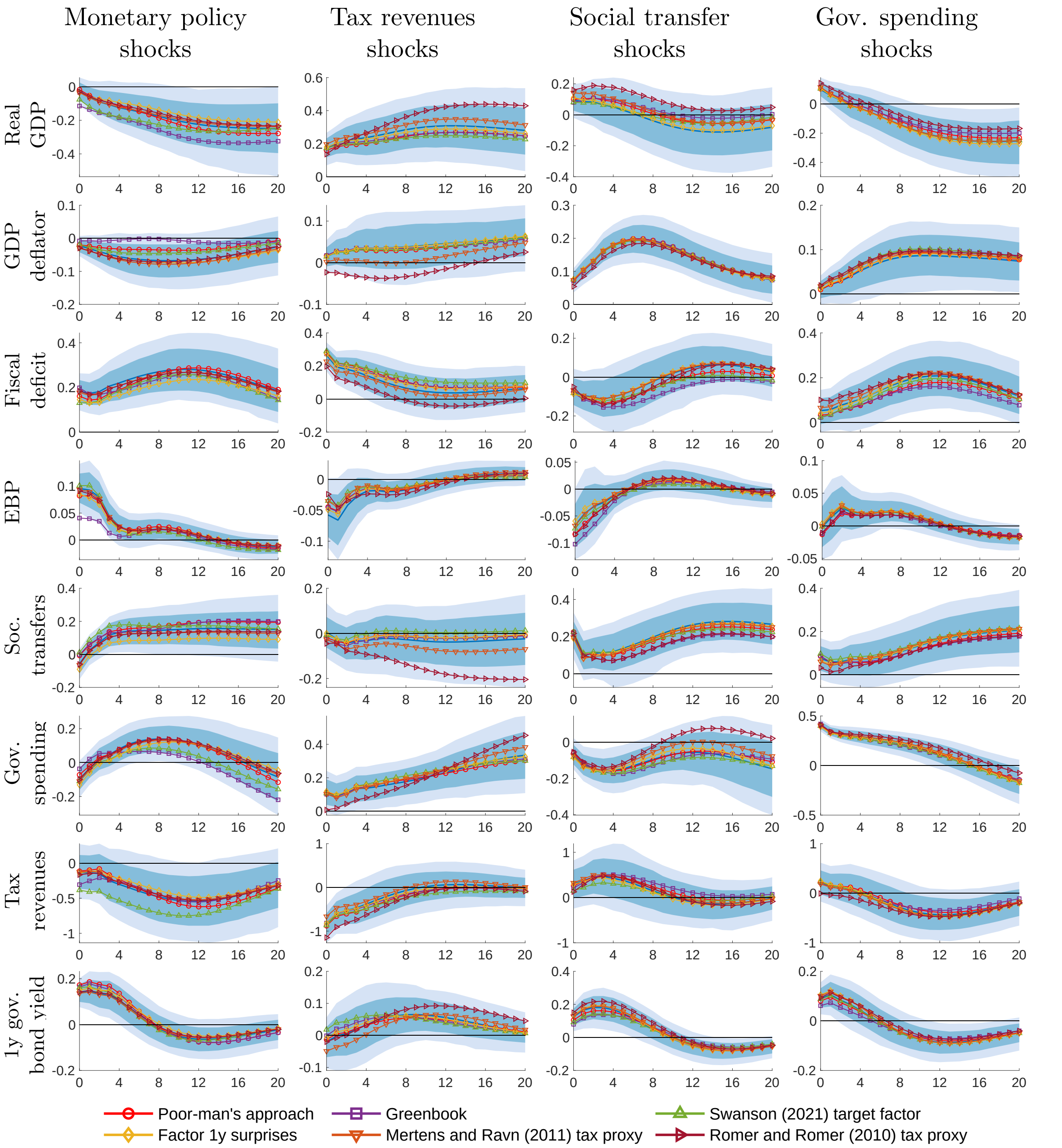
Notes: The lines with markers show the posterior point-wise median impulse responses to a contractionary one standard deviation monetary policy shock from estimations across different samples and data frequencies. The vector of endogenous variables in each estimation includes an output measure (industrial production or real GDP), a price measure (CPI or GDP deflator), the excess bond premium, and the one year government bond yield.

Figure A.2: Additional impulse response functions to expansionary fiscal policy shocks



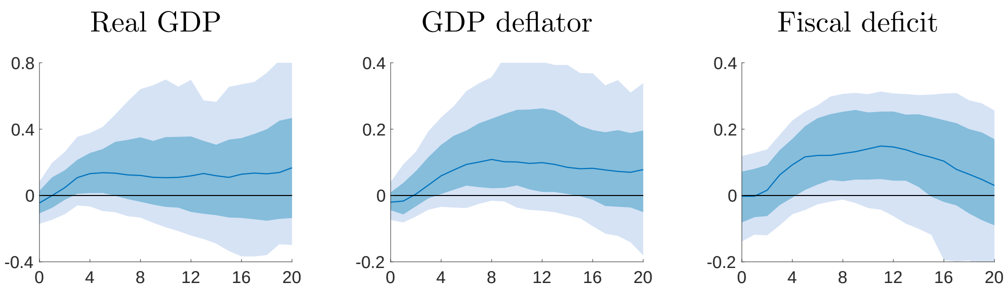
Notes: The lines show the posterior point-wise median values of the baseline impulse responses to an expansionary one standard deviation tax revenue shock (first column), social transfer shock (second column), and government spending shock (third column). The shaded areas represent 68% and 90% centered point-wise probability bands.

Figure A.3: Impulse response functions to contractionary monetary and expansionary fiscal policy shocks from various robustness checks



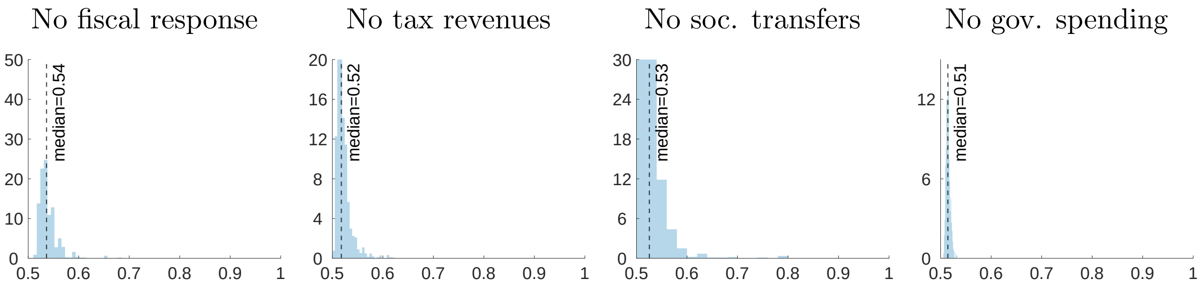
Notes: The lines without markers show the posterior point-wise median impulse responses of the baseline specification to a one standard deviation contractionary monetary policy shock (first column), expansionary revenue shock (second column), expansionary social transfer shock (third column), and expansionary government spending shock (fourth column). The shaded areas represent 68% and 90% centered point-wise probability bands of the baseline specification. The lines with markers show posterior point-wise median impulse responses of alternative specifications. In the specification labelled 'poor-man's approach' and 'Greenbook' we purge the policy surprises from information effects as described in Jarociński and Karadi (2020) and Miranda-Agrippino and Ricco (2021); in 'Swanson (2021) target factor' we use the federal funds rate factor provided by Swanson (2021) purged from information effects (see also Miranda-Agrippino and Nenova, 2022); in 'Factor 1y surprises' we use a factor of interest rate surprises of interest rate derivatives with maturity up to one year (see, e.g., Nakamura and Steinsson, 2018); and in 'Mertens and Ravn (2011) tax proxy' and 'Romer and Romer (2010) tax proxy' we either use the tax proxy provided by Mertens and Ravn (2011) or Romer and Romer (2010) and set missing values to zero.

Figure A.4: Difference between baseline and counterfactual impulse responses



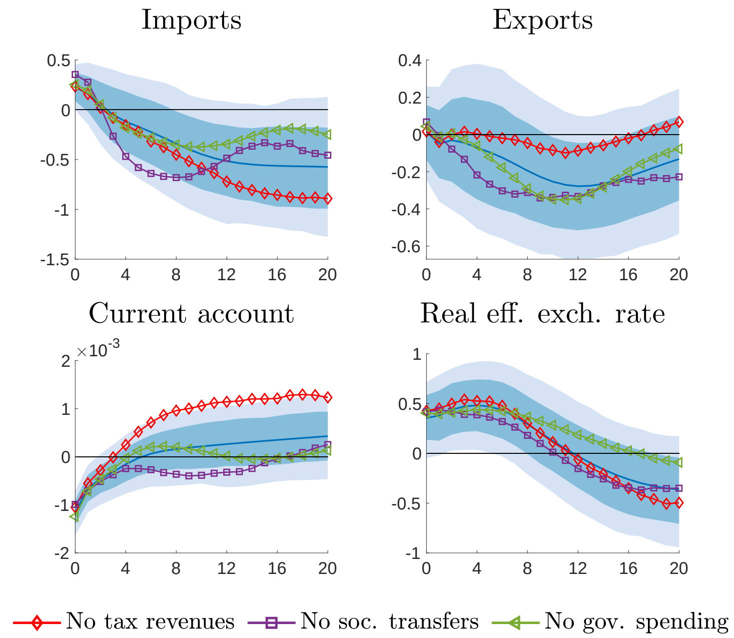
Notes: The lines show the posterior point-wise median of the difference between the baseline impulse responses to a contractionary one standard deviation monetary policy shock and the counterfactual impulse responses when all endogenous fiscal responses—tax revenues, social transfers, and government spending—are simultaneously neutralized. The shaded areas represent 68% and 90% centered point-wise probability bands. We discard counterfactuals when the offsetting shock at the end of the forecast horizon is larger (in absolute terms) as compared to the offsetting shock on impact.

Figure A.5: q-divergence of Antolín-Díaz et al. (2021)



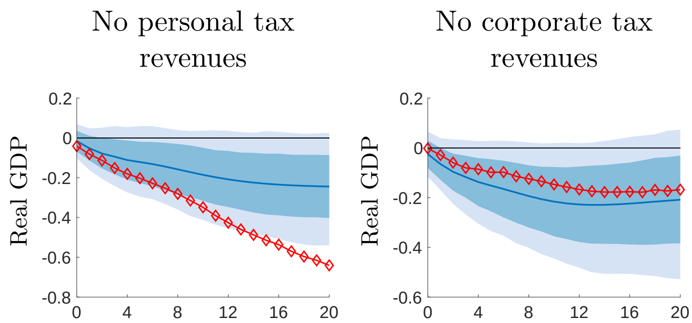
Notes: The histograms show the distribution of the q-divergence of Antolín-Díaz et al. (2021) for the counterfactual impulse responses when either all endogenous fiscal responses are simultaneously neutralized (first column), or when the individual fiscal response of tax revenues (second column), social transfers (third column), or government spending (fourth column) is neutralized separately. The y-axis is measured in percent.

Figure A.6: Impulse responses and counterfactuals of imports, exports, the current account, and the real effective exchange rate



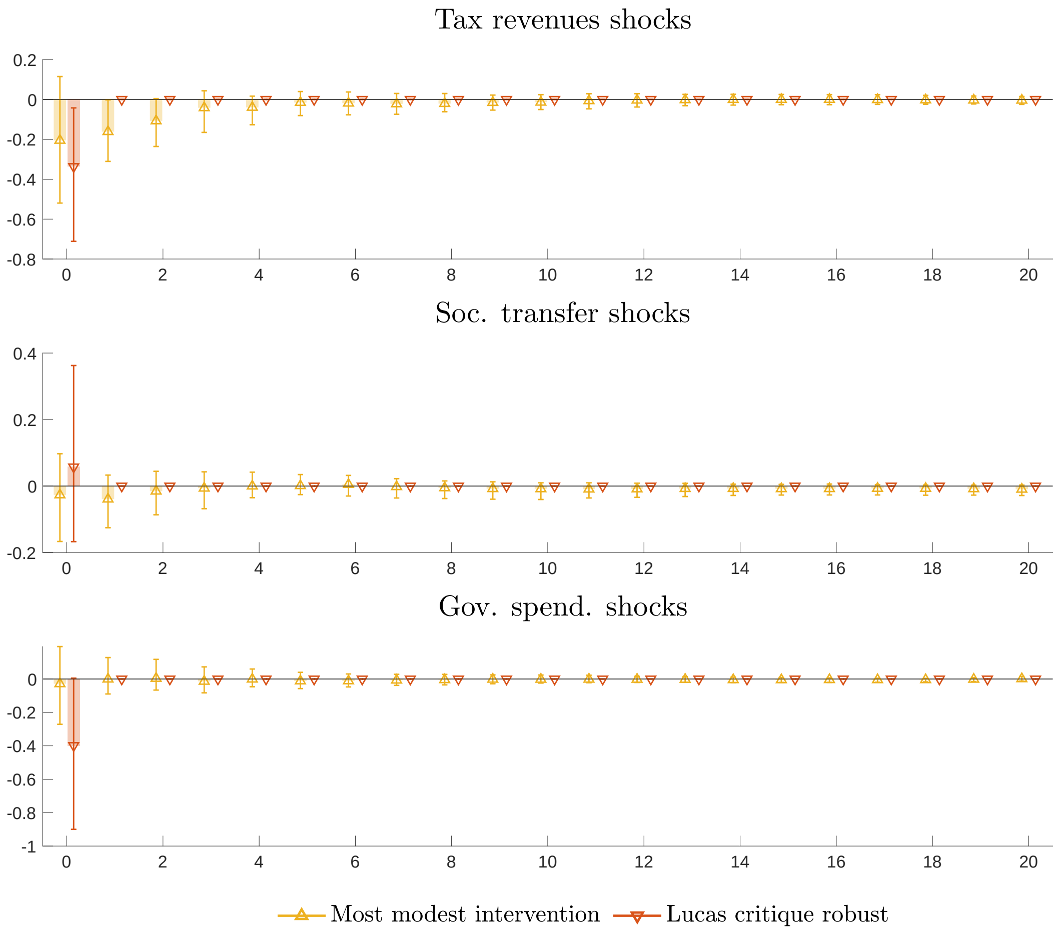
Notes: The lines without markers show the posterior point-wise median values of the baseline impulse responses to a contractionary one standard deviation monetary policy shock. The lines with markers depict the posterior point-wise median values of the counterfactual impulse responses when either the response of tax revenues (diamonds), social transfers (squares), or government spending (triangles) is neutralized separately. The median values of the corresponding q-divergence statistics lie between 0.51 and 0.52. The shaded areas represent 68% and 90% centered point-wise probability bands for the baseline impulse responses.

Figure A.7: Impulse responses and counterfactuals using personal versus corporate income tax



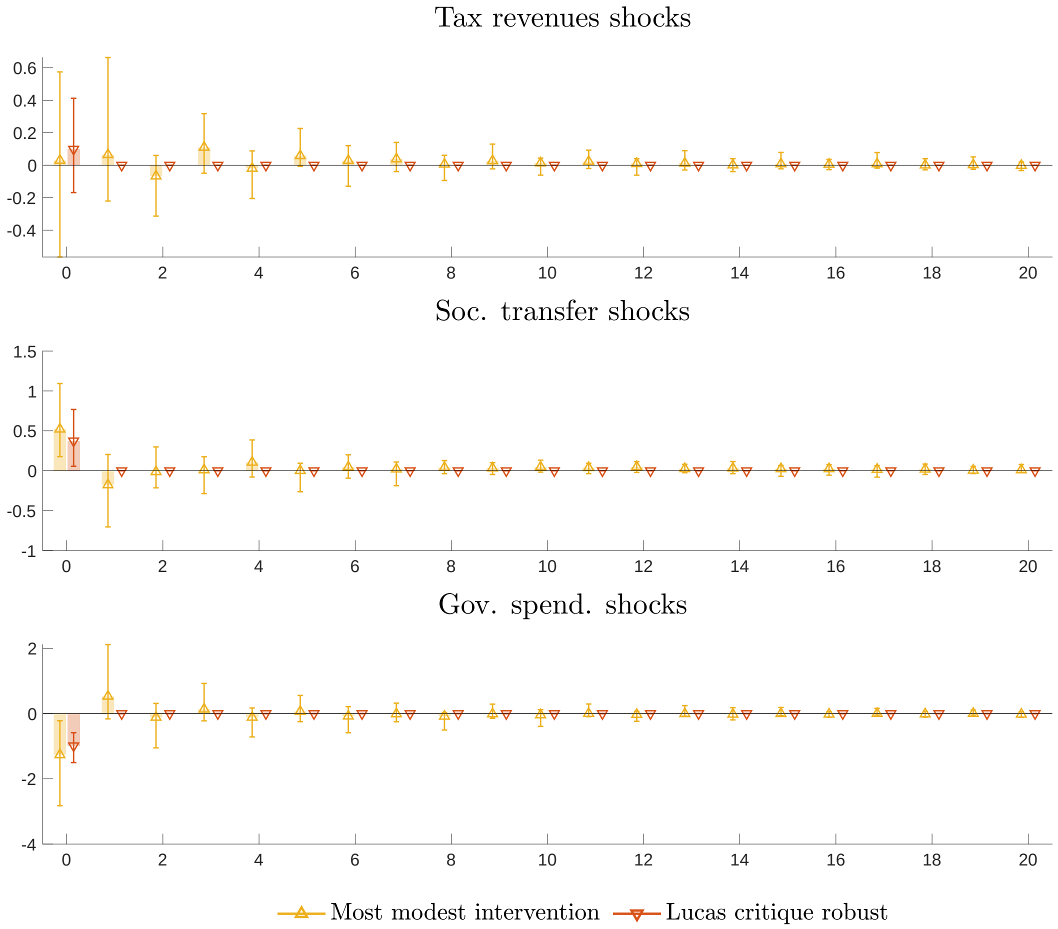
Notes: The lines without markers show the posterior point-wise median values of the baseline impulse responses to a contractionary one standard deviation monetary policy shock and the lines with circles depict the posterior point-wise median values of the counterfactual impulse responses when either the response of personal tax revenues (first column), or corporate tax revenues (second column) is neutralized. The median values of the corresponding q-divergence statistics are 0.51 and 0.53. The shaded areas represent 68% and 90% centered point-wise probability bands for the baseline impulse responses.

Figure A.8: Neutralizing shocks in the fiscal-activism policy counterfactuals



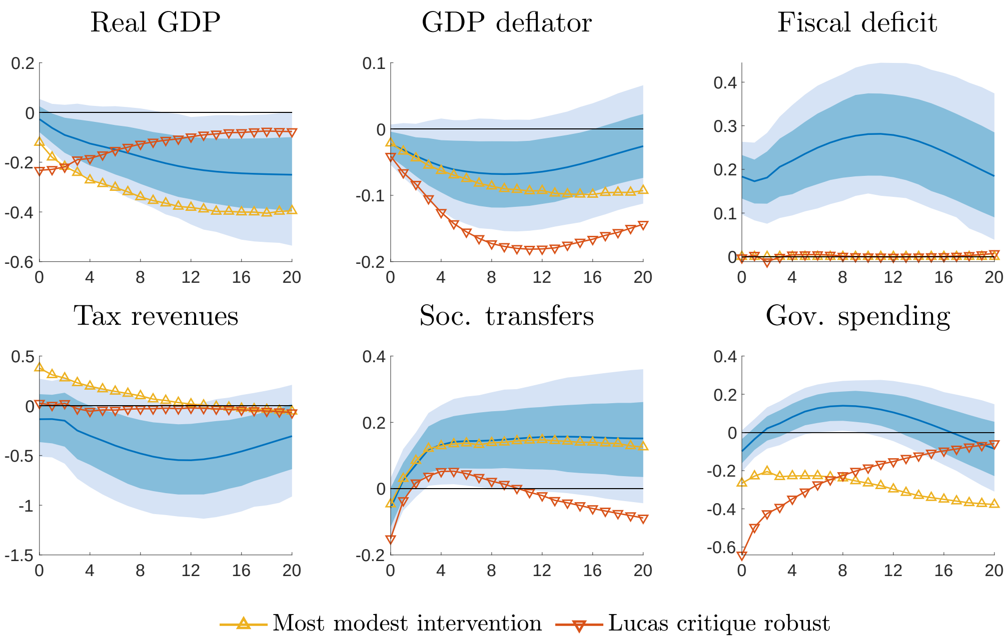
Notes: The bars indicate the point-wise median prevalence of fiscal shocks to impose the fiscal-activism rule over the forecasting horizon h. The counterfactual policy rule is imposed using all three fiscal policy shocks either over the entire impulse horizon (upward-pointing triangles) or only on impact (downward-pointing triangles). The whiskers indicate 68% centered point-wise probability bands.

Figure A.9: Neutralizing shocks in the constrained-fiscal policy counterfactuals



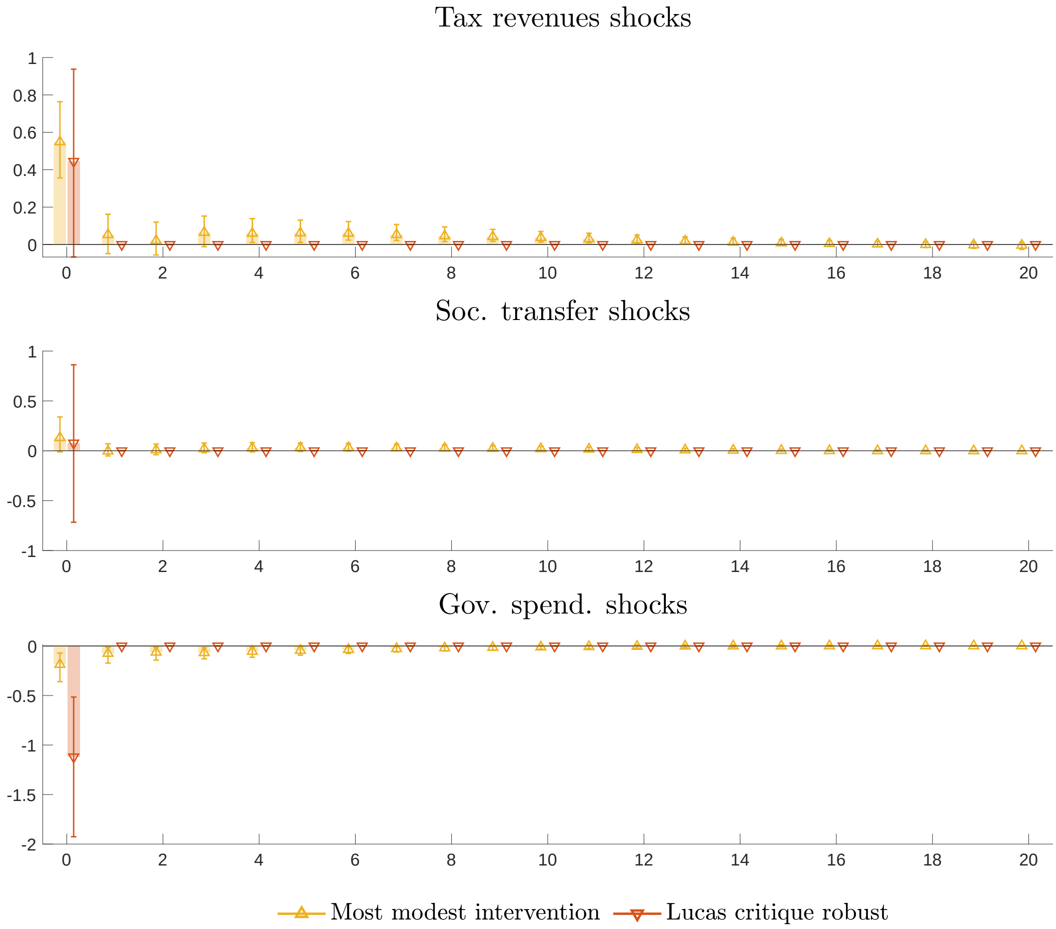
Notes: The bars indicate the point-wise median prevalence of fiscal shocks to impose the fiscal-activism rule over the forecasting horizon h. The counterfactual policy rule is imposed using all three fiscal policy shocks either over the entire impulse horizon (upward-pointing triangles) or only on impact (downward-pointing triangles). The whiskers indicate 68% centered point-wise probability bands.

Figure A.10: Impulse responses and counterfactual responses in the no-deficit scenario



Notes: The lines without markers show the posterior point-wise median values of the baseline impulse responses to a contractionary one standard deviation monetary policy shock. The lines with markers depict the posterior point-wise median values of the counterfactual impulse responses when the fiscal deficit is neutralized using all three fiscal policy shocks either over the entire impulse horizon (upward-pointing triangles) or only on impact (downward-pointing triangles). The median values of the corresponding q-divergence statistic are 0.52 and 0.55. The shaded areas represent 68% and 90% centered point-wise probability bands for the baseline impulse responses.

Figure A.11: Neutralizing shocks in the no-deficit policy counterfactuals



Notes: The bars indicate the point-wise median prevalence of fiscal shocks to impose the no-deficit rule over the forecasting horizon h. The counterfactual policy rule is imposed using all three fiscal policy shocks either over the entire impulse horizon (upward-pointing triangles) or only on impact (downward-pointing triangles). The whiskers indicate 68% centered point-wise probability bands.

B Contemporaneous zero restriction in the BPSVAR

The reduced form of the model in Equation (1) is

$$\widetilde{\boldsymbol{y}}_t = \widetilde{\boldsymbol{A}}_0^{-1}\widetilde{\boldsymbol{c}} + \sum_{l=1}^{p} \widetilde{\boldsymbol{A}}_0^{-1}\widetilde{\boldsymbol{A}}_l \widetilde{\boldsymbol{y}}_{t-l} + \widetilde{\boldsymbol{A}}_0^{-1}\widetilde{\boldsymbol{\varepsilon}}_t, \tag{B.1}$$

where the inverse of $\widetilde{\boldsymbol{A}}_0$ is given by

$$\widetilde{\boldsymbol{A}}_0^{-1} = \begin{bmatrix} \underset{(n\times n)}{\boldsymbol{A}_0^{-1}} & \underset{(n\times k)}{\boldsymbol{0}} \\ \underset{(k\times n)}{-\boldsymbol{\Gamma}_{0,2}^{-1}\boldsymbol{\Gamma}_{0,1}\boldsymbol{A}_0^{-1}} & \underset{(k\times k)}{\boldsymbol{\Gamma}_{0,2}^{-1}} \end{bmatrix} \equiv \begin{bmatrix} \underset{(n\times n)}{\boldsymbol{A}} & \underset{(n\times k)}{\boldsymbol{0}} \\ \underset{(k\times n)}{\boldsymbol{B}} & \underset{(k\times k)}{\boldsymbol{C}} \end{bmatrix}. \tag{B.2}$$

Then, the reduced form equations of the proxy variables are

$$\boldsymbol{m}_t = \begin{bmatrix} \boldsymbol{B} & \boldsymbol{C} \end{bmatrix} \widetilde{\boldsymbol{c}} + \sum_{l=1}^{p} \begin{bmatrix} \boldsymbol{B} & \boldsymbol{C} \end{bmatrix} \widetilde{\boldsymbol{A}}_l \widetilde{\boldsymbol{y}}_{t-l} + \boldsymbol{B}\boldsymbol{\varepsilon}_t + \boldsymbol{C}\boldsymbol{\nu}_t. \tag{B.3}$$

Given that the k structural shocks of interest are the last k elements of $\boldsymbol{\varepsilon}_t$, i.e. $\boldsymbol{\varepsilon}_t' = [\boldsymbol{\varepsilon}_t^{o\prime}, \boldsymbol{\varepsilon}_t^{*\prime}]$, the exogeneity condition $E[\boldsymbol{m}_t\boldsymbol{\varepsilon}_t^{o\prime}] = \boldsymbol{0}$ implies that the first $n-k$ columns of $\boldsymbol{B}$ are set to zero:

$$\widetilde{\boldsymbol{A}}_0^{-1} = \begin{bmatrix} \underset{(n\times n)}{\boldsymbol{A}} & \underset{(n\times k)}{\boldsymbol{0}} \\ \left(\underset{(k\times n-k)}{\boldsymbol{0}} \quad \underset{(k\times k)}{\boldsymbol{V}} \right) & \underset{(k\times k)}{\boldsymbol{C}} \end{bmatrix}. \tag{B.4}$$

The relevance condition requires that $\boldsymbol{V}$ is non-singular. As the number of zero restrictions is larger than $\widetilde{n}(\widetilde{n}-1)/2$ Arias et al. (2021) use the Gibbs sampler of Waggoner and Zha (2003).

Following Caldara and Herbst (2019), we require that the proxies are relevant instruments (see also Mertens and Ravn, 2013). Specifically, we impose that each of the identified shocks accounts for at least 10% of the variance of the respective proxy variable. Arias et al. (2021) show that these restrictions imply that the minimum eigenvalue of the reliability matrix $\boldsymbol{R} = (\boldsymbol{V}\boldsymbol{V}' + \boldsymbol{C}\boldsymbol{C}')^{-1}\boldsymbol{V}\boldsymbol{V}'$ lies above 0.1.

C Specification of selection matrices in the structural counterfactuals

C.1 Restrictions on $\overline{n}$ observables with $\overline{k}$ neutralizing shocks over forecast horizon h

We study structural counterfactuals with restrictions on a different number of observables, and considering a different number of neutralizing shocks. In the first counterfactual, in which all three fiscal measures are set to zero by a combination of the three respective fiscal policy shocks, $\overline{n} = \overline{k} = 3$. When we zoom in and shut-off the fiscal measures separately, $\overline{n} = \overline{k} = 1$. In both cases, we set

$$\underset{(\overline{n}h\times nh)}{\boldsymbol{O}} = \boldsymbol{I}_h \otimes \boldsymbol{I}'_{(n,\boldsymbol{e}_n^o)} \tag{C.5}$$

$$\underset{((n-\overline{k})h\times nh)}{\boldsymbol{S}} = \begin{bmatrix} \boldsymbol{I}_h \otimes \boldsymbol{e}_n^{mp} \\ \boldsymbol{I}_h \otimes \boldsymbol{I}'_{(n,\boldsymbol{e}_n^s)} \end{bmatrix} \tag{C.6}$$

$$\underset{((n-\overline{k}+\overline{n})h\times 1)}{\boldsymbol{f}_{\tau+1,\tau+h}} = \begin{bmatrix} \boldsymbol{0}_{(\overline{n}h\times 1)} \\ \boldsymbol{e}_h^{mp\prime} \\ \boldsymbol{0}_{((n-\overline{k}-1)h\times 1)} \end{bmatrix}, \tag{C.7}$$

where $\boldsymbol{e}_n^o$ is a $1 \times n$ vector of zeros with unity in $\overline{n}$ positions corresponding to the position of the restricted observables in $\boldsymbol{y}_{\tau+1}$, selecting $\overline{n}$ columns of $\boldsymbol{I}_n$, $\boldsymbol{e}_n^{mp}$ is a $1 \times n$ vector of zeros with unity in the position of the monetary policy shock in $\boldsymbol{\varepsilon}_{\tau+1}$, $\boldsymbol{e}_n^s$ is a $1 \times n$ vector of ones with zeros in $\overline{k}$ positions, selecting all columns of $\boldsymbol{I}_n$ except the columns corresponding to the $\overline{k}$ neutralizing shocks, and $\boldsymbol{e}_h^{mp}$ is a $1 \times h$ vector of zeros with unity in the first position.

To restrict prices in the policy counterfactuals to respond similar to the (unrestricted) baseline response over h horizons, we define $\boldsymbol{\theta}_h^{mp}$ to represent the baseline impulse responses of prices to the monetary policy shock over h periods, and order prices after output and the fiscal deficit in $\boldsymbol{y}_{\tau+1}$. Moreover, to incorporate discounting in the policy counterfactuals, we replace $\boldsymbol{I}_h$ in Equation (C.5) with $\boldsymbol{P}$, where $\boldsymbol{P}'\boldsymbol{P} = \boldsymbol{W}$, with $\boldsymbol{P}$ capturing the upper triangular Cholesky factor of the $h \times h$ discounting matrix $\boldsymbol{W}$ in Equation (8), and set

$$\underset{((n-\overline{k}+\overline{n})h\times 1)}{\boldsymbol{f}_{\tau+1,\tau+h}} = \begin{bmatrix} vec\begin{pmatrix} \mathbf{0}'_{((\overline{n}-1)\times h)} \\ \boldsymbol{P}\boldsymbol{\theta}_h^{mp\prime} \end{pmatrix} \\ \boldsymbol{e}_h^{mp\prime} \\ \mathbf{0}_{((n-\overline{k}-1)h\times 1)} \end{bmatrix}, \tag{C.8}$$

where $vec(\cdot)$ stacks the columns vertically.

C.2 Restrictions on $\overline{n}$ observables with $\overline{k}$ neutralizing shocks on impact only (as in McKay and Wolf, 2023)

In case of the McKay and Wolf (2023) policy counterfactual, where the neutralizing fiscal policy shocks are allowed to materialize only on impact, we set

$$\underset{(\overline{n}h\times nh)}{\boldsymbol{O}} = \boldsymbol{P}\otimes \boldsymbol{I}'_{(n,\boldsymbol{e}_n^o)} \tag{C.9}$$

$$\underset{(n-\overline{k}\times n)}{\boldsymbol{S}} = \begin{bmatrix} \boldsymbol{e}_n^{mp} \\ \boldsymbol{I}'_{(n,\boldsymbol{e}_n^s)} \end{bmatrix} \tag{C.10}$$

$$\underset{(n-\overline{k}+\overline{n}h\times 1)}{\boldsymbol{f}_{\tau+1,\tau+h}} = \begin{bmatrix} \mathbf{0}_{((\overline{n}-1)h\times 1)} \\ \boldsymbol{\theta}_h^{mp} \\ 1 \\ \mathbf{0}_{(n-\overline{k}-1\times 1)} \end{bmatrix}. \tag{C.11}$$

C.3 Translating the McKay and Wolf (2023) solution to the general solution of Antolín-Díaz et al. (2021)

McKay and Wolf (2023) suggest to solve an under-identified counterfactual by selecting the linear combination of neutralizing shocks that impose the counterfactual constraints 'as well as possible', represented by the following minimization problem (replicating Equation 31 in their paper with similar notation):

$$\min_{s}\left\|\widetilde{\mathcal{A}}_x(\boldsymbol{x}_A(\boldsymbol{\varepsilon})+\boldsymbol{\Omega}_{x,A}\times \boldsymbol{s})+\widetilde{\mathcal{A}}_z(\boldsymbol{z}_A(\boldsymbol{\varepsilon})+\boldsymbol{\Omega}_{z,A}\times \boldsymbol{s})\right\|, \tag{C.12}$$

where $\boldsymbol{x}$ and $\boldsymbol{z}$ capture n_x macroeconomic observables and n_z policy instruments; $\{\widetilde{\mathcal{A}}_x, \widetilde{\mathcal{A}}_z\}$ are $h\times n_x h$ and $h\times n_z h$ selection matrices imposing the counterfactual policy rule; $\boldsymbol{x}_A(\boldsymbol{\varepsilon}) =$

$\boldsymbol{\Theta}_{x,\varepsilon,A} \times \boldsymbol{\varepsilon}$ and $\boldsymbol{z}_A(\boldsymbol{\varepsilon}) = \boldsymbol{\Theta}_{z,\varepsilon,A} \times \boldsymbol{\varepsilon}$ with $\{\boldsymbol{\Theta}_{x,\varepsilon,A}, \boldsymbol{\Theta}_{z,\varepsilon,A}\}$ being the $n_x h \times n_\varepsilon$ and $n_z h \times n_\varepsilon$ stacked baseline impulse responses of $\{\boldsymbol{x}, \boldsymbol{z}\}$ to n_ε non-neutralizing shocks $\boldsymbol{\varepsilon}$; and $\boldsymbol{\Omega}_{x,A} = \boldsymbol{\Theta}_{x,s,A}$ and $\boldsymbol{\Omega}_{z,A} = \boldsymbol{\Theta}_{z,s,A}$ capture the $n_x h \times n_s$ and $n_z h \times n_s$ stacked baseline impulse responses to n_s neutralizing shocks $\boldsymbol{s}$.

Consider $\boldsymbol{S} = [\mathbf{0}_{1\times n_s}, \mathbf{0}_{1\times n_\varepsilon - 1}, 1]$, and $\boldsymbol{f}_{\tau+1,\tau+h} = [\mathbf{0}_{1\times h}, 1]'$, if the shock of interest is ordered last. Moreover, let $\boldsymbol{O} = [\widetilde{\mathcal{A}}_z, \widetilde{\mathcal{A}}_x]$, $\boldsymbol{\Theta}' = [\boldsymbol{\Theta}'_{z,s+\varepsilon,A}, \boldsymbol{\Theta}'_{x,s+\varepsilon,A}]$ with $\boldsymbol{\Theta}_{z,s+\varepsilon,A} = [\boldsymbol{\Theta}_{z,s,A}, \boldsymbol{\Theta}_{z,\varepsilon,A}]$ and $\boldsymbol{\Theta}_{x,s+\varepsilon,A} = [\boldsymbol{\Theta}_{x,s,A}, \boldsymbol{\Theta}_{x,\varepsilon,A}]$, and $\overline{\boldsymbol{\varepsilon}}'_{\tau+1} = [\boldsymbol{s}', \boldsymbol{\varepsilon}']$, then the under-identified system in Equation (C.12) can be more compactly written as

$$\begin{pmatrix} \boldsymbol{O}\boldsymbol{\Theta} \\ \boldsymbol{S} \end{pmatrix} \overline{\boldsymbol{\varepsilon}}_{\tau+1} = \boldsymbol{f}_{\tau+1,\tau+h}. \tag{C.13}$$

With $\boldsymbol{C}' = [\boldsymbol{O}', \boldsymbol{\Theta}^{-1\prime}\boldsymbol{S}']$ we obtain the same under-identified problem as in Equation (7):

$$\boldsymbol{C}\boldsymbol{\Theta}\overline{\boldsymbol{\varepsilon}}_{\tau+1} = \boldsymbol{f}_{\tau+1,\tau+h}. \tag{C.14}$$

McKay and Wolf (2023) approximate the solution using the method of least squares, meaning $\overline{\boldsymbol{\varepsilon}}_{\tau+1} = (\boldsymbol{D}'\boldsymbol{D})^{-1}\boldsymbol{D}'\boldsymbol{f}_{\tau+1,\tau+h}$, where $\boldsymbol{D} = \boldsymbol{C}\boldsymbol{\Theta}$. The solution of Antolín-Díaz et al. (2021) is given by $\overline{\boldsymbol{\varepsilon}}_{\tau+1} = \boldsymbol{D}^*\boldsymbol{f}_{\tau+1,\tau+h}$, where $\boldsymbol{D}^*$ is the Moore-Penrose inverse of $\boldsymbol{D} = \boldsymbol{C}\boldsymbol{\Theta}$. The two solution are identical as $\boldsymbol{D}^* = (\boldsymbol{D}'\boldsymbol{D})^{-1}\boldsymbol{D}'$ (see Corollary 2 in Penrose, 1956).

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The Fiscal Channel of Monetary Policy

Abstract
This paper empirically quantifies the importance of fiscal policy in shaping the monetary policy transmission mechanism and derives implications for monetary-fiscal interactions. First, we document that a contractionary monetary policy shock, besides lowering output and prices, leads to a pronounced adjustment in fiscal measures and a significant increase in the fiscal deficit. We then construct different structural counterfactuals, in which we shut down the endogenous responses of fiscal measures following a monetary policy shock. The conduct of fiscal policy significantly shapes the monetary transmission mechanism: the impact of a monetary policy shock on prices is more than halved by the endogenous adjustment in public transfers, whereas the tax system significantly reduces the effect on output. We show that changes in the fiscal framework can enhance monetary policy effectiveness.

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